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How to identify Unidentified Flying Objects (UFOs)? How to investigate Anomalous Aerospace Phenomena (AAP)?

Reference book

Under the general editorship of I. Kalytyuk

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The reference book "How to identify Unidentified Flying Objects (UFOs)? How to investigate Anomalous Aerospace Phenomena (AAP)?" was conceived back in 2013 by Igor Kalytyuk, with the goal of separating UFO identification and AAP study from the quasi-scientific subculture called Ufology and putting an end to this dispute. To show that it is possible to investigate AAP and identify UFOs within the framework of already recognized scientific disciplines, therefore, there is no need to create a separate science to multiply existence without necessity *"pluralitas non est ponenda sine neccesitate"*.

We are not ufologists; UFO identification does not deal with extraterrestrials, does not deal with observations without material evidence and data to which the scientific method cannot be applied, but we can consider independent group observations and data from monitoring complexes and drones. UFO identification is a full-fledged scientific interdisciplinary direction that unites scientists and volunteers. UFO identification has a clear terminology and methodology and invites scientists and everyone who adheres to this vision to cooperate. Unlike ufology, UFO identification requires serious training, and not only the ability to recognize all known natural and man-made phenomeвna, but also the ability to understand modern military experimental developments, distinguish between little-studied natural phenomena, the human factor, and recognize fakes. And the purpose of the AAP study is to investigate little-studied natural phenomena, or copy technologies of unidentified anomalous objects, etc.

For 80 years, scattered efforts around the world have produced fragments of data, occasional insights, and endless debate. After all, the typical problem of all these ufologists is that they “reinvent the wheel” over and over again. The main thing is to learn to ask yourself: what is the purpose of doing this? What do we want to achieve? What is needed for this? What was missing was not curiosity, but coherence – a unified methodological framework, a common language, and a set of tools designed for verification rather than belief. This guide aims to become that framework. It is written freely, without funding or institutional backing, yet with the conviction that rigor, transparency, and collaboration are worth more than any budget.

The reference book is written in English solely for the convenience of translation into other foreign languages. Anyone willing to translate or add something useful is invited to cooperate.

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This work combines not only the work by Igor Kalytyuk (M.Sc.) and Alina Mykolyshyn (M.Sc.), but also a lot of material by Clas Svahn, Dorit Thormeyer (Ph.D.), Jochen Ickinger (M.Sc.), Volodymyr Mantulin, Volodymyr Rubtsov (Ph.D.), Oleksandr Beletsky (M.A.), Eduard Yermilov (Ph.D.), Sergey Yefimov (Ph.D.), Michail Gershtein, Sergiy Petrov, Alexandr Kartuzhansky (Ph.D.), Ryom Varlamov (Ph.D.), Mathieu Ader, David Morgan (Ph.D.), Artem Bilyk (Ph.D.), Olexiy Kirichenko (M.Sc.), Yevhen Kovalenko (Ph.D.), Yuriy Raytarovsky, Ruben Lianza, Milton Hourcade, Vicente-Juan Ballester Olmos, Francois Louange (Ph.D.) and many others.

I express my gratitude for ideas, corrections and moral support in writing the book to: Michail Gershtein, Sergey Yefimov (Ph.D.), Clas Svahn, Alina Mykolyshyn (M.Sc.), Dorit Thormeyer (Ph.D.), Jochen Ickinger (M.Sc.), Sergiy Petrov, Ruben Lianza, Wim van Utrecht, Manuel Borraz Aymerich, Milton Hourcade, Vicente-Juan Ballester Olmos, Aliona Bespalenko (M.Sc.), Julia Nechayeva, Andriy Chvartkovsky (M.Sc.), Artem Bilyk (Ph.D.), Francois Louange (Ph.D.).

Preface

Modern world is making such progress that even most ambitious futurologists could only have dreamt about just half a century ago. Never before have scientists had an opportunity to rely on extensive experience and bring together powerful means for exploring the outside World, as they do today. However, research tools and relevant skills alone are not sufficient to push and drive forward our cognition. Any breakthrough begins with becoming aware of an anomaly, that is with establishing the fact that the nature we see around us has somehow did not justify our expectations anticipated by dominant paradigms, which direct the scientific advances. Prehistoric people lived in close contact with anomalies, or phenomena of the outside World. Its explanatory aspect (according to them) was based on an intelligible basis founded on limited life experience. Obviously, such a situation is impossible. Anomalous phenomena are non-periodic fast-flowing phenomena that are actually observed in the environment. However, they remain only in the form of a descriptive part of the parameters and characteristics, without explanation within the boundaries of concepts and the composition of the existing scientific paradigm. Thus, the actual goal of research into anomalous aerospace phenomena is to form a scientific picture of such phenomena as part of the scientific image of the World as a whole.

In this reference book the methodology of visual and instrumental observation of an object or phenomenon, the work of a stationary monitoring complex, a mobile monitoring complex, a field mobile laboratory, and the training of specialists are clearly described. A detailed catalog of natural and man-made phenomena that can serve as a source of errors in identification has been created. The methodology for collecting samples of material at the site of exposure is influence: geochemical, cytological, biological analyses, metrological measurements, and much more.

We prefer use the old terms **UFO** (unidentified flying object) and **AAP** (anomalous aerospace phenomenon) from the 60s and 70s instead of the newfangled ones, not UAP (unidentified/unrecognized aerial/aerospace phenomena), not AOP (aerospace objects and phenomena), not NPTPE (non-periodic transient phenomena in the environment) etc. But we do not exclude the use of new terms, everyone chooses a term that is convenient for them. Because it makes no sense for me to invent a new term, I'm not collecting evidence for some belief, my task is to identify the phenomenon. And if it has factors of anomaly, then distribute them into working catalogs for further study, for example, if it is some new drone/missile - study it with the aim of copying technologies; if it is some interesting natural phenomenon, then investigate it in more detail and describe it; and so on... Although a logical innovation would be the term **NIIVS** (not initially identified visual stimulus) this covers covers every scenario, even if it is only drones or military secret programs. They are all visual stimuli which have not been immediatly identified. Even if the stimulus is seen through a radar screen, regardless of it being real or a radar glitch, the operator still gets a visual stimulus in his brain. And, best of all, it does not intend to introduce any idea on an extraordinary, exotic, phenomenon, neither does it exclude it.

I want to make the reference book universal not only for identifiers; but also for those who build monitoring complexes with the aim of creating or including it in the existing global monitoring network (in the future, one way or another, it will be planetary in scale, so to speak, planetary defense); for those who study the influence of the human factor, are looking for a motive; many ways can be applied - then the project will live and develop, many researchers will take it as a basis, take it into account in their own research. To be a point of support, so to speak, this guide is called the "Breakthrough" project, its continuation will be called "Fulcrum", a support for those who want to create a commission in their country to identify UFOs, or something else...

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Igor M. Kalytyuk

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Education:

• National University of Water Management and Nature Management, Rivne, Ukraine (Master's degree, 2010);
• European University, Kyiv, Ukraine (specialist, second higher education, 2013)
• Dozens of other training certificates: drones, electronic warfare, optical networks, work at height, etc. (since 2025) IT-handyman, installation-service of network, video surveillance, cosmetic and cash register equipment, etc. (since 2002)

Analytical activity:

• Head of ISRC "EIBC" (2009–2014);
• Editor and creator of the project "Enlightenment": Ufology News www.ufology-news.com (since 2011) and YouTube channel "UFO and AAP scientifically" (since 2023);
• Conducted examinations of UFO and AP testimonies received from the State Committee of Ukraine for Hydrometeorology (Goskomhydromet) from 1990 to 2018; License IPACO with CNES/GEIPAN and Airbus/DS (since 2024);
• He has carried out or organized the process of digitizing and subsequently with the aim of declassifying more than 6,000 UFO reports, as well as thousands of Soviet-era documents, as an expert of the information and technical department of SRCAA "Zond" is located in Kyiv Polytechnic University in Aircraft and Space systems department also as a separate unit, a member organization of the Aerospace Society of Ukraine and "Knowledge" Society of Ukraine (since 2014);
• Conducted a long-term experiment (2013-2025), within the framework of which was created create an expert council "Ufology News" for UFO-identification, some of the experts went through an open selection and training program among readers, a total of 273 messages were received for processing in the array of primary messages: 125 messages were rejected (insufficient quantitative or qualitative data to perform the examination, or wrong address); and 26 messages were identified as optical effects - glare, bokeh, aberrations; 25 birds or insects out of focus; 14 air and mylar helium balloons, aerostats, weather balloons; 10 computer fakes, fakes; 9 astronomical objects; 8 pareidolia; 6 airplanes, drones, copters, hang gliders; 6 artificial satellites; 5 Chinese lanterns; 4 rocket launch effects; 4 signal lights, flare bombs on parachutes; 4 reflections in glass from a bright light source; 3 clouds; 3 meteorites, condensation trails; 3 the reflection of snowflakes; 3 drops of water; 2 airborne navigation lights; 2 lamps, spotlights; 2 dust, dirt in the frame; 2 matrix overexposure; one each toroidal vortex, anti-twilight rays, round-horizontal arc, glow, halo, Tyndall effect, geoseismic work, laser, glass defect, man-made geoglyph, tree trunk, tree leaf, spider web.

Scientific research:

• Project coordinator within the ISRC "EIBC": "Enlightenment" (since 2011), "Global archive UAP-study and UFO-identification" the largest online archive on UFO and SETI topics (since 2011), "Cold Fog" (2011-2016), "Unification" (2009-2014, 26 people who claimed to have been abducted by aliens were tested: where 7 testimonies were found to be false, 8 are suspected of various forms of mental disorders, 5 have obvious ASCs and only 6 have been selected, which have yet to be studied).
• Coordinator of the "Breakthrough" project within the ISRC "EIBC" (since 2013) – where one of the goals is writing and distributing this reference book. The "Fulcrum" project is in the process of development (since 2025).

Skills:

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Education:

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• Special course of Doctor of Sciences, Professor Rudolf Krause, Germany, Hannover "Psychodynamic Diagnostics" (2008);

• School of Analytics of the International Center for Promotion and Development of UNESCO Programs and Projects, Lviv, Ukraine (2010-2013).

Analytical activities:

• Correspondent of "Forum International", Rome, Italy, Lviv, Ukraine (2012-2020);

• Head of ISRC "EIBC" (2012–2013) and expert of the system-analytical department of SRCAA "Zond is located in Kyiv Polytechnic University in Aircraft and Space systems department also as a separate unit, a member organization of the Aerospace Society of Ukraine and "Knowledge" Society of Ukraine (since 2014);

• Methodologist of the software department of NU LP, Lviv, Ukraine (2016–2018);

• Analyst (internship) CCA, Kyiv, Ukraine (2021–2022).

Scientific research:

• Developer and author of the analytical measurement technique "to-1.0–1.1-tests" in the Subject-oriented research program of the intellectual system of a witness of an anomalous phenomenon: respondents were tested within the framework of the "Unification" project, ISRC "EIBC" (2009–2014).

Skills:

-methodological developments and writing of scientific articles, books, reference books, bulletins, assistance with collections, editing and publishing of videos, etc.

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Section 1. Visual and instrumental observation of the phenomenon

1.1. Behavior of an eyewitness when an object or phenomenon appears

First of all, if you notice something strange in the sky, the main thing is not to rush to convince yourself that this is something anomalous. It is worth gathering all your self-control and calmly concentrating on this phenomenon or object. If what you saw hardly fits into the framework of explanations, try to draw the attention of people nearby to it. This will increase the credibility of the case, since other eyewitnesses may observe details that a single observer may miss. Because visual non-group observations have limited reliability. If the object is moving, pay attention to its speed (fast, smooth, jerky, etc.). If the speed changed during the flight, then note how this happened. If there is more than one object, you can remember the general nature of the movement of the entire group of objects. Follow the direction of the object's movement, not necessarily along the cardinal points, it is enough to look towards familiar landmarks. Make a visual description of the shape of the object, and then the main components of it if the distance allows. If the movement or "hovering" of an object is accompanied by light effects, trace their direction and nature. Assess the angular dimensions of the object, or measure the linear dimensions (length) of the object. If the object is in a stationary position, measure the approximate angle to the horizon, or you can sketch the object on paper. And it is even better if you have a photo or video camera at hand. It is advisable to take photos and videos in a stable position, fixing the photo or video camera motionless; do not use digital zoom or other software "special effects". It can sometimes be useful to take a shaken shot as well, in order to detect any unnoticed intensity fluctuation from a luminous object, for example, it may reveal 100 or 120 Hz light flicker related to the frequency for alternating-current power (50 or 60 Hz, depending on the country). If the object is very bright: protect your eyes from strong infrared and ultraviolet radiation, use sunglasses of the 3rd or 4th protection category (18-3% light transmission), with photochromic or polarized absorption technology and interference of light reflection.

1.2. Actions of an eyewitness to register their observation

Immediately after the observation, record the time from the observation/appearance of the object until its complete disappearance. This does not require special accuracy, it is enough to simply indicate the time interval (for example: from 23:40 to 0:10; or, for small intervals - 17:30, observation for about a minute). Pay attention to what the weather conditions were. This primarily concerns cloudiness and visibility of stars (at night). If the object was above a certain level of clouds, it is enough to simply remember the nature of this layer. This data is recorded directly during the observation, or restored from memory soon in the same place.
See also: Questionnaire on observation of an unidentified object or phenomenon in the appendix.

1.3. Determining the size in angular degrees

To find out the distance between the observer and the observed object and its angular size in degrees, simple actions should be performed during observation.

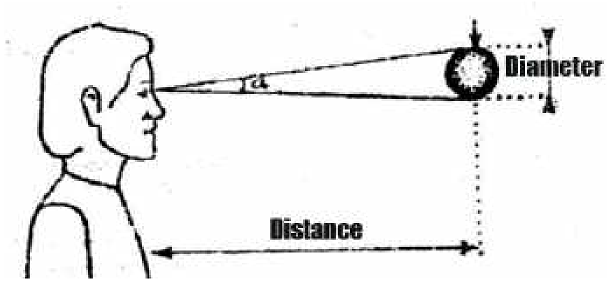


Fig.1.1 The observer sees the object at an angle α, which depends only on the ratio of the diameter of the object to its distance (M. Shevchenko)

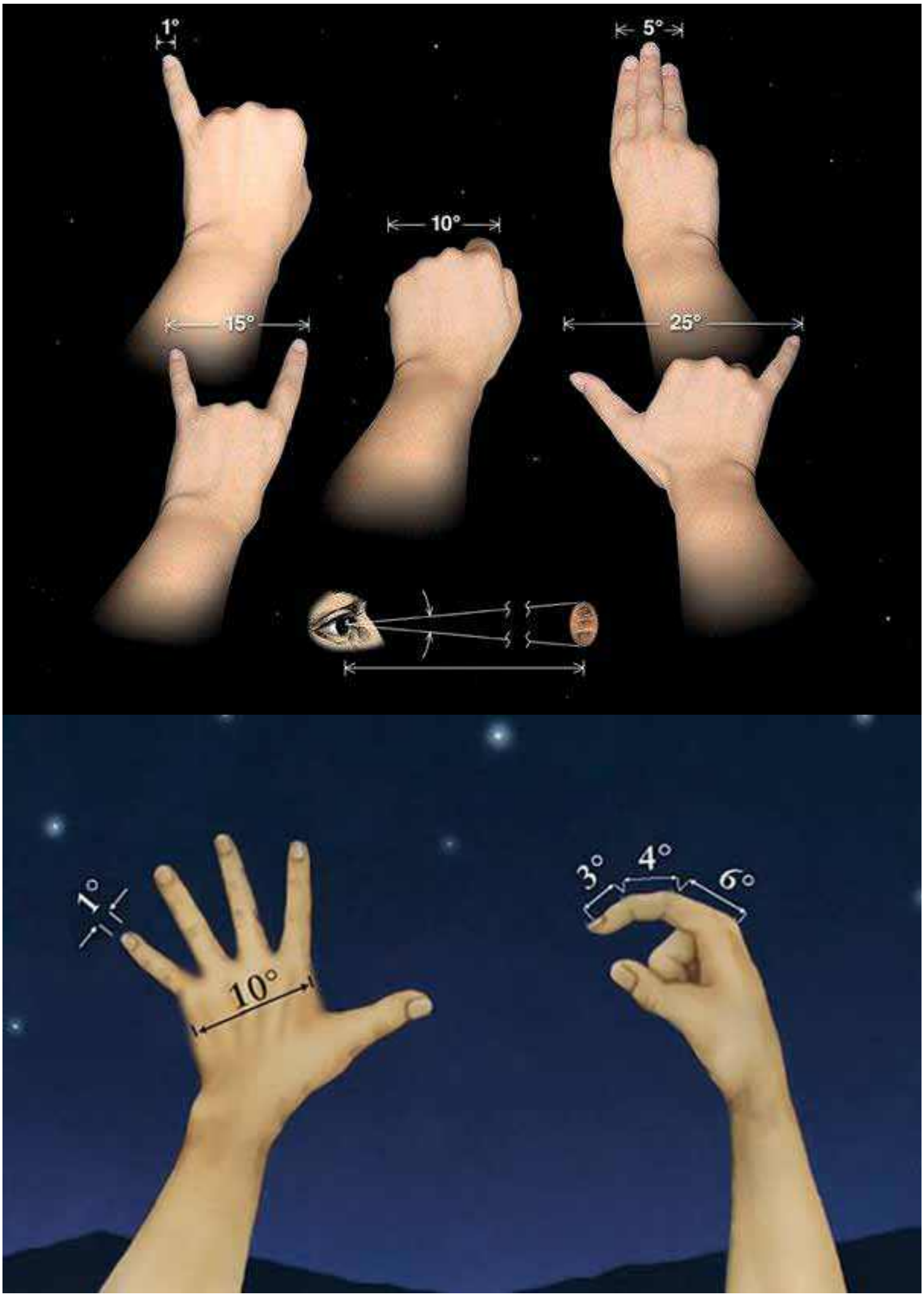


Fig.1.2 Determining angular size in degrees using hand. But these angular distances are not exact, each person has different palm proportions, so the figure shows approximate angular distances, each person should calibrate themselves before making these kinds of estimates. (CC/GFDL)

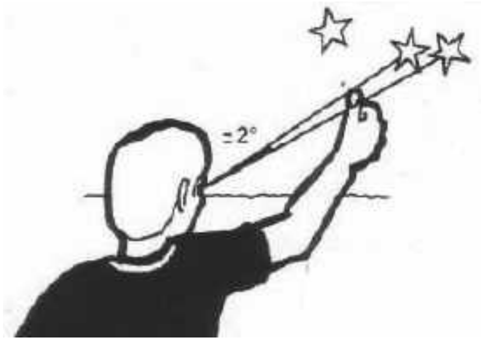


Fig.1.3 If you stretch your hand in front of your eyes, the nail of your thumb will have an angular size of approximately 2° of arc (D. Robin, GEPAN)

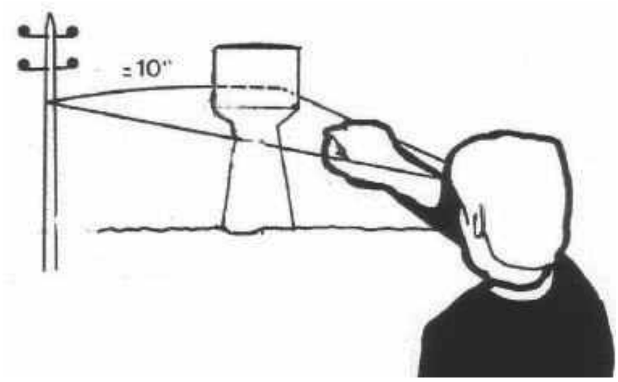


Fig.1.4 If you stretch your hand in front of your eyes, the fist will have an angular size of approximately 10° of arc (D. Robin, GEPAN)

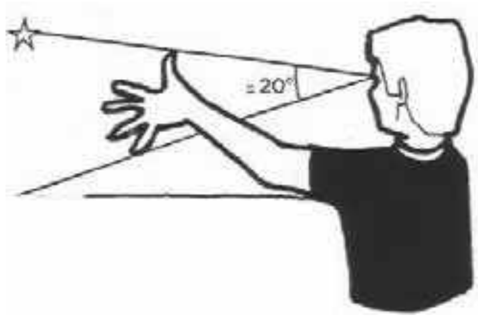


Fig.1.5 If you stretch your hand in front of your eyes, the angular distance from the little finger to the thumb will be approximately 20° of arc (D. Robin, GEPAN)

Table 1.1. Angular size of objects at arm's length

Subject	Size (mm)	Angle*
Matchstick: Thickness	2	10'
Matchstick: length	43	3°50'
The width of the thumb on the hand	27	2°20'
Fist	120	10°
Pencil: length	178	14°25'

**The angles are determined based on the fact that the distance from the observer's eye to the fingertips of an outstretched arm is 70 cm.*

At an angle of 20° from 5 meters you can see a person of average height
At an angle of 10° from 25 meters you can see a car, from 1.5 meters – a football
At an angle of 2° from 290 meters you can see a bus
At an angle of 0.5° you can see the Sun and the Moon in the sky, and from 200 meters – a person of average height.

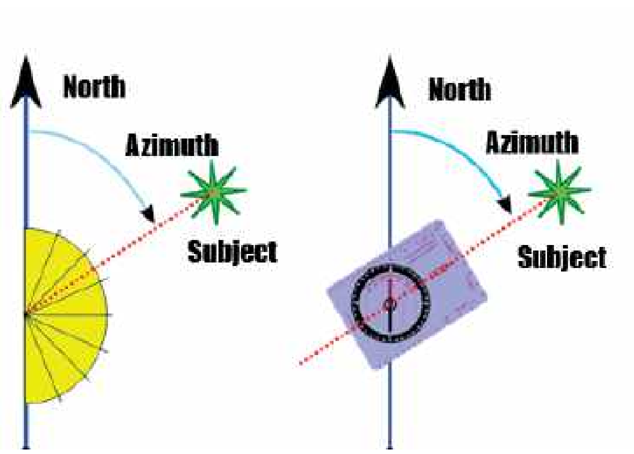


Fig.1.6 Determining azimuth using a compass (CC/GFDL)

An angular degree is a common unit of measurement of plane angles, 1° = 2π/360° = π/180° radians = 1°/ρ°, 1° = 1/360 of a turn, 1° = 400/360 grads, this value is also used to determine the azimuth. The angular size is determined by the angle at which the object is observed. The angle α depends on the ratio of the diameter of the observed object and the distance to it and can be approximately found by the formula:

$$\alpha = \frac{\text{diameter}}{\text{distance}} \times 57^\circ \quad (1.1)$$

Obviously, both the diameter and the distance, when substituted into the formula, must be displayed in the same unit (centimeters, meters).

Table 1.2 Angular units of measurement

unit	**value**	**designation**	**abbreviation**	**approximate radian**
degree	1/360 circumference	°	deg	17,4532925 mrad
minute	1/60 of a degree	′	arcmin, amin, $\hat{\prime}$, MOA	290,8882087 μrad
second	1/60 minutes	″	arcsec	4,8481368 μrad
millisecond	1/1000 of a second		mas	4,8481368 nrad
microsecond	1×10^{-6} seconds		μas	4,8481368 prad

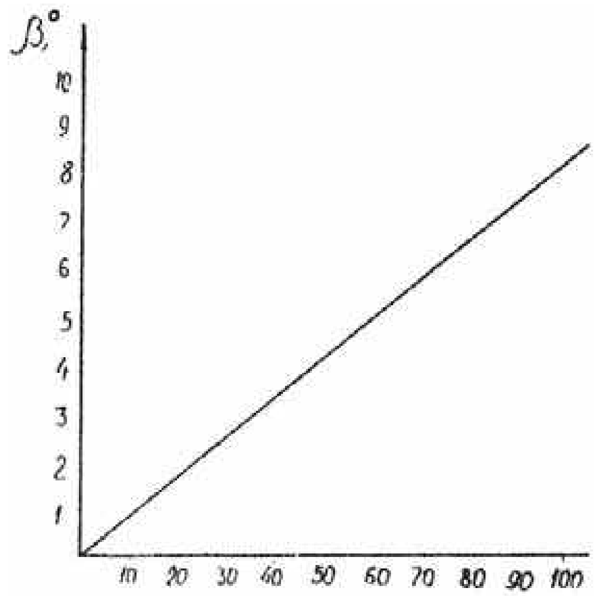


Fig. 1.7 Graph of recalculation *of angular dimensions into linear ones from distance (V. Mantulin)*

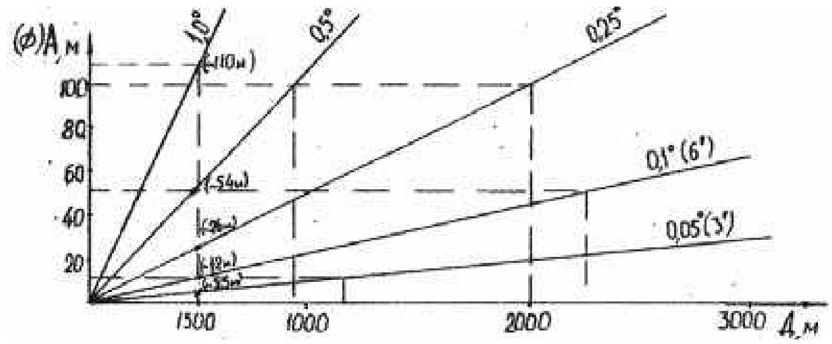


Fig. 1.8 Graph of recalculation of angular dimensions into linear distances (V. Mantulin)

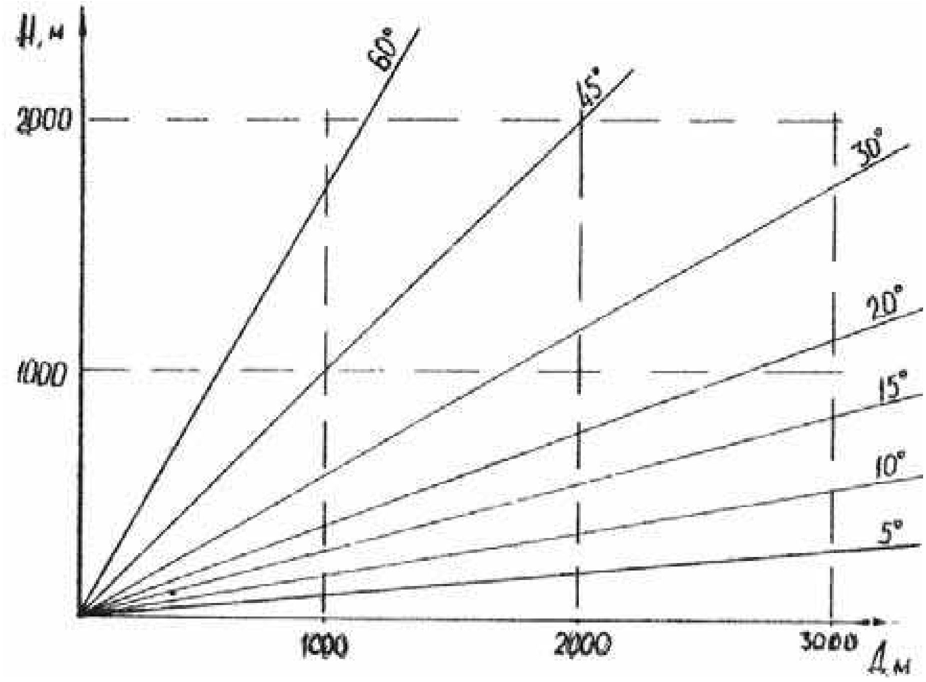


Fig. 1.9 Graph of recalculation of object height from angular height and distance (V. Mantulin)

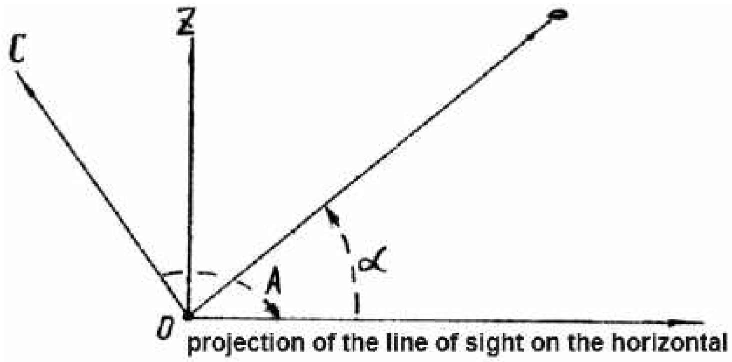


Fig.1.10 Scheme of radial coordinates of the observation object (V. Mantulin)

The distance to an object can be reliably measured only when the object of study is relatively close. Human binocular vision allows us to estimate distances no further than 60-100 meters. Beyond this distance, measuring distances with the naked eye loses all meaning:
- when observing unusual phenomena, the human imagination is especially capable of exaggerating what is observed;
- all information received by our senses undergoes corresponding processing in the brain, which sometimes leads to various kinds of perception errors;
- if you look at a stationary luminary for a certain period of time, in the vicinity of which there are no reference points, then a persistent perception of the movement of this object arises;

- there is a reverse effect of perception, when during observation of uniform movement of an object in a straight line, for example, an artificial satellite of the Earth (AES), an eyewitness "sees" that the object stops or changes its trajectory of movement;
- the distance from the observer to the object, between which there is open space, is usually underestimated;
- bright objects are perceived as closer than dark ones, and this effect is enhanced by increasing the contrast between the color of the object and the background;
- long objects in a horizontal orientation seem longer and more distant than vertical ones;
- during the day, the Sun has a certain influence on the assessment of distance: if the observer stands facing the Sun, the distance seems smaller, and if with his back to it, then it seems greater;
- at night, bright objects seem to be closer than they actually are;
- in open terrain, for a person of average height, the horizon line is approximately 4.5 km away;
- an object will become clearly visible if its dimensions exceed three degrees of arc;
- the most accurate dimensions of an object are determined when it is at eye level.

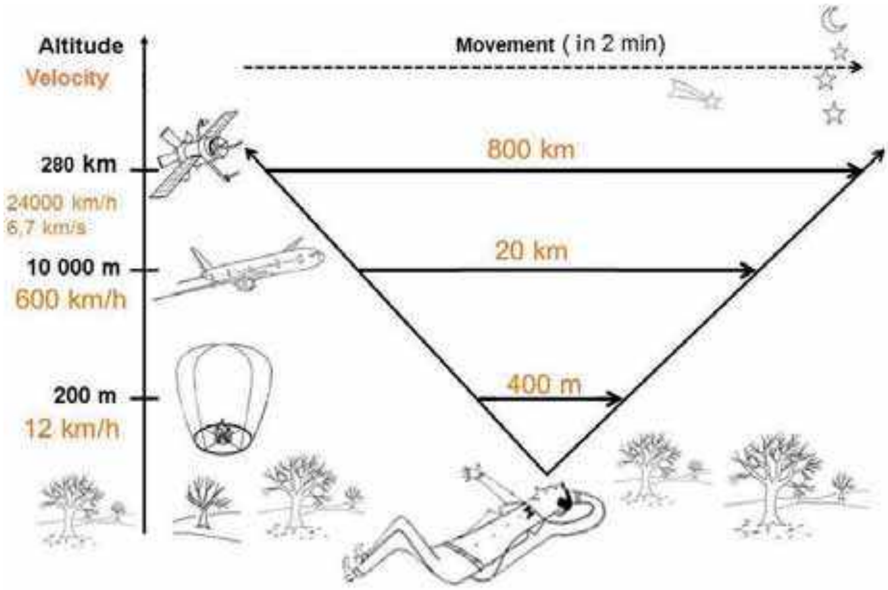


Fig.1.11 Example of ambiguity of visual estimates of 60 meters and less than 1° of arc (GEIPAN)

A person with a very keen eyesight can perceive a depth of space of up to 1-1.5 km, but there cannot be any precise distance estimates, only vague sensations of “closer-farther”.

Table 1.3 Brightness assessment in comparison with known phenomena

Famous object	Stellar magnitude
Planet Venus	-4
Star Sirius	-1.5
Star of the Ursa Major constellation	2
Less bright stars in the countryside	4

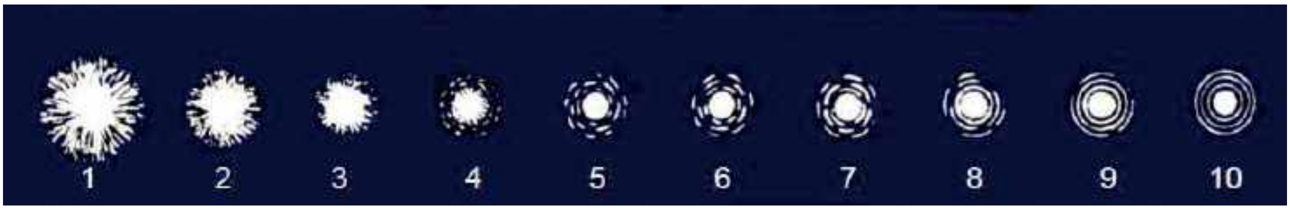
The transparency of the atmosphere is not constant and depends on the meteorological conditions: even a change in wind direction can significantly affect this indicator. The content of aerosols in the air decreases significantly after heavy rains, as well as after the arrival of clean and cold air masses. Some aerosols "leave" the atmosphere when dew falls. The degree of transparency of the atmosphere is accurately measured using a polariscope, since the presence of even a small amount of aerosols in the air significantly reduces the degree of polarization of the air. During the day, with a transparent atmosphere, the appearance and setting of cumulus clouds behind the horizon is visible, the sky has a clear turquoise color, and at an altitude of ≈30° above the horizon, a greenish tint. The halo of diffused light around the Sun does not exceed several degrees. The color of the halo is also an indicator of transparency: with an increase in the proportion of aerosols, it changes in the following sequence: sapphire, blue, steel, whitish, golden. Accordingly, the length of the halo also increases: from 2-3° to 30° and more. On lunar nights, there is no halo around the Moon (to make sure of this, the Moon's disk must be covered with a small screen).

In addition to artificial illumination, there is natural sky illumination, which is made up of the total illumination of all space objects and the illumination of the Earth's atmosphere. The level of natural illumination is the same in the city and outside of it.

Table 1.4 Transparency of the atmosphere

Observation conditions	**LM, m**	**SB, m/arcsec²**	**Objects for observation**	**Signs**
Center of a 1 million city	2	≈16,0	Moon, planets	The entire sky glows brightly (like white or reddish). Only the brightest stars and planets are visible
Outskirts of 1-million city or full moon	3	≈17,0	Planetary nebulae, the brightest objects in the Messier catalog	Faint constellations, the handle of the UMi dipper, the Milky Way are not visible. M45 – with difficulty. Only stars brighter than 2^m are visible near the horizon.
20 km from the outskirts of the 1 million city or twilight	4	≈18,0	Messier objects, bright NGC objects	The sky is whitish. The brightest parts of the Milky Way are visible. Bright glow of the sky at the horizon
35 km from the outskirts of a 1 million city or astronomical twilight	5	19,5	Comets, meteor showers, NGC objects, dark nebulae	Good visibility of the Milky Way. M33 is visible in binoculars. M31, M44 are visible to the naked eye. Clouds are brighter than the background, light pollution near the horizon
100 km from the city. Moonless night	6	21,0	Faint comets, extended nebulae	Faint parts of the Milky Way are visible. Zodiacal light is visible in autumn and spring, M33 is visible with averted vision, M13 with direct vision. The sky is brighter towards the horizon
A place with an excellent view of the sky	7	22,0	All types of observations	Zodiacal light (band), M33 visible to the naked eye. Many faint stars and clusters. Clouds darker than the sky.

Where LM is the limiting stellar magnitude visible to the naked eye; SB is the brightness of the sky background. At LM>4, the following dependence is observed: $SB = 24{,}19 – 2{,}814 \times LM + 0{,}369 \times LM^2$



d>3 2”<d<3 1.2”<d<2” 0,6”<d<1,2” d<0,6”

Fig. 1.12 Perking's 10-point scale for assessing the state of the atmosphere (N. Andrianov, A. Marlensky)

Fig.1.13 Example of the presence of subjective assessments and problems with visual acuity (C. Svahn)

1.4. Definition of size in milliradian of an arc

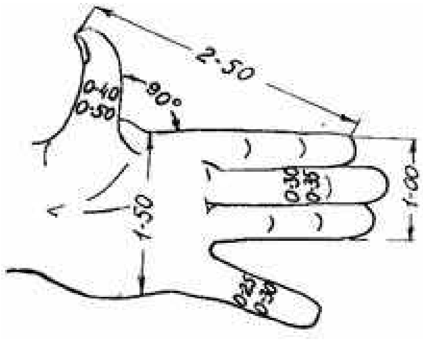


Fig.1.14 Determining milliradian using your hand (Y. Raitarovsky)

Milliradian is the central angle subtended by an arc equal to 1/6000 of the circumference of a circle or 1/1000 of the radius of that circle. Ratios: 1° = 6000/360° = 16.7, rounded to 17 milliradian, or 0-17, 0 – 01 = 360°/6000 = 0°,06 = 3,6'

The visual determination of an angle consists of comparing the measured angle with the known one. The angular value, or goniometric "value" of fingers, a fist, a match, a pencil, a coin and other handy object in milliradian is determined as follows. The measured value of a given handy object is divided by the length of the observer's outstretched arm (measured during self-control), that is, by the distance from the eye to the handy objects. The number of milliradian in a decimal fraction obtained from this division gives the goniometric "value" of the selected object in milliradian. Thus, an angle of 2-50 (15°) is obtained by sighting through the thumb and index fingers, placed at an angle of 90° and held 60 cm from the eye, and an angle of 1-00 (6°) corresponds to the angle of sighting on three closed fingers (index, middle and thumb) positioned at the same distance. With such measurements, it is important to practice placing the hand at the required distance from the eye. Angles can be measured using a dial of a clock as a protractor. By directing the 12-hour mark along the left side of the angle, we notice the intersection of the right side of the angle with the dial. In accordance with the definition of "thousandth", the value of the angle measured this way by the number of minutes will be equal to the number of large divisions of the protractor (in the accepted form of writing - the number before the hyphen).

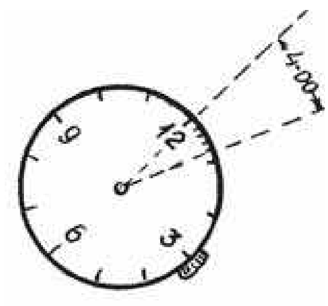


Fig.1.15 Determining the angular size using a clock (Y. Raitarovsky)

An observer equipped with binoculars can measure an angle using the binoculars' angle scale. The extreme line of the scale in the binoculars' field of view is aligned with one side of the angle of the object being measured and, without changing the position of the binoculars, the number of divisions to the other edge of the object (or to the other side of the angle) is counted. The resulting number of divisions is multiplied by the binoculars' division value (usually 0-05).

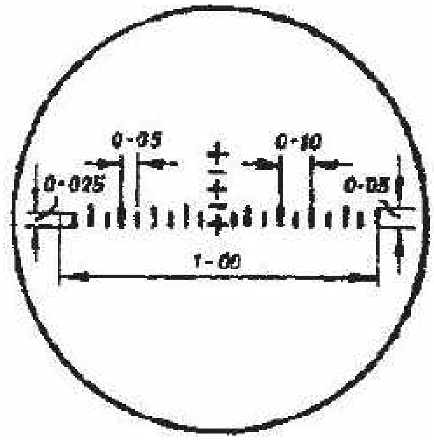


Fig.1.16 Field binocular scale (CC/GFDL)

This appendix standardizes angular measurement units used throughout the reference book. All calculations, measurements, and visual estimations should adhere to these equivalences and formulas.

Table 1.5 Measurement Units Conversion Table

Unit	**Symbol**	**Definition**	**In Degrees (°)**	**In Radians (rad)**	**In Milliradians (mrad)**	**Notes**
Degree	°	1/360 of a full circle	1	π/180 ≈ 0.0174533	17.4533	Main reference unit
Radian	rad	Angle subtended by an arc equal to radius	57.2958	1	1000	SI base unit
Milliradian	mrad	1/1000 of a radian	0.0572958	0.001	1	Used in optics, military, radar
Arcminute	′	1/60 of a degree	0.0166667	0.000290888	0.290888	Often used in astronomy
Arcsecond	″	1/60 of an arcminute	0.000277778	0.000004848	0.004848	Fine optical measurement
Minute of Angle	MOA	1/60 of a degree (same as arcminute)	0.0166667	0.000290888	0.290888	Common in ballistics & targeting
Microradian	µrad	1×10^{-6} radians	0.000057296	0.000001	0.001	Used for precision optics
Grad	g	1/400 of a circle	0.9	π/200	15.708	Used in geodesy, obsolete

Table 1.6 Conversion Formulas

Conversion	**Formula**	**Example**
Degrees → Radians	rad = ° × π / 180	45° × π/180 = 0.7854 rad
Radians → Degrees	° = rad × 180 / π	0.1 rad × 180/π = 5.7296°
Degrees → Milliradians	mrad = ° × 17.4533	10° × 17.4533 = 174.533 mrad
Milliradians → Degrees	° = mrad / 17.4533	100 mrad / 17.4533 = 5.73°
Arcminutes → Degrees	° = arcmin / 60	30′ = 0.5°
Arcseconds → Degrees	° = arcsec / 3600	1800″ = 0.5°
Degrees → Arcminutes	arcmin = ° × 60	0.5° = 30′
Degrees → Arcseconds	arcsec = ° × 3600	0.5° = 1800″
Degrees → Microradians	µrad = ° × 17453.3	1° = 17 453.3 µrad
Milliradians → Microradians	µrad = mrad × 1000	1 mrad = 1000 µrad

1.5. Instrumental observations

Visual detection relies on direct human observation and basic optical aids, offering high availability, mobility, and rapid deployment. However, such methods are inherently limited under low-light conditions and require specialized equipment, such as night vision or thermal imaging, to remain effective. Visual observation is also highly susceptible to overidentification, as numerous natural and artificial objects – birds, insects, balloons, clouds, satellites, or launch effects – may mimic aerial targets. Furthermore, visual identification alone provides limited discriminatory power in modern conditions, as similar aircraft and UAV designs, camouflage measures, and deceptive markings complicate reliable determination at long distances.

Thermal detection methods identify UFO by recording infrared radiation emitted by heated components, enabling the detection of objects invisible to the naked eye; however, their effectiveness is reduced by adverse weather conditions, low-emissivity or camouflaged materials, and the fact that not all phenomena exhibit distinct thermal signatures.

Acoustic detection methods employ specialized sensors to analyze the ambient sound spectrum and identify aerial objects based on characteristic acoustic signatures; however, their accuracy is limited, and they are ineffective for silent, supersonic, low-noise, or space-based phenomena, as well as in acoustically cluttered environments. Radio frequency detection relies on monitoring the electromagnetic spectrum to identify control, telemetry, or communication emissions from artificial aerospace objects, offering long detection ranges, weather-independent operation, and rapid response due to the speed of signal propagation. Nevertheless, RF methods are limited to man-made systems and can be degraded by radio silence, spoofing, non-standard frequencies, or autonomous and wired-controlled platforms, making them insufficient for identifying UFOs.

Radar detection employs active systems that emit radio waves and analyze reflected or scattered signals to estimate an object's range, velocity, and basic characteristics using Doppler-based processing. While pulsed Doppler radars are effective against many aerial targets, small UAVs often exhibit low radar cross-sections due to plastic structures, low-altitude flight, and limited metallic components, which restricts detection range and reliability. Additional challenges arise from stealth shaping, specialized coatings, deliberate deception measures, and natural scatterers such as bird flocks, all of which can distort radar returns and lead to misidentification of UFO.

Space-based platforms enable long-range monitoring of using high-resolution optical imaging, thermography, and electronic reconnaissance, providing near-global coverage and near-real-time observation of the Earth's surface. However, their effectiveness is constrained by large observation distances requiring advanced optics, limited spatial and temporal coverage due to orbital geometry, and a focus on narrow observation areas. High development and deployment costs, along with limited opportunities for rapid upgrades, also reduce the flexibility of space-based systems in adopting emerging observation methodologies.

Manned and unmanned aerial vehicles, as well as missiles, represent relatively affordable and flexible platforms for deploying monitoring systems, particularly in proximity to conflict zones where near-real-time observation and rapid threat assessment are critical. UAVs offer advantages in low observability, maneuverability, persistence, and the ability to approach phenomena closely, while manned platforms provide enhanced situational awareness at the cost of increased risk to personnel. Missiles may be used for rapid, short-term deployment of monitoring payloads following initial detection, though their high speed and limited maneuverability restrict detailed observation.

Observation balloons, aerostats, and stratospheric platforms provide low-mobility but cost-effective means for deploying monitoring systems at high altitudes, enabling wide-area and persistent observation. Stationary aerostats are particularly efficient for long-duration monitoring, while mobile variants offer limited flexibility. However, these platforms are highly vulnerable to weather conditions, wind loads, limited speed and range, and are difficult to camouflage, which constrains their operational survivability and deployment options

Specialized stationary and mobile monitoring systems represent one of the most promising approaches for detection due to their relatively low cost, scalability into networked configurations, ease of concealment, and rapid upgradability. Such systems may be deployed on ground installations, towers, masts, buildings, vehicles, or unmanned mobile platforms, typically integrating multispectral sensors with data recording and transmission capabilities. Their primary limitation is the low observation altitude, which constrains line-of-sight visibility and overall detection range.

The evolution of sensing technologies and data integration frameworks has progressively transformed the methodological standards applied to the study of anomalous aerospace observations. While individual eyewitness reports historically constituted an important source of information, contemporary analytical practice increasingly emphasizes the value of multi-sensor documentation, temporal–spatial correlation, and structured data recording.

Isolated visual observations remain relevant as initial indicators or sociological records; however, their scientific interpretability is inherently limited in the absence of measurable parameters or instrumental support.

Greater analytical value emerges when observations are independently confirmed, instrumentally recorded, and correlated with environmental or technical datasets.
In this context, the prioritization of integrated monitoring architectures reflects not a dismissal of human testimony, but an adaptation to modern scientific standards, where reproducibility, traceability, and data integrity are essential for meaningful interpretation.
Effective detection of anomalous aerospace phenomena increasingly relies on multi-source monitoring architectures integrating optical sensors, radar systems, radio-frequency spectrum monitoring, satellite observations, and environmental data. Such combined approaches significantly reduce the probability of misidentification and allow cross-verification of observations across independent detection channels.
Another key requirement for future AAP research is the interoperability of observation databases across institutions and countries. Shared data formats, standardized metadata, and coordinated archival practices allow independent researchers and governmental organizations to compare cases, identify patterns, and improve statistical modeling of anomalous events on a global scale.

1.6. Use of radar stations

Radar significantly expands human capabilities in understanding of the world. Since the beginning of the period of mass application of radar systems (RS) and up to the present day, operators have encountered various mysterious effects. Some of them, associated with the imperfection of equipment and natural phenomena, have received a theoretical explanation, and are partially eliminated with the help of filters, more advanced equipment. Radars used in civil aviation airports: airfield surveillance radars (ASR), control radars (CR), passive radars (PR) and weather radars (WR), allow to record air objects quite reliably in a wide range of ranges, speeds and altitudes. And this, in turn, according to a number of signs of anomaly - helps to identify unidentified objects, in addition, plasma phenomena (under certain conditions) - an ideal reflector of radio waves. Radars, as a rule, work on the principle of receiving a reflected wave. Active radars in passive mode record all objects that reflect waves: thunderclouds and bird flocks. But this also allows for better knowledge of the air situation. The accuracy of radars in terms of range is no worse than 150 m. The time unit in radar is 1 μsec. In 1 μsec, the radar beam travels 300 m.

$$S = c \cdot t = (3 \cdot 10^8) \cdot (10^{-6}) = 3 \cdot 10^2 = 300\text{m} \quad (1.2)$$

The range is determined by the delay time of the reflected signal:

$$Д = c \cdot t_{del} / 2 = (3 \cdot 10^8) \cdot 10^{-6} / 2 = 150\text{m} \quad (1.3)$$

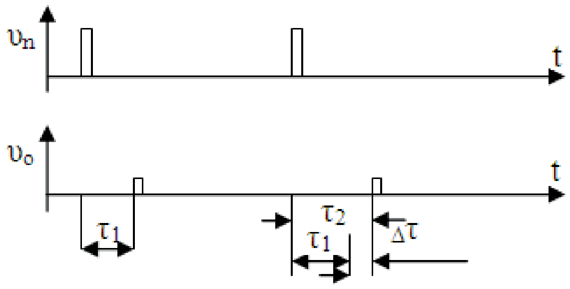


Fig. 1.17 The operator determines the change in the distance of the target from the radar antenna by accumulating time changes in the reflected signal on the radar screen. (I. Kalytyuk)

A similar effect underlies the Doppler principle, which is used in the radar operating mode - motion target indication (MTI), i.e. selection of moving targets. This mode is used to select targets against the background of passive interference. However, it also has disadvantages. The operating range of the radar in MTI is 60-75% of the passive. A significant disadvantage of MTI is the manifestation of "blind speeds". These are flight speeds at which the aircraft moves in space during the sending time.

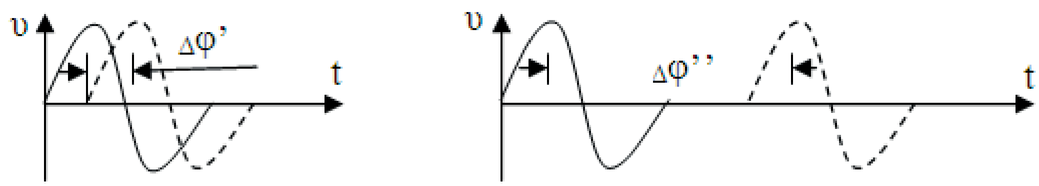


Fig. 1.18 The phase shift of the Doppler frequency will be constant when the aircraft moves during the time between pulse sending equal to the passage of a half-wave and a multiple of the value of K. (I. Kalytyuk)

S = K · λ / 2, where K! = 1,2 … determine the first, second ... fifth "blind speeds". (1.4)
In general, the value of "blind speed" can be determined from the following relationship:
W_{bs} = 0,018 · K · λ · F_n , where 0.018 is a constant coefficient; (1.5)
K – multiplicity coefficient = 1,2,3…;
Fn – number of pulses per second.

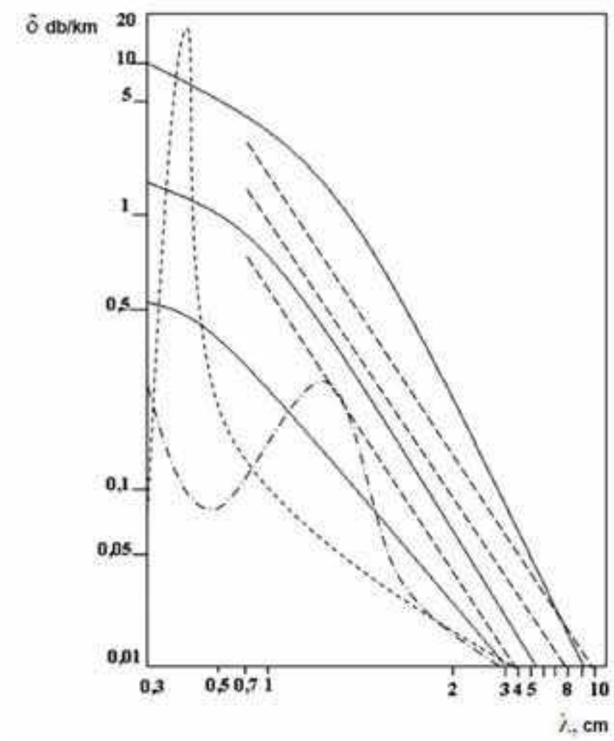


Fig. 1.19 The range of the most advantageous use of radar (I. Kalytyuk)

It follows from the graph that different increases in radio wave attenuation are observed near the wavelength of 0.25 and 0.5 cm for oxygen and 0.18-1.35 cm for water vapor. These peaks on the graph are explained by resonant absorption of energy near the corresponding frequencies. With small particle sizes (for example, with fog), energy is mainly absorbed, while with large particles (rain), scattering occurs. The attenuation of radio wave energy during rain and fog is shown by curves 3-8.

Synchronicity of the movement of the electron beam sweep on the radar screen with the rotation of the antenna is achieved by the coincidence of the mechanical and electrical parts through the selsyn sensors of the antenna and the selsyn receivers of the signal amplifier of the converting equipment. The accuracy of the mechanical part of the best radars reaches 0.1^{o}, and the resolution - by the width of the radiation pattern of the antenna - 0.5^{o}.

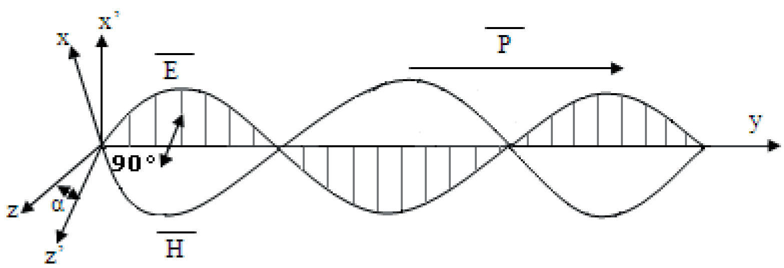


Fig.1.20 Electromagnetic component and Komov-Poynting vector (I. Kalytyuk)

E – electrical component;
H – magnetic component;
P – Komov-Poynting vector – radio wave propagation vector
The line-of-sight range is calculated using the formula:

$$\sqrt{((R_3 + h)^2 - R_3^2)} + \sqrt{((R_3 + h)^2 - R_3^2)} \text{ , where} \quad (1.6)$$

R_3 – Earth's radius is 6370 km;
h – antenna height;
H – aircraft flight altitude.

Since 2R3>>h and 2R3>>H, we can approximately write ≈ 113 (√h + √H) km (1.7)

The accuracy of determining coordinates (ADC) is much higher than ASR, CR. Since the attenuation of the energy of radio waves longer than 10 cm is very insignificant, it may not be taken into account for decimeter and meter range radars. However, landing radars operating in the centimeter range are very susceptible to atmospheric interference. This forced designers to use devices in PRL vibrators that change the polarization of radio waves to linear or circular, which made it possible to distinguish aircraft against the background of intense precipitation in the form of rain or snow. The altitude of the radar reaches the middle layers of the atmosphere. But not only a high flight altitude improves aircraft detection. The surface reflection area and the geometry of the object, as well as the material from which the aircraft is made, also play a significant role.

Table 1.7 Radar Cross-Section of the object, m²

The warhead of the rocket	0,2
Human	0,8
Submarine conning tower	1
Fighter	<3-5
Frontline bomber	7-10
Heavy bomber	15-20
Transport aircraft	50

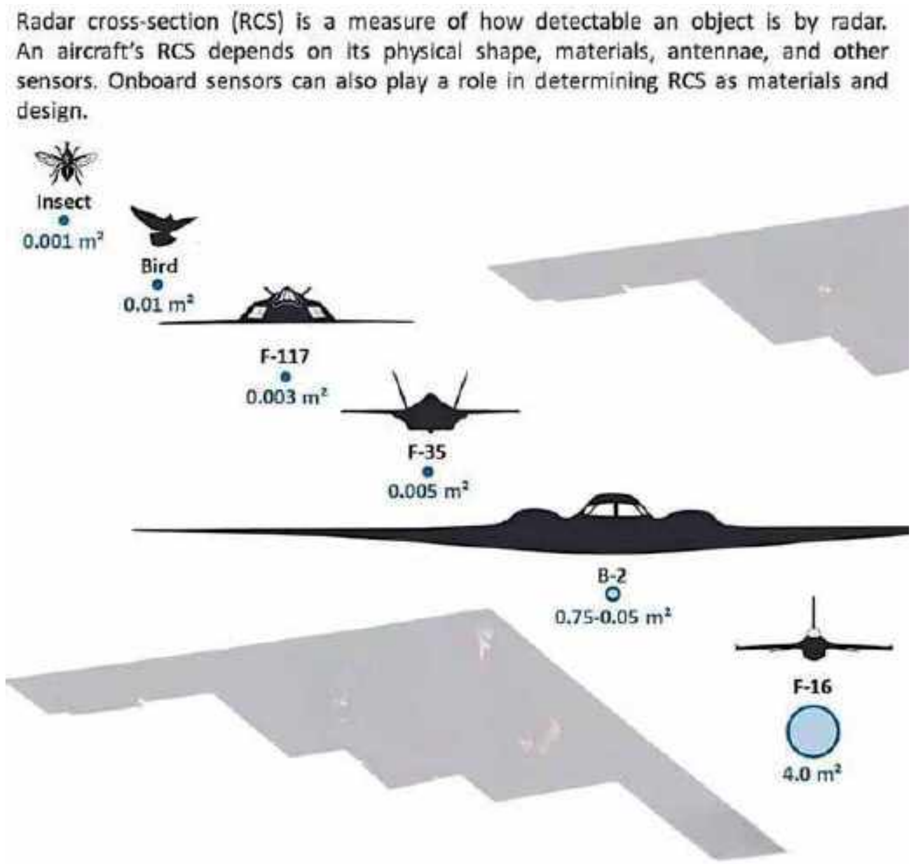


Fig.1.21 RCS (CC/GFDL)

In the first, imperfect radars - when the system of interference protection was not sufficiently developed and the circuits did not have effective filters - signal oscillations were not uncommon, sometimes increasing like an avalanche: either from an unusually strong reflected signal, or from oscillations of secondary signals in the radio circuit. Sometimes, for example, it is possible to receive an additional reflected mark from the target due to one of the sides (SL) or rear lobes (RL) of the directional pattern (DP) of the radar antenna, which is possible when the value of the reflected signal from the direction where the SL (RL) of the DP is moving at that moment exceeds the receiver sensitivity threshold. The reasons for such radio reception may be a very large equivalent scattering surface (ESR) of the target, incorrect threshold adjustment, or a malfunction of the side lobe suppression system of the DP of the radar antenna.

Usually, such false marks are recognized quickly enough by experienced operators. The task becomes more complicated when the side lobe begins to receive a signal from the target, re-reflected from stationary large-sized structures located on the surface of the Earth (towers, pipes, water towers). such a re-reflected echo signal always has a lower level and will change its position relative to the main target according to the laws of geometry when reflecting a beam, since the microwave radio waves used for radar propagate according to laws close to the laws of optics. Such marks are not easy to distinguish from anomalous objects (AO) marks.

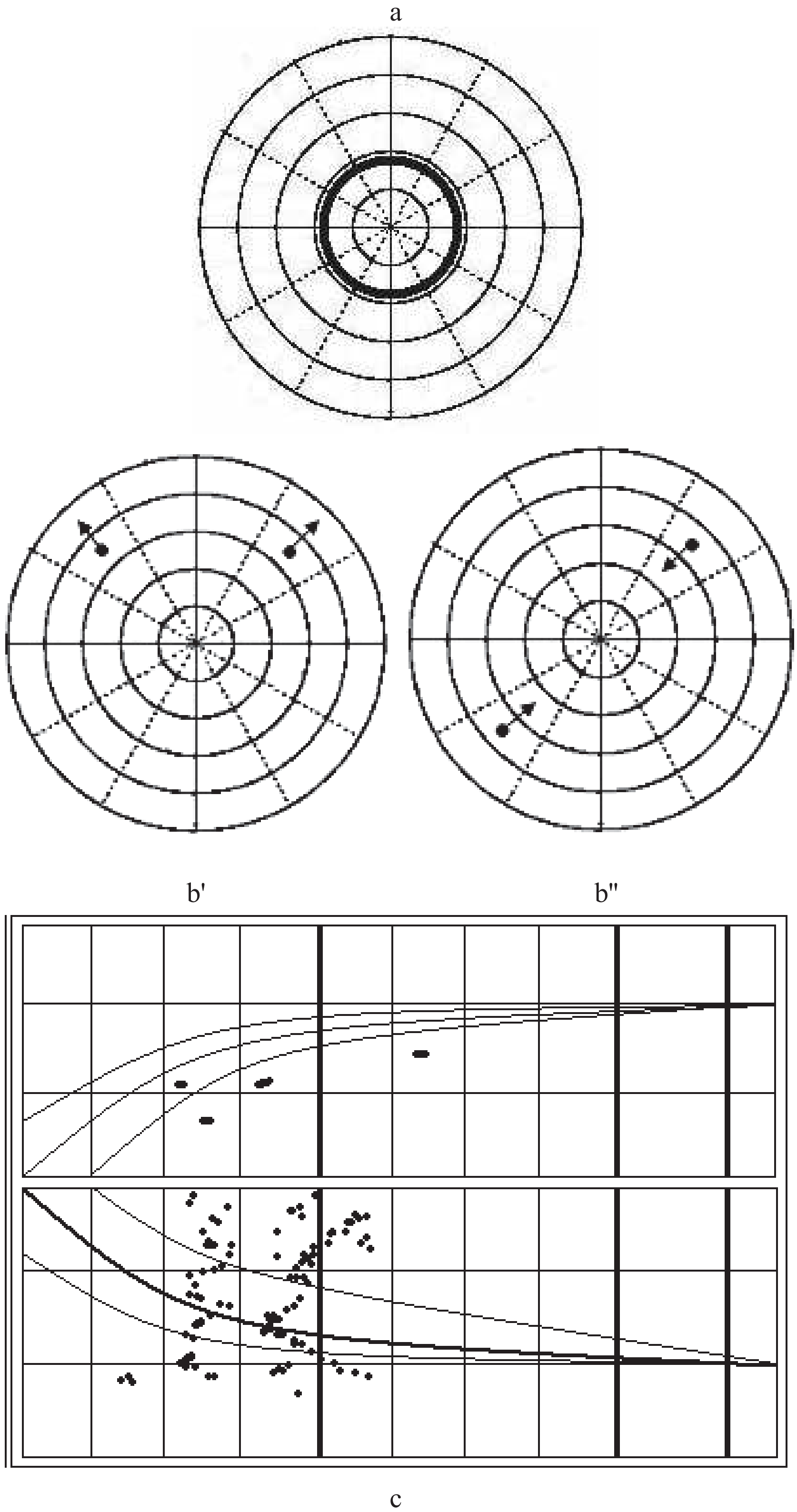
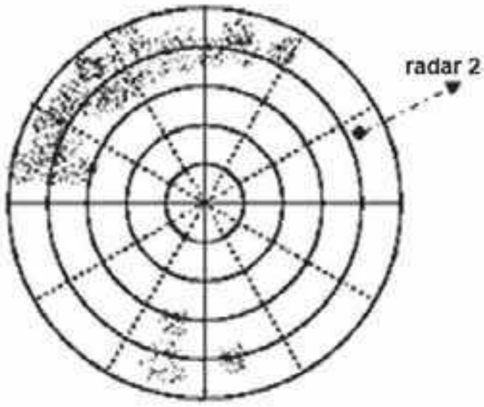


Fig. 1.22 “Rings”, false targets and flocks of birds (I. Kalytyuk)

The source of errors may be marks from targets located far beyond the horizon, when a super-refraction phenomenon occurs in the atmosphere. In this case, the radar-radio altimeter and surveillance radar will show marks of targets at fictitious altitudes inaccessible to conventional aircraft, which can also be interpreted as AO. In this case, it is possible to observe stationary "targets" at large distances and "heights" caused by reflections from large-sized structures on the ground far beyond the horizon. Such marks are not eliminated even when the stationary target signal suppression system is turned on (moving target selection system - MTS), since at large distances, due to significant signal phase fluctuations, the MTS system operates ineffectively. To eliminate such errors, it is necessary to know the azimuths and ranges to such large-sized ground structures, which is usually taken into account when choosing a radar position and is known to operators. When "mirror" reflecting layers appear in the atmosphere due to temperature inversion, it is also possible to receive false marks corresponding to large distances and heights. However, their recognition here is facilitated by the presence of wind drift of these reflected "mirror" spots. Such phenomena are most typical of hot weather in desert and steppe areas. Such marks can also be large in size.

Sometimes there are observations of marks from vortices or local turbulences in the atmosphere, also drifting in the wind direction, which is always known from meteorological data. In addition, the Doppler spectrum from such reflections, due to their small linear and circular velocities, is usually tens of hertz. Therefore, reflections from such irregularities in the atmosphere can easily be suppressed by the MTS system. The so-called "rings" (a) and false, symmetrical to the real target, marks (b) are not uncommon on modern radars. The reflected signal from sea waves, received by a radar antenna located low above the water, is quite consistent with the currently developed theory of the "wave channel", when the radar beam can bend around the surface for significant distances in the inversion layer. Turbulent eddies, flocks of birds (c), insect clusters, electrification zones (d) - detected by radars of various types - do not surprise anyone anymore.

When the network of similar radars became dense enough and overlapping zones arose, marks began to be recorded, arising from the re-emission of counter-radio waves, coinciding in phase and pulse strength. To identify the nature of such a signal, it is sufficient to change the frequency of antenna rotation or note the immobility of the mark (d), which will not be visible on the PRV screen. After a change in atmospheric conditions, this rarely recorded effect will disappear.



d

Fig. 1.23 Zones of electrification and re-radiation (I. Kalytyuk)

Various types of radars based on the territory of large airports cover the airspace in their air traffic control (ATC) zone quite completely, and the availability of operational communications between control points of the Unified ATC System allows for promptly informing adjacent CPs about observed unidentified objects and exchanging the necessary information on tracking them, which generally significantly increases flight safety.

Usually, air objects observed by radar operators are identified by them as anomalous if the following signs of anomalousness are present:
- anomalous trajectory of movement, right-angle turn or U-turn without losing speed;
- abrupt stops and hovers;
- anomalous changes in altitude and flight speed;
- anomalous pulsations of the mark and specific interference or electromagnetic effects;

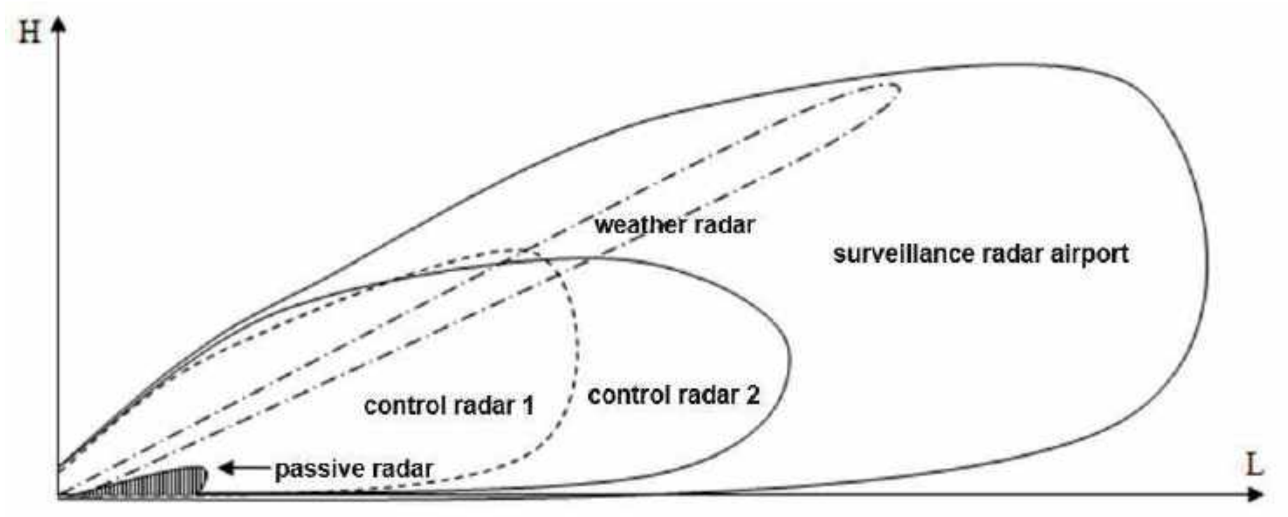


Fig.1.24 Range of different radars (I. Kalytyuk)

Naturally, it is possible to talk about identifying objects as anomalous only if the radar is operating stably. In some cases, the reliability of radar detection of anomalous objects is confirmed by visual observations (moreover, the reports of Civil Aviation crews are documented by audio recording).
It is advisable to request the altitude of the object and the degree of contrast of the mark on the air defense radar screen from the air defense radar operators. When the radar is operating, suggest that the radar operator detect the object and measure the altitude, and also track the object for some time. It is necessary to use photo and video recorders more widely: for the purpose of subsequent documentation of the observations of the aircraft and their analysis. Therefore, it is useful to suggest that the Ministry of Civil Aviation equip the radars with video indicators.

When detecting anomalous objects (AO) – both radar and visual – it is recommended to use the entire radar complex, informing the dispatchers of all control centers of the Unified ATC System – in whose sector the object is located – about the observation. With the existing system of radar control and air traffic management in the Ministry Civil Aviation Administration, it is quite possible (and without any special costs) to organize observations of AO; this only requires familiarization of dispatchers with the methodology of radar observations of AO. In general, this will contribute to increasing flight safety and restoring sincerity when encountering anomalous situations in flight, which is for the crew a close observation of an anomalous object.

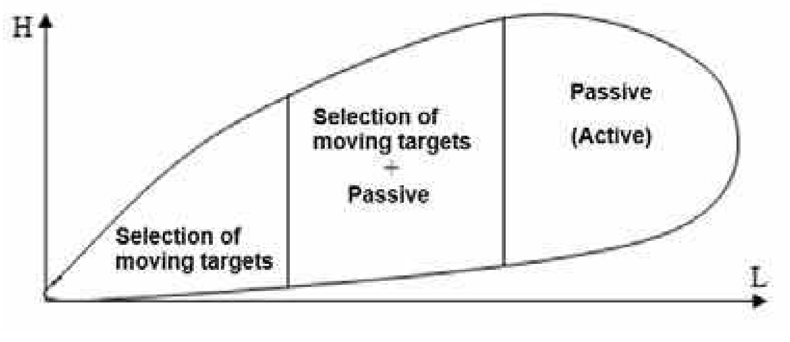


Fig.1.25 Using the MTI and Passive mode (I. Kalytyuk)

1.7. Using reflections in multistatic passive radiolocation

The system is based on the use of time-synchronized radio receivers to capture high-frequency radio signals reflected from a target. The time error between the received signals, together with three-dimensional Doppler shift analysis, allows calculation of the target's location, speed, acceleration, flight path and other parameters, possibly even the target's size. The analysis of the reflected signal, combined with the analysis of the target's characteristics, allows to distinguish suspected AO from targets of known origin, such as aircraft, satellites, space debris, meteor trails, upper atmospheric conditions, weather events, bird migrations, the Moon, etc.

One of the proposed applications could allow detection of AO within at least 27,600 kilometers from the Earth's surface. The principle of radar is based on the ability of some materials to reflect electromagnetic radiation (ER). Examples of such objects are most metal objects, the Earth's ionosphere, ionized "trails" behind meteors, plasma under certain conditions, satellites, space debris that entered the dense layers of the atmosphere, the Moon, the Earth's surface, migrating birds, etc. Many materials, such as air, wood, plastic, mostly glass, etc., may not reflect ER. Reflection may depend on the size of the target, its material, geometry, the frequency of the ER, etc.

Passive radar (PR) is a type of radar system that uses one (or more) receiver(s) but does not have an active transmitter. The system detects radio signals emitted by nearby radio transmitters. Potential sources of electromagnetic radiation that may be exploited by a passive radar system include:
1) commercial radio and television signals,
2) signals from towers serving cell phones,
3) sources from space platforms and others.

The concept of passive radar can be used in several variants. For example, in the form of:
• Monostatic radar is a radar system in which the transmitter and receiver are: stationary and in the same location.
• Bistatic radar is a radar system in which its elements, either the transmitter(s) and/or receiver(s), are: stationary and in different locations, i.e. spaced.
• Multistatic radar, which is similar to bi-static radar but uses more than two permanent transmitters and/or receivers.
• The Global Positioning System (GPS) allows very precise position determination. This system uses time-synchronized radio signals transmitted by satellites to determine not only position but also time. This system uses time shift measurements to calculate the distance from each of several transmitting satellites, which in turn allows the distance from each of the transmitting satellites to be calculated.

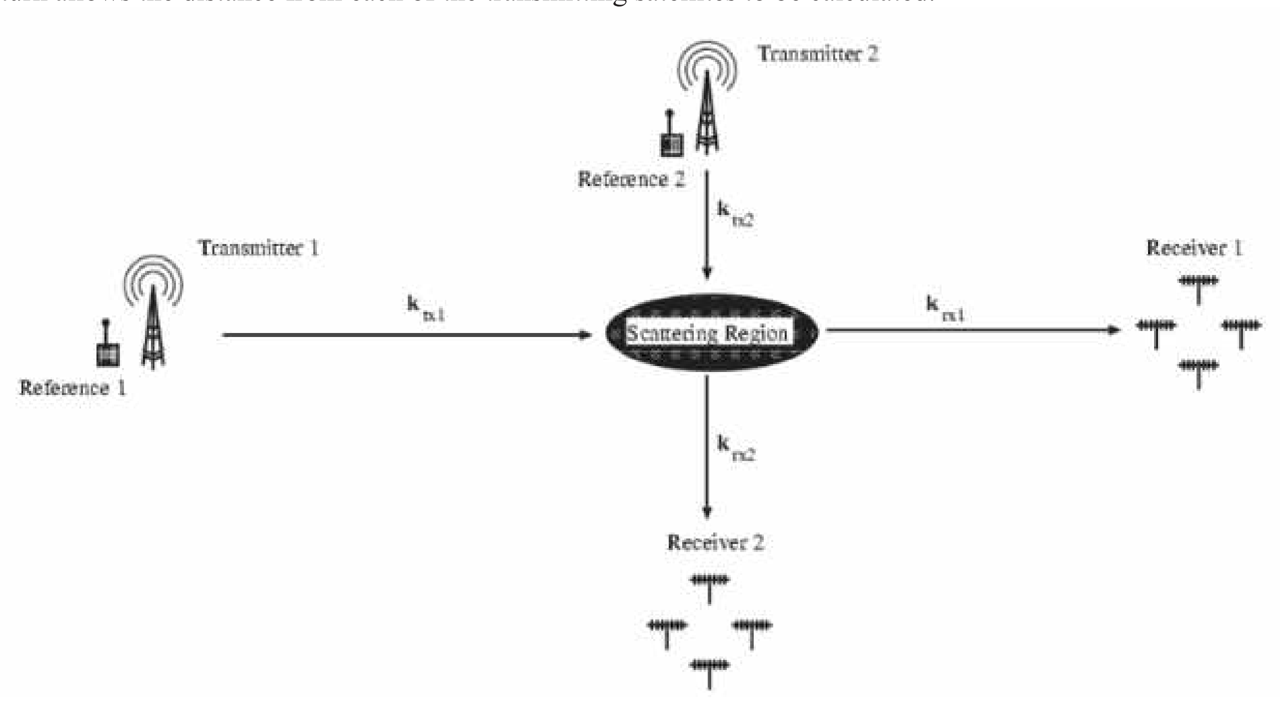


Fig.1.26 Multistatic radar (NUFORC)

Using multistatic radiolocation:
• Over-the-horizon PR – increasing the long-range radar by reflecting the transmitted radar signal off the Earth's ionosphere.
• Lunar relay communication (LRC) – receiving radio signals reflected from the surface of the Moon. This option requires considering the Faraday effect – when the Earth's magnetic field causes the polarization of the radio wave to rotate several times as the radio signal passes through the ionosphere on its way to the Moon and back, which leads to cyclic fading of the received signal.
• Meteor trail communication – using ionized trails of hot gas from meteors entering the Earth's atmosphere as short-lived, 1-5 second, reflection points to transmit radio signals above the horizon to a separate receiver.
• Reflection of signals from commercial frequency modulation (FM) radio stations and mobile phone towers
• Receiving a radar signal using a network of artificial Earth satellites (AES).

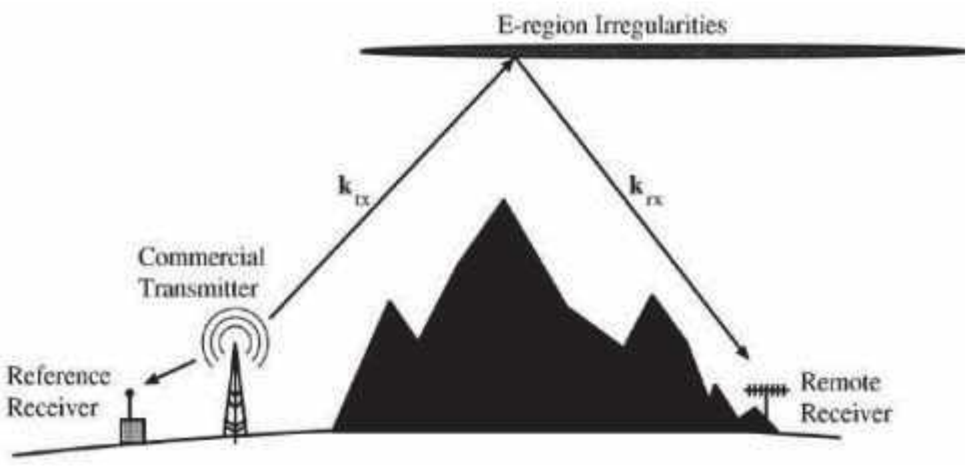


Fig.1.27 Over-the-horizon radar (NUFORC)

Fig.1.28 PR using satellite (NUFORC)

The interest of government, military and intelligence agencies in passive micro frequency radar can be explained by the fact that this technology is suitable for surveillance and defense requirements due to the following advantages of passive radar:
• It does not require an active transmitter, only multiple receivers.
• This system detects targets continuously, often, many times per second.
• This system cannot be detected while it is in operation, since it does not have an active transmitter as part of the system.
• It can detect targets over a wide area, up to hundreds or thousands of kilometers in radius.
• Such a system is relatively inexpensive, since it requires nothing more than a receiver, a very accurate time source, and the ability to process an adequate signal.
• The construction and operation of the system do not require government licenses and are therefore not controlled by a government licensing agency.
• A passive system can be operated from virtually any location.

The deployment of the Global Positioning System (GPS) allows for very accurate time measurements, which is necessary for time synchronization of radio receivers, and also allows for the precise location of receiver antennas.

System Design. The design of a passive, multi-static MF radar system is relatively simple compared to an active system. The basic elements of a single, bi-static, passive radar system include the following:
• A sensitive MF receiver to detect a radio signal, typically in the 30-230 MHz frequency range, depending on the type of target to be detected.
• A computer with sufficient power to record a large number of intercept points per second and capable of very fast signal processing.
• Suitable software for fast signal processing to enable the calculation of three-dimensional Doppler shift information.
• Access to GPS equipment to measure precise time and position.
• Knowledge of, or access to, the original transmitted radio signal.

The system operates in three phases.

• *Intercept Phase:*

1) The receiver's composite antennas are deployed so that they are shielded from direct line-of-sight communication with the MF transmitter, but are able to detect any signals reflected from the target area.
2) The system's antennas are connected to a radio receiver which is tuned to the transmitter's reference frequency.
3) Precise timing equipment (usually from a GPS) is used so that the arrival time of the reflected signal at each receiving antenna can be measured very accurately.
4) The precise frequency of each of the reflected signals received by each receiving antenna is measured and recorded.

• *Signal processing phase.*

Once the interception of a return signal is recorded, which is a process that may occur hundreds or thousands of times per second, the intercepted signal can be analyzed in a variety of ways to extract information from the signal.

5) The time shift when the return signal is intercepted by each respective complex antenna is used to triangulate the location of the return signal.
6) Multiple target location calculations are used to calculate the target's velocity, acceleration, and heading.
7) Any very subtle change in frequency (Doppler shift) of the return signal caused by target motion relative to the fixed antenna location can be compared to the frequency of the reference transmitted signal to calculate the target's velocity.

• *Target discrimination phase.*

The data obtained can be used to analyze the source or cause of the reflected signal. Probably the most useful elemental information for determining the nature of a target is its location, elevation, extent, speed, acceleration, and flight path.

Analysis of any one of these parameters may be sufficient to eliminate the probability of one or more target categories. For example, migrating birds would not be expected above a certain altitude or speed. Likewise, most aircraft would be observed below a certain altitude and not as stationary objects. A meteor would not be a stationary object. Other target categories may also be eliminated by similar considerations.

<u>The described detection systems can be used in the following scenarios:</u>

Scenario 1: Use of Commercial MF Radio and TV Signals

A large number of high-power commercial radio stations offer a readily available source of MF signal in broadcasts (88-108 MHz for radio) for use by a typical multistatic radar system. The prerequisites for a passive radar system to operate are: 1) the signal processor has access to the broadcast signal, which serves as a reference, and 2) the transmitter is not "seen" by the receivers, i.e., it is over the horizon from the receivers or is somehow "shielded" from them. With a receiver tuned to the operating frequency of either radio station, intercepts by the system can be attributed to a nearby reflection point either in the atmosphere or on the surface. Comparison of the received signal with the original broadcast signal will provide information about the nature of the target. With sufficient signal analysis capability, the system is able to calculate the target's location, speed, acceleration, and flight path, and possibly estimate its size. This information must be adequate to distinguish between different types of targets.

Scenario 2: Naval Surveillance System Transmitter Use

The nature of the phased array antenna transmissions used by the Naval Surveillance System to detect and track orbiting objects makes it ideal for amateur target tracking in or outside the near-Earth environment. The system's transmitters transmit a very powerful (768 kW), high-frequency continuous wave signal (216.98 MHz) that should allow for easy detection and high resolution of objects in the vicinity of the system's three transmitters. Given that the system was designed to detect targets approximately 10 centimeters in diameter at ranges up to 27,600 kilometers, detecting a target on the order of ten meters in diameter at that range would be trivial.

1.8. Actions of the radar operator to register his observation

We understand anomalous objects (AO) recorded on radar screens as marks from unidentified targets, material objects with anomalous characteristics of speed, altitude, maneuverability, recorded by radar and manifested during observation of these objects. Detection of AO is difficult, since marks from them do not always differ in contrast and are sometimes poorly distinguishable against the background of interference. In addition, sometimes signals from bird flocks, cloud formations, electromagnetic charges during thunderstorms, gas and dust vortices mislead operators. Occasionally, "angel echoes" that occur during re-emission, reception of a secondary reflected wave or failures in the radar delay line are taken for real targets or AO.

"Angel-echo" is determined if the secondary mark has the same angular velocity as the mark from the real target (but at a different range) or is shifted radially at the same range as the mark from the real target (i.e. at a different azimuth), but maintaining the radial (tangential) component of the velocity equal to the velocity from the real target. Sometimes observations are recorded by photographing or video recording information from radar screens, which is valuable documentary material. In some cases, radar observations of anomalous objects are confirmed by independent visual observations, which significantly increases their reliability. When detecting an AO on the screen, the operator must first make sure that the equipment is in good working order, without stopping observation of the mark of the potential AO that has attracted attention with its anomalous characteristics. At the same time, write down on a palette or chart the time, coordinates of the object (azimuth and distance) and their change, approximate courses and approximate flight speeds of the object (the distance flown by the object in one turn of the antenna or per minute). Note the weather conditions in the observation area and in the airfield area. If there was a change in the direction of movement, measure the curvature of the trajectory. In the case of a speed maneuver, indicate its change in stages. If civil or departmental aviation aircraft are located near the AO mark, the dispatcher must inform their crews, provide the AO position relative to the aircraft's flight path (course angle and distance) and recommend bypassing the area. Ask the crew if they are observing an AO and what it is; information from the crew about the angular dimensions of the object, its position relative to the horizon, angular velocity, color, halo, whether there is a plume, phenomena associated with an AO, and how the instruments and equipment of the aircraft work is also valuable.

When another dispatcher or control center, including the Air Force (AF), controls an airfield, it is necessary to immediately transmit information to them about the observation of an AO in their ATC area and receive confirmation that the information has been correctly understood.

In parallel with your observation of the AO, you should clarify whether the AO mark is observed on the radar screens of other control points (especially adjacent ones). When the AO moves into the responsibility zones of another CP, you should inform the controller of the adjacent CP about the coordinates of the AO mark, its contrast, speed, and continue to observe this AO, and later report the results obtained. Inform the Air Force and Air Defense agencies about the observation of the AO, its location, course, speed, and ask the Air Defense (if possible) to determine the altitude of the AO using a radio altimeter.

Of course, for a meteorological radar (MR) not directly connected to air traffic control and with limited communication with the military sector, identification of the AO is difficult. Therefore, when receiving information about the AO from MR observers, dispatchers must carefully review the sector of probable of the AO observation and, if it is detected, mark the location of the AO, record the speed, changes in trajectory, contrast of the mark, presence of electrification, cloud density, and report the main parameters to the interested dispatcher.

The altitudes can be determined by requesting information from the Air Defense through the approach circle controller or the district center in addition to your measurements.

If you independently detect a mark from a target that meets the AO characteristics, you must inform the circle controller (if the AO is up to 40 km away) or the approach controller of the corresponding sector (if the AO is over 40 km away). In this case, you must inform about the main factors of the anomaly, the AO location, its speed, and flight course. Of course, in a complex air situation, we can only talk about an approximate fixation of the AO with subsequent recording, but in order to ensure flight safety, it is necessary to inform the crews of the aircraft closest to the AO. That is, the degree of danger to the aircraft can be quite high.

When detecting and monitoring an AO, the operator must maintain a responsible attitude to observation and act depending on the specific situation, but in no way discard information for any personal reasons. Sometimes characteristic interference created by (or accompanying) the AO can be a valuable sign of AO detection. Any apparent trifle noticed during AO observation must be carefully recorded, since the final picture of events and AO detection usually depend on the complex of anomaly manifestations.

After off duty (or in the nearest free time after observation), the dispatcher must report the AO observation to the senior dispatcher and flight director, compose a message (keeping the chronology of the event and the main AO observation parameters). Specify the meteorological conditions in the observation area (according to on-board weather and weather station data), wind by altitude.

Make drawings of the observed anomalous phenomenon in dynamics, determine and record the main angular parameters, observation azimuths. The angular parameters include the angular height, angular velocity, and angular dimensions of the AO. For a more accurate determination of the angular parameters, it is advisable to use a ruler (or a standard object) at arm's length, and recalculate the obtained data into angular values later. To determine the angular velocity, you can use a wristwatch timer with the recording of characteristic landmarks - over which (or in the line of which) the object flew - with subsequent determination of the azimuths of the landmarks and calculation of horizontal angles.

See also: Questionnaire for an air traffic controller or pilot about observing an unidentified object or phenomenon.

1.9. Using a spectrum analyzer

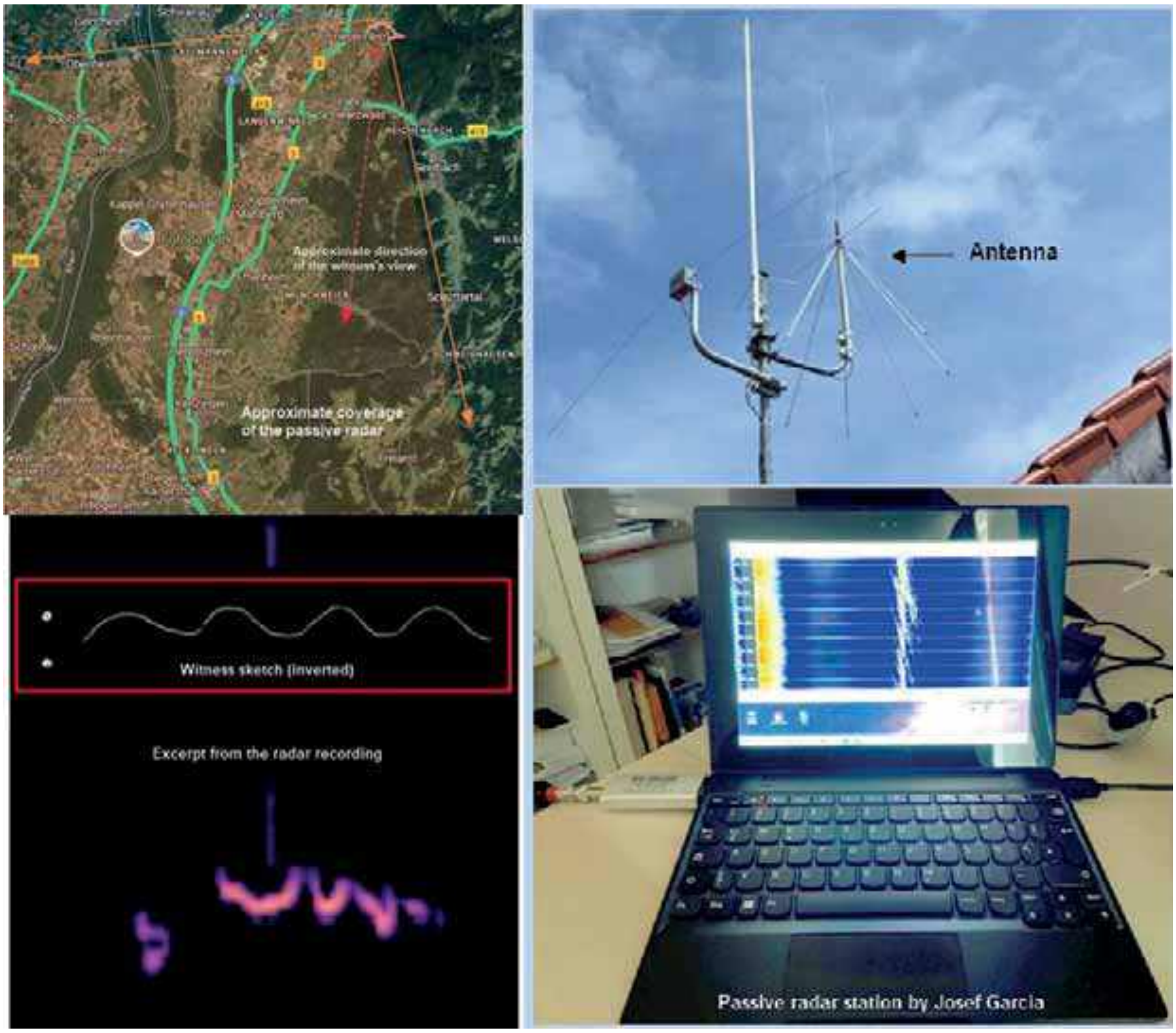


Fig. 1.29: Map of the sighting location, excerpt from the radar recording with witness sketch, and the passive radar station by Josef Garcia (GEP/JUFOF 46(1), edited)

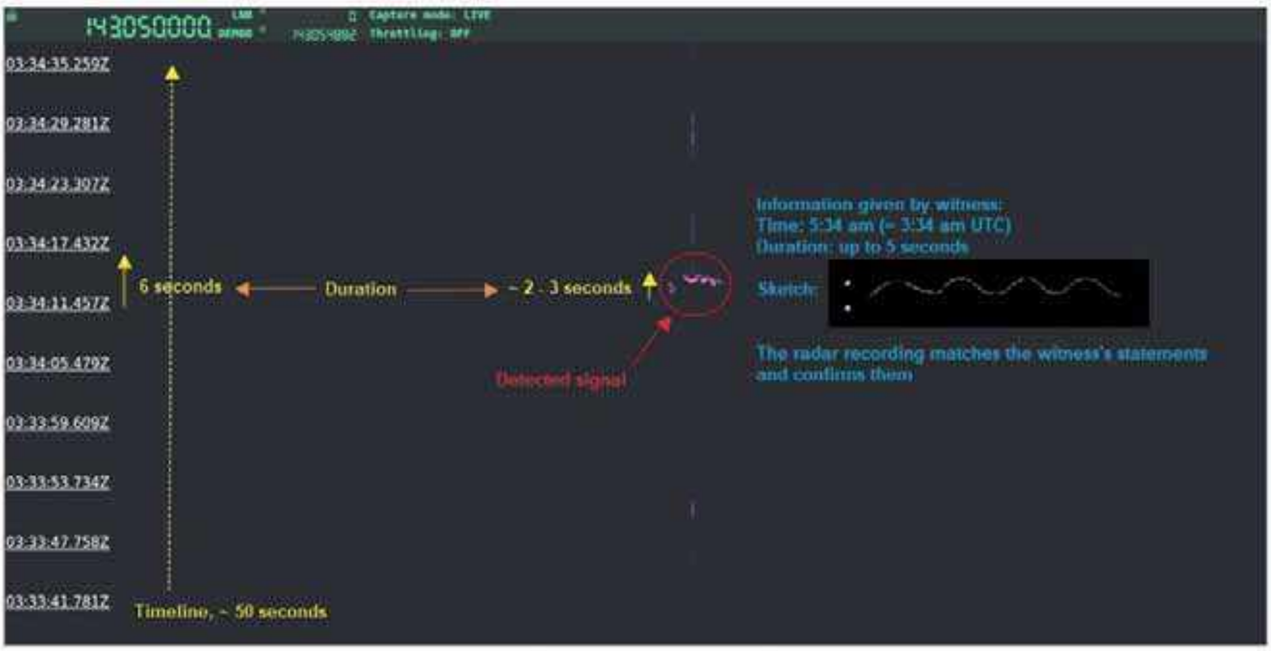


Fig. 1.30: Screenshot of the radar recording with analysis and comparison with witness statements (GEP/JUFOF 46(1), edited)

Passive radar data should be interpreted strictly as a complementary verification tool rather than a standalone detection method. Meaningful analysis is only possible when passive radar records are temporally and spatially correlated with a documented other obtained by instrumental and visual methods observation supported by accurate time, location, and directional information. Within this constrained verification role, passive radar implementation relies on relatively simple receiving hardware and signal processing techniques that enable Doppler-based analysis of reflected signals when proper correlation conditions are met.

The receiving system consists of a simple antenna and a communications receiver capable of receiving for example 143.050MHz with a single sideband (SSB). The simple antenna is a 3 element Yagi, but it is possible to obtain radar returns with an even simpler monopole antenna. The SSB detector is required in order to generate an audio signal with a frequency related to the Doppler shift of the radar return. This audio signal can then be analyzed in a spectrum analyzer to reveal the many frequency – time forms, of the meteor trail signal. The most convenient spectrum analyzer to perform this task is based on Fast Fourier Transform (FFT) software.

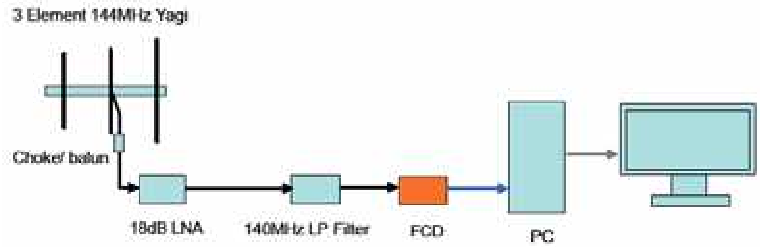


Fig.1.31 Radar receiver configuration (D. Morgan)

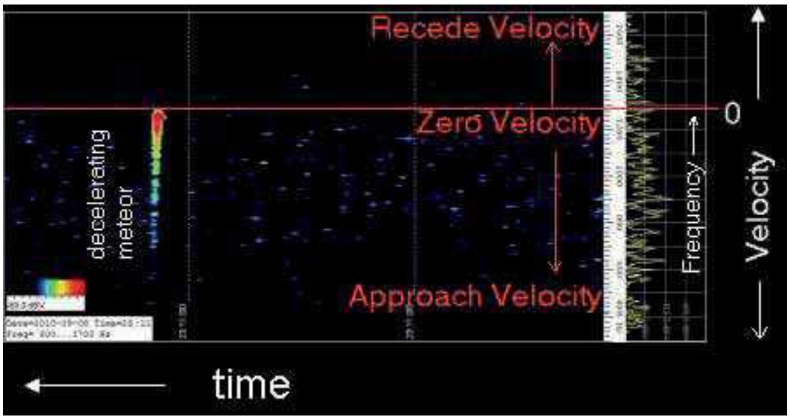


Fig.1.32 Spectrum & waterfall plot return signal (D. Morgan)

An example of the output from the Spectrum Lab software. In this picture we see a spectrum of the signal on the right (in yellow) with frequency rising from 300Hz to 1.7kHz with a 10dB/division amplitude scale. In this plot of course, frequency equates to line of sight velocity of the meteor and is shown in the waterfall plot. The horizontal axis is time, with the markers at 5 second intervals. Zero Doppler frequency of 143.050MHz appears at a demodulated frequency of ~1290Hz, with higher and lower RF frequencies appearing above and below this value – but in the opposite sense.

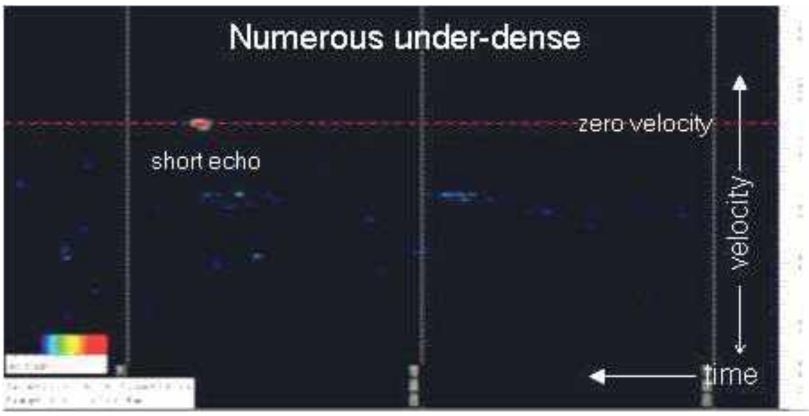


Fig.1.33 A weakly ionized Meteor Trail Echo. This is rather faint and short, produced by a weakly ionized meteor trail that only exists for a very short time. It may have no significant velocity at the time when the echo is strong enough to observe. The red dotted line marks zero LOS velocity. This is probably an example of an under dense meteor trail formation. In this case it either has no LOS velocity or exists for such a short time at a density that causes a good reflection, that no velocity change is observed. The vast majority of echoes received are of this type and are created by low mass particles with m <10^{-3}g. (D. Morgan)

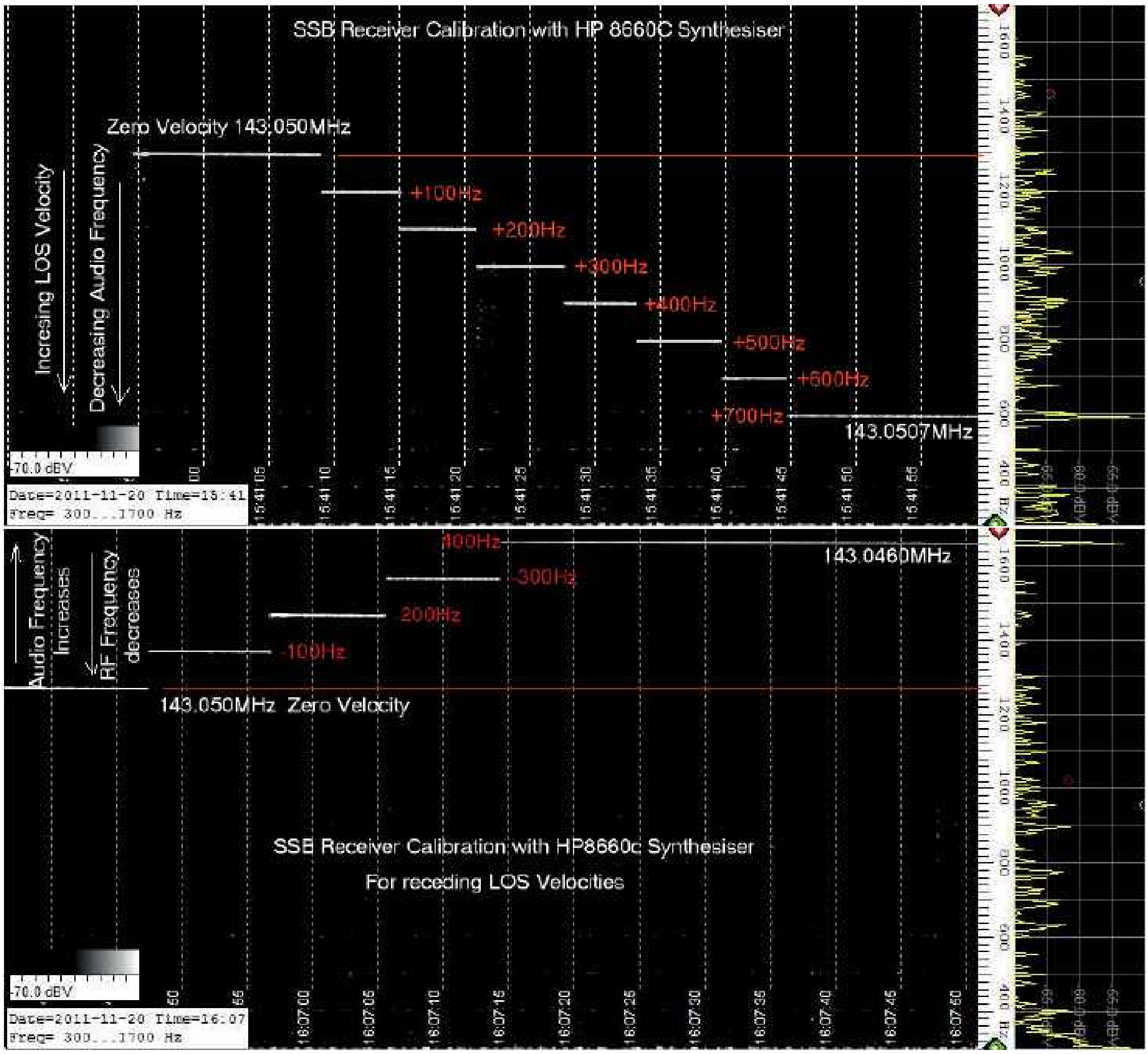


Fig.1.34 Synthesizer calibration of velocity display (Spectrum Lab)

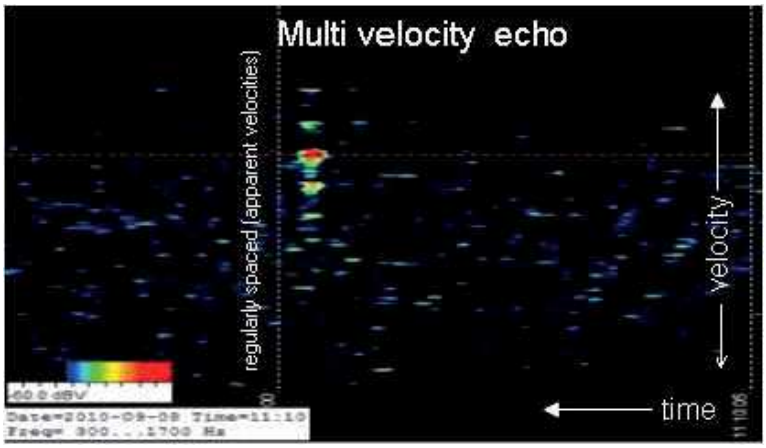


Fig.1.35 Multi-velocity' Meteor Echo. The strongest return has a zero LOS velocity but there are signals at regularly spaced intervals of frequency (velocity) either side of this. The signals corresponding to approach velocities seem to be stronger than those for receding velocities. It is difficult to see how a physical trail can move with these separate velocity components. It is probable that this type of echo arises from some form of diffraction effect along the length of the meteor trail. (D. Morgan)

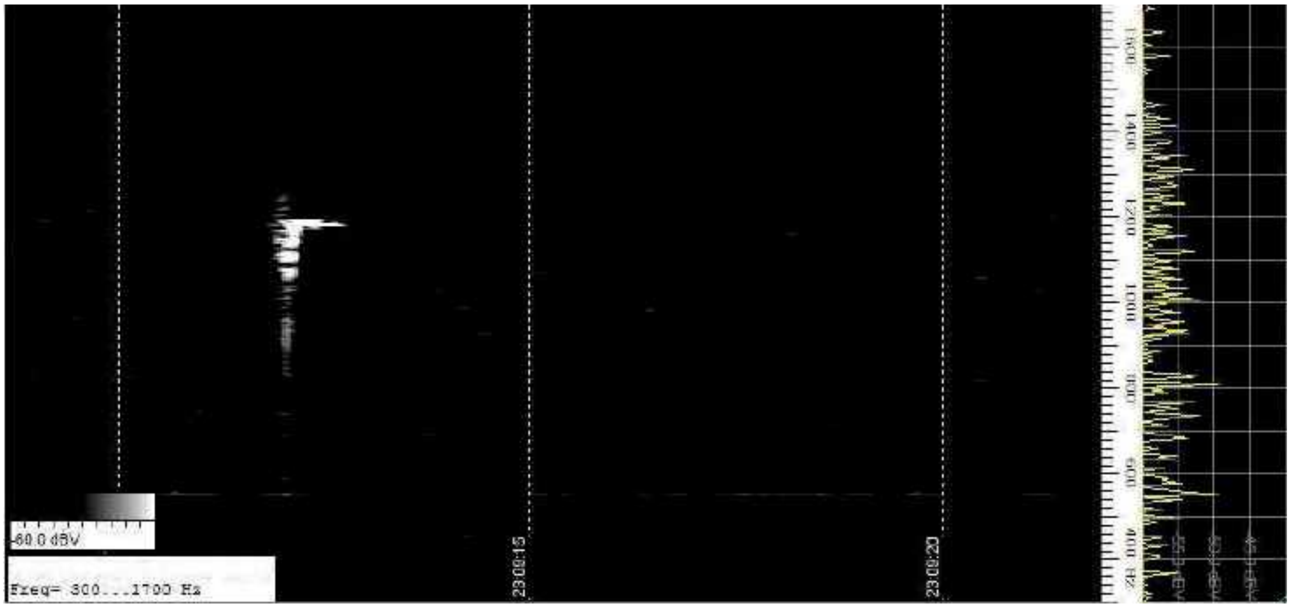


Fig.1.36 These tend to be intense echoes and suggest strong ionization from an over dense meteor trail that has been generated by a particle with a mass greater than 10^{-3}g. (D. Morgan)

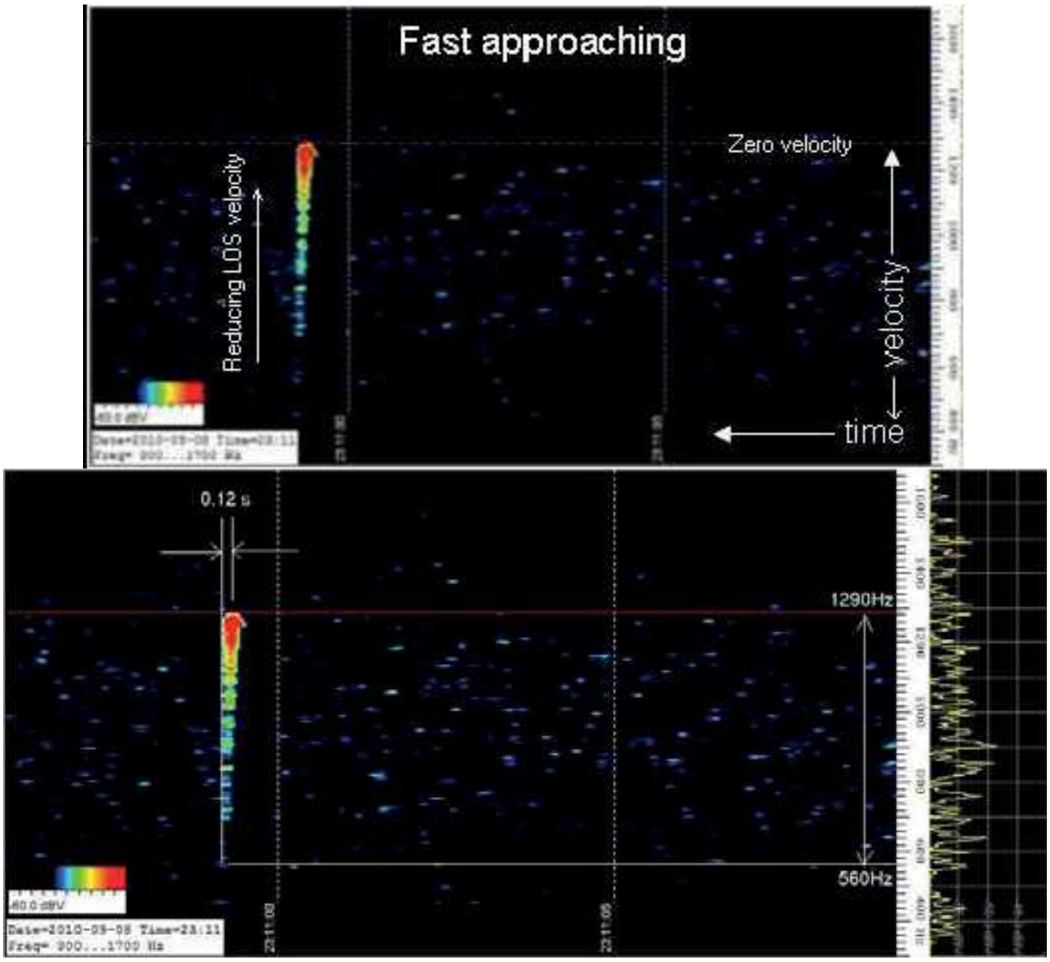


Fig.1.37 A rapidly decelerating Meteor trail. This type of record is relatively uncommon and may be observed on only a few occasions per hour in a meteor shower. The trail lasts for 0.12 seconds (at the sensitivity of this equipment) and the frequency change is 1290Hz - 560Hz = 730Hz (D. Morgan)

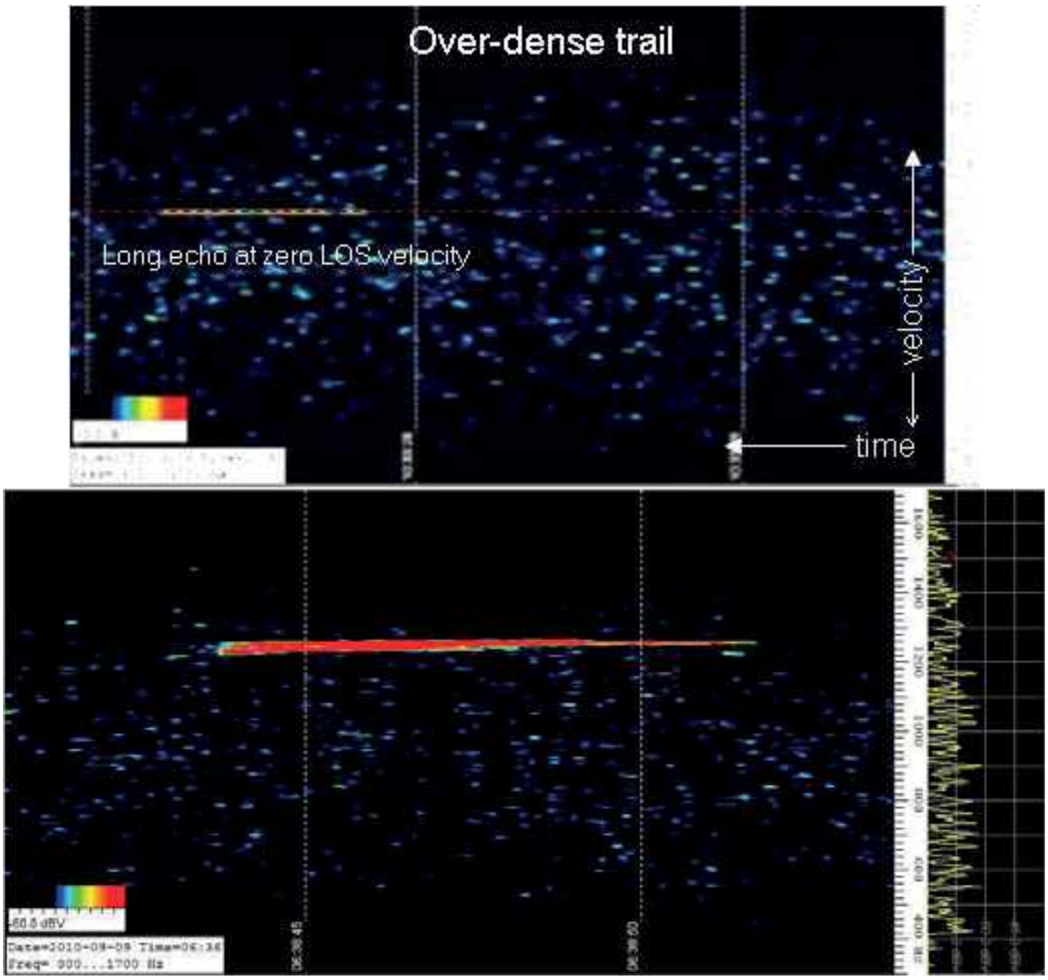


Fig.1.38 A long Meteor Trail Echo. This is probably a genuine meteor echo as it has some change in velocity over the period of its existence. This may be attributed to a drifting trail, possibly due to high speed – high altitude winds. It is not an aircraft. The echo from an aircraft usually shows no appreciable Doppler shift and the velocity profile of spacecraft or space debris can be clearly differentiated from this long echo. (D. Morgan)

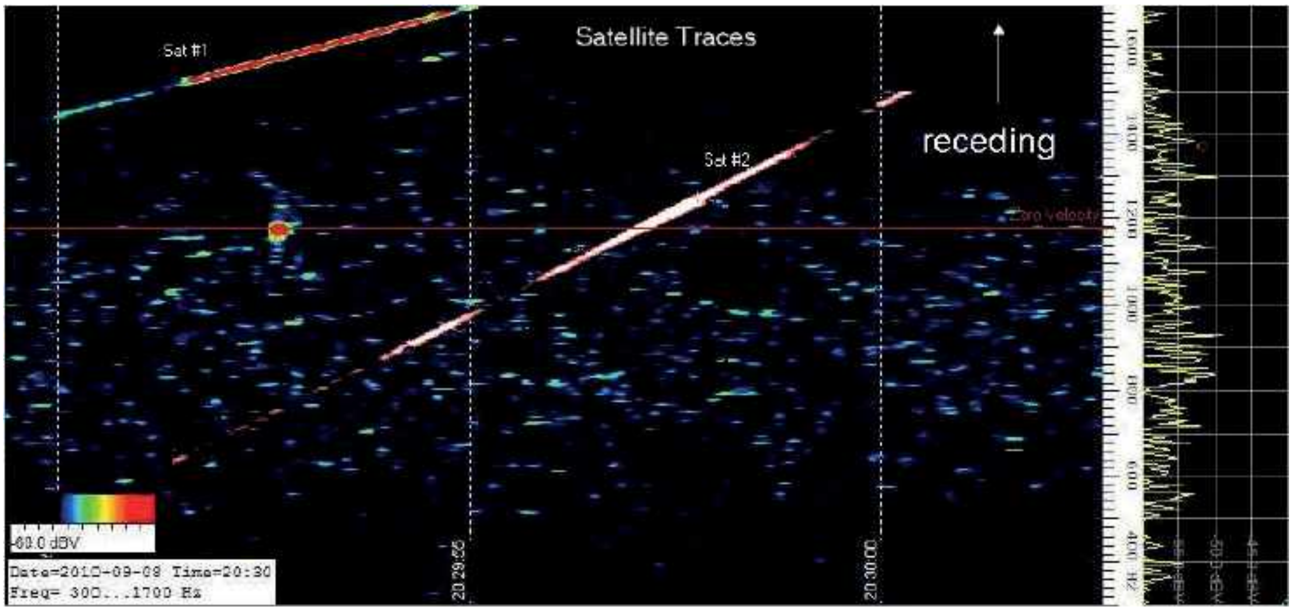


Fig.1.39 Artificial Satellite echoes. Satellites are easily distinguished from meteor echoes as they present a clean almost linear velocity profile over a few seconds. (D. Morgan)

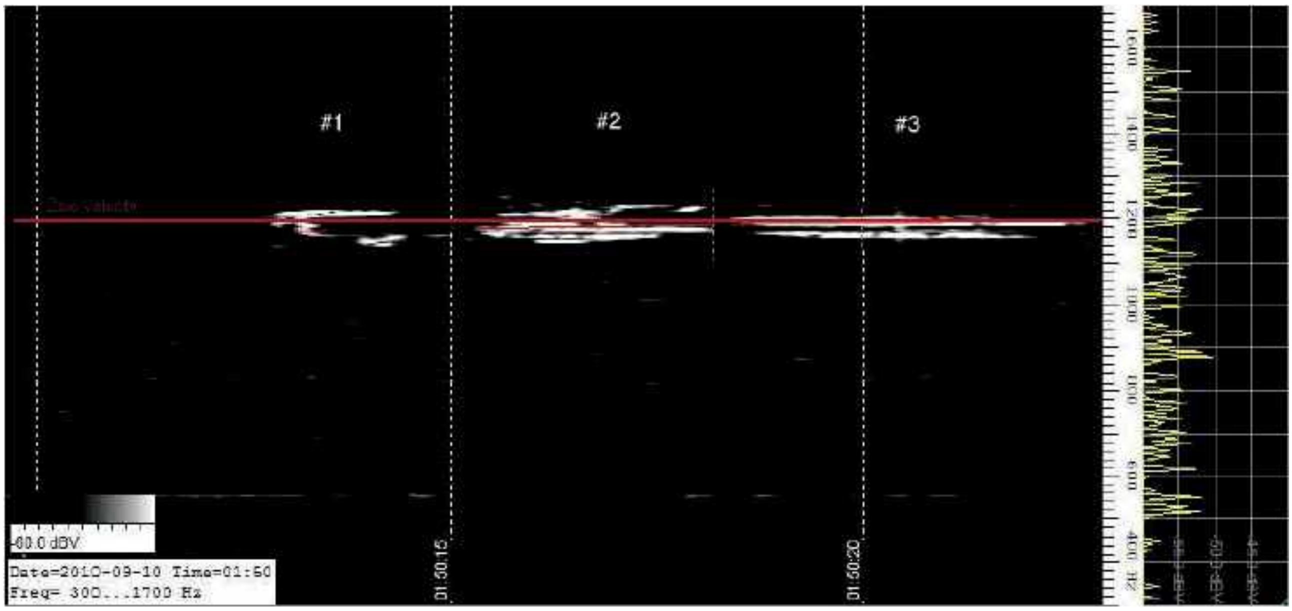


Fig.1.40 Examples of complex branched echoes. They present a challenge to interpret them and visualize what is happening during their generation. The forms are very variable, but there are some common features. There are components at different frequencies (velocities), they start at a defined time, they fade and may reappear at the same frequency and they may, as a collective, last for several seconds. It would be hazardous to propose a single explanation for the production of these forms and it is probable that a mix of processes contribute to their generation. For example, the meteor may 'break up' and produce regions of ionization that become disconnected and move with differing velocities. (D. Morgan)

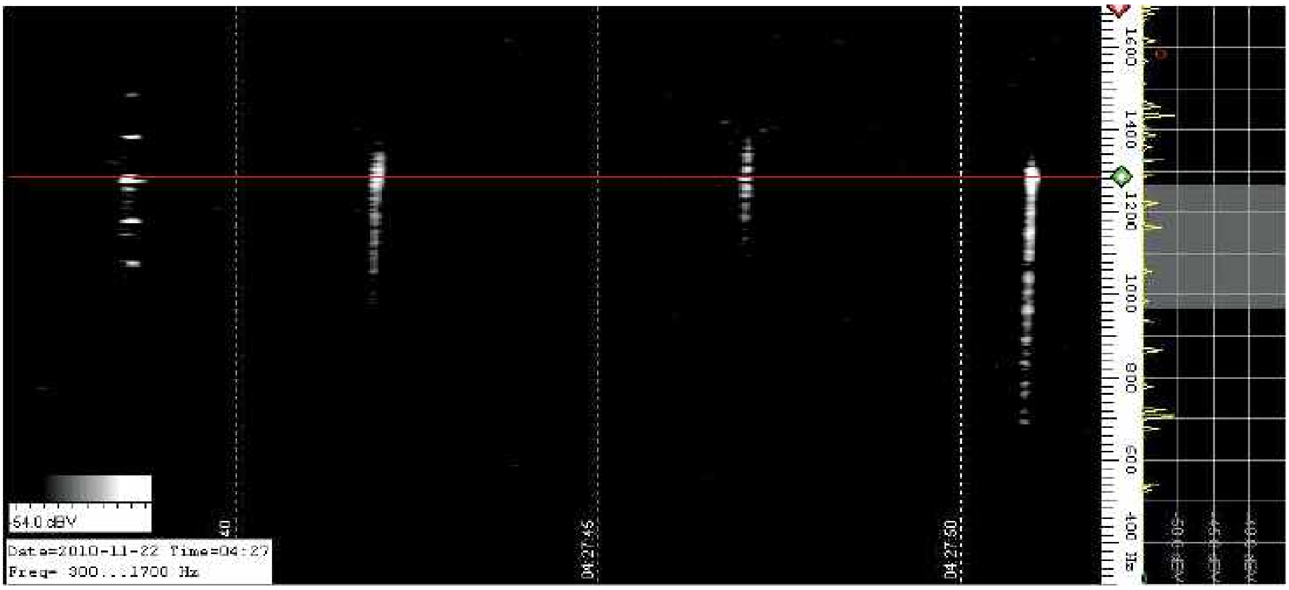


Fig.1.41 Possible example echoes from diffracted meteor trails. In many of the echoes produced by fast decelerating meteors that present a significant LOS velocity to the observer the frequency / time waterfall trace shows a regular pattern of signal variation. The regularity of the fading of the signal may be a clue to the mechanism involved. It is probable that the incident transmitter signal is being diffracted by a long ionised trail during its formation. (D. Morgan)

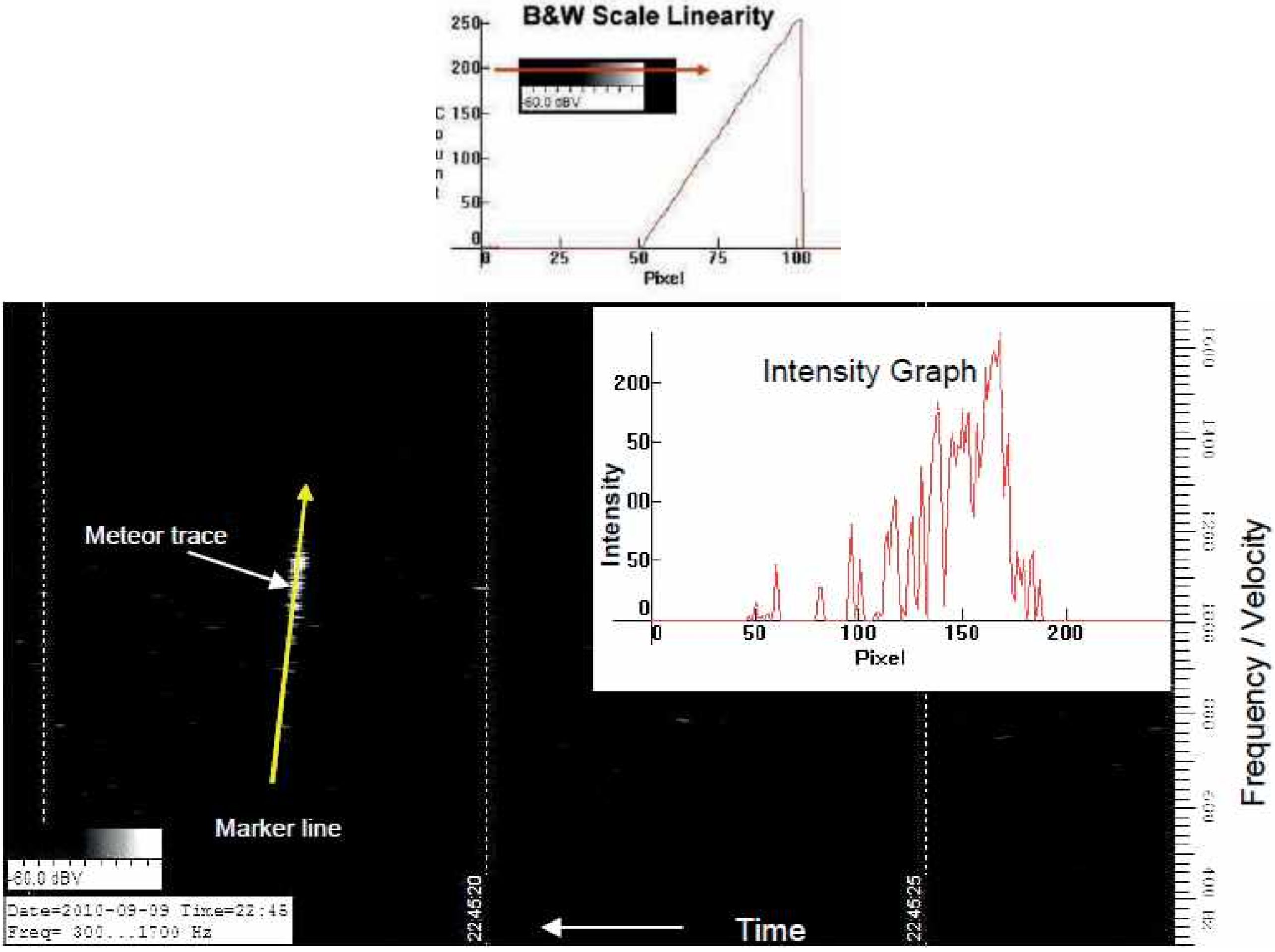


Fig.1.42 Using IRIS software intensity profile feature and intensity profiling of a meteor echo. In order to examine the variety of echo traces observed, it is useful to have a software tool that can produce a graph of signal intensity as a function of echo duration. Software packages such as IRIS can perform this task. The software enables the user to place a 'marker line' through the echo trace on the waterfall plot that defines the axis along which the intensity of the echo will be measured. A The software measures the intensity at each point along the line and plots a corresponding graph. (D. Morgan)

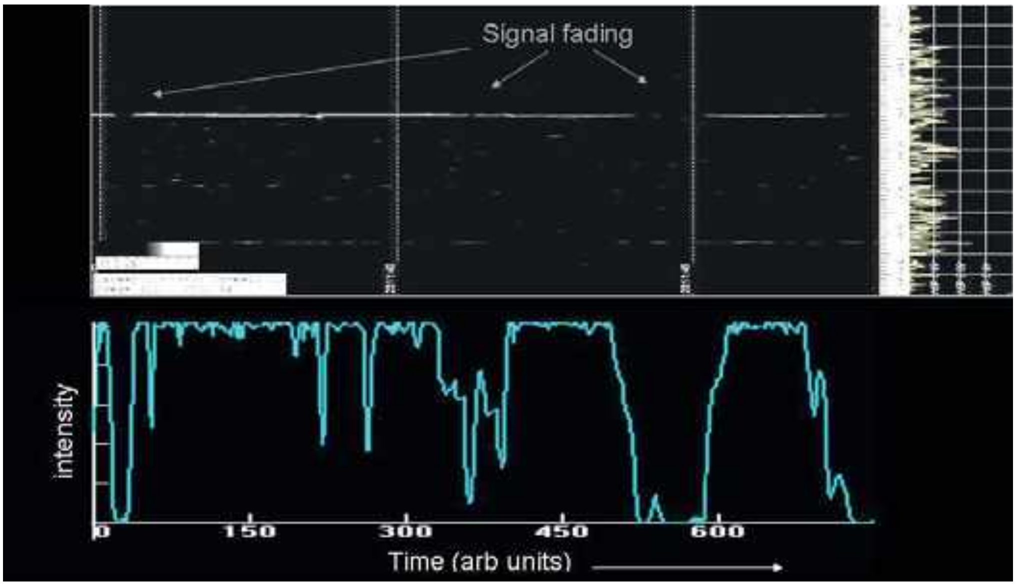


Fig.1.43 Intensity profile of an aircraft echo. We see that the very long-lived echo is 15 seconds long and has significant fading at periods during its life. The IRIS profiling tool has been used to generate the intensity graph shown in blue in the lower pane. This tool is key to analyzing the signal fading produced by diffraction of a meteor trail whilst forming. (D. Morgan)

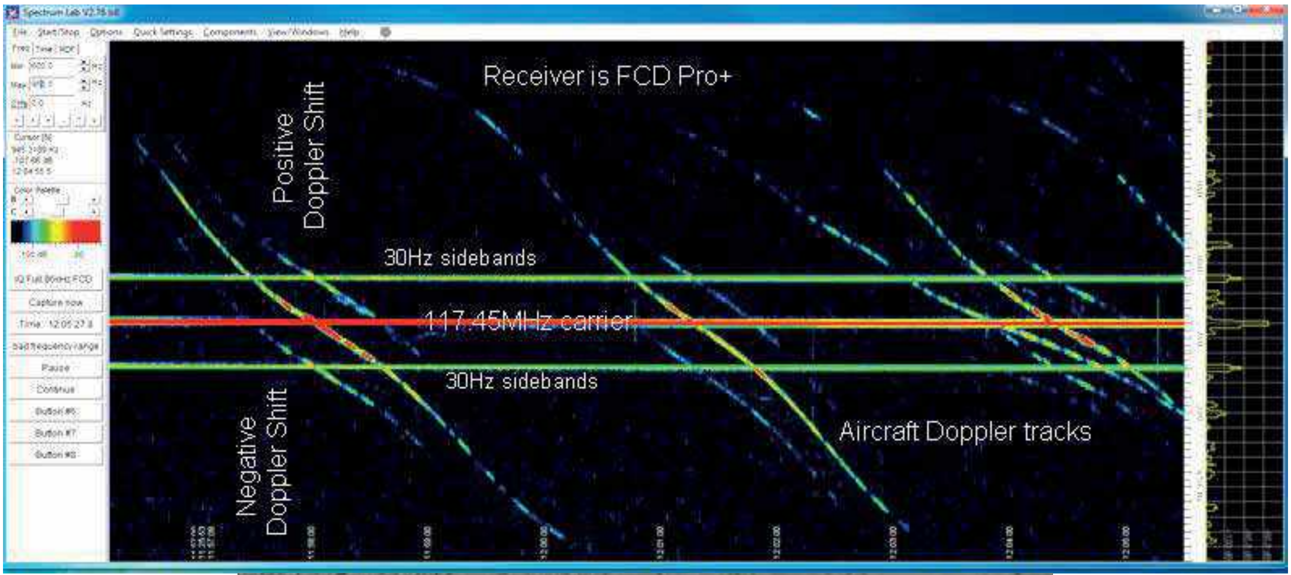


Fig.1.44 Aircraft Doppler Tracks from Brecon VOR (D. Morgan)

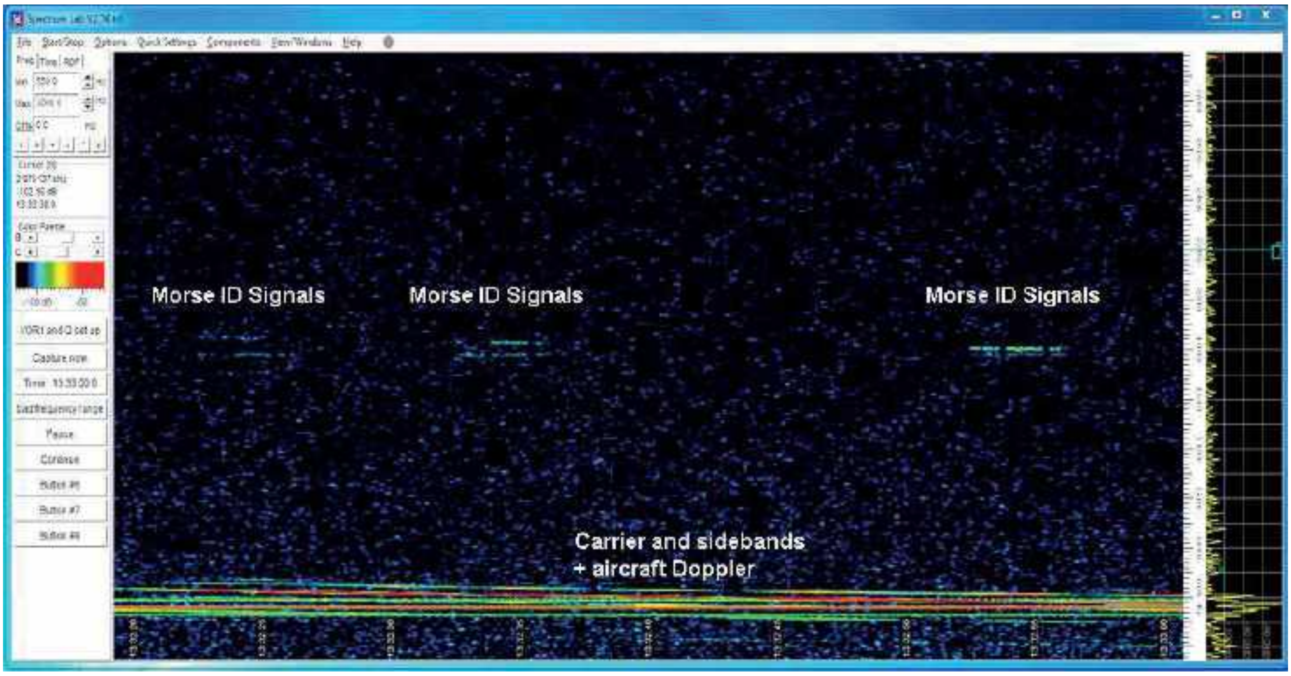
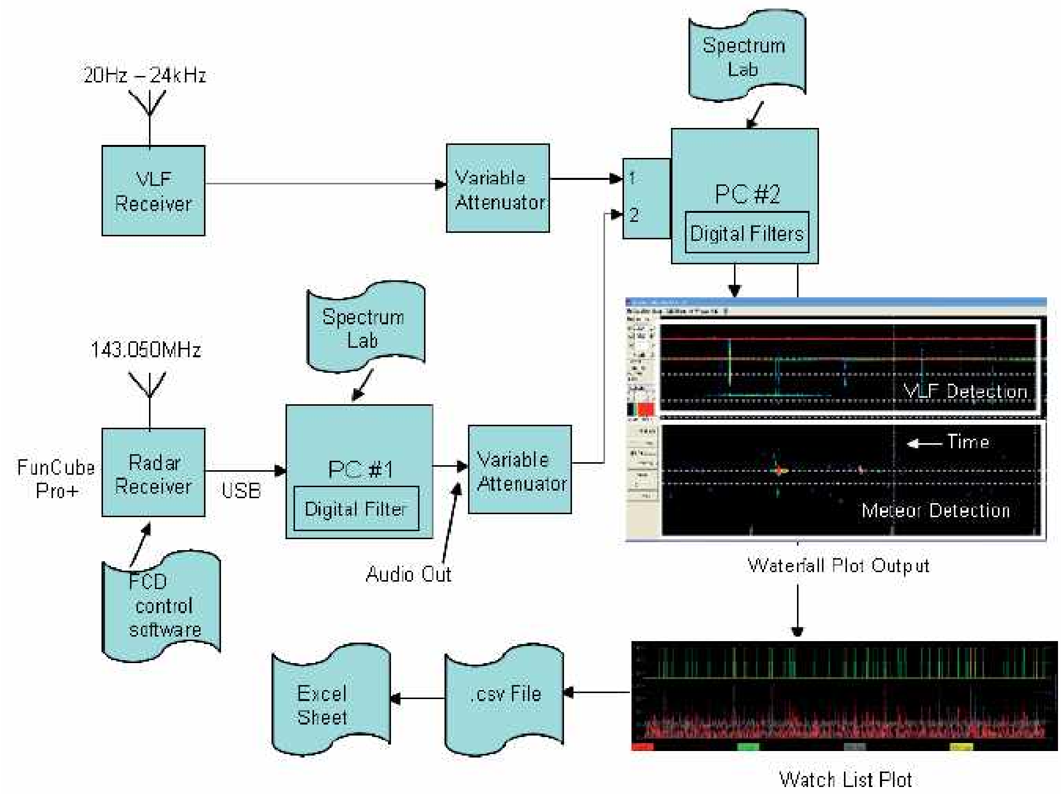


Fig.1.45 The beacon transmits an ID signal in morse code at F +1020Hz. (D. Morgan)



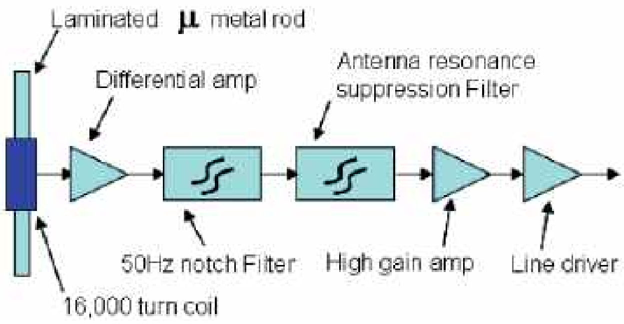


Fig.1.46 Compact wideband VLF receiver and the system block diagram (D. Morgan)

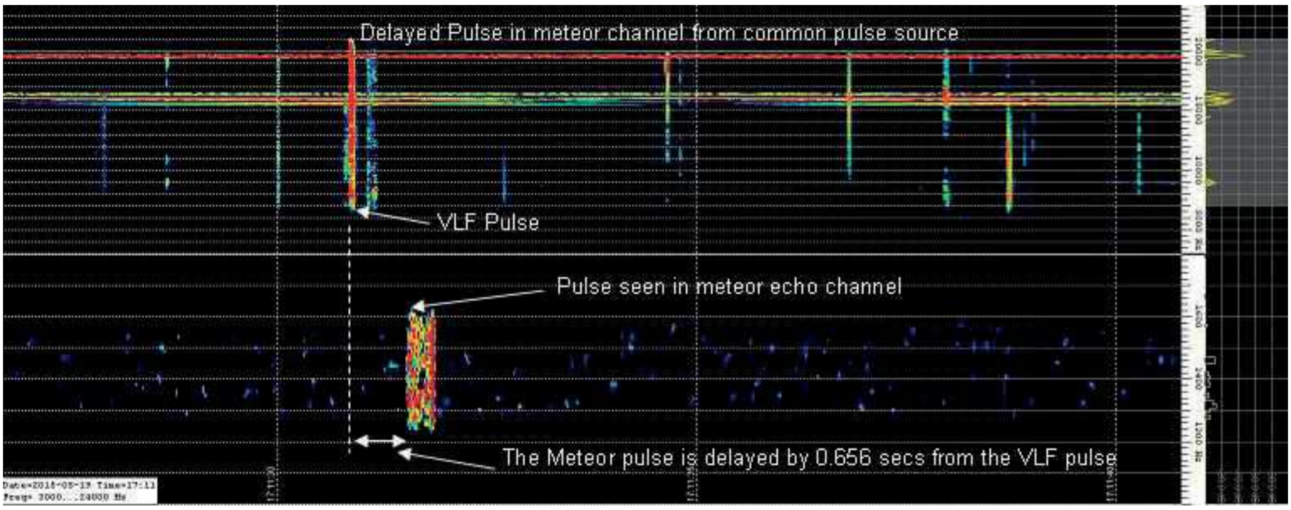


Fig.1.47 Calibrating the meteor channel delay (D. Morgan)

This is a concise but standardized reference of spectral fingerprints (reflectance, emissivity, and absorption characteristics) for commonly encountered aerospace and terrestrial materials.

Table 1.8 Analytical techniques

Technique	Spectral Range	Use case	Notes
VIS–NIR Spectroscopy (350–2500 nm)	Visible & Near-Infrared	Optical characterization of metals, ceramics, and composites.	Portable spectrometers or fiber-coupled systems.
FTIR Spectroscopy (2.5–25 µm)	Mid-Infrared	Molecular bonding and surface oxide identification.	Ideal for ceramics, polymers, and coatings.
X-Ray Fluorescence (XRF)	Elemental Composition	Rapid, non-destructive metal identification.	Confirm alloy composition in debris samples
Raman Spectroscopy (400–2000 cm^{-1})	Vibrational Fingerprinting	Detects crystal structure and lattice stress.	High specificity; sensitive to contaminants.
UV–Vis Reflectance	200–800 nm	Surface oxidation and plasma interactions.	Used for "flash event" spectral matching.

Table 1.9 Reference spectral database - common aerospace materials

Material	Peak reflectance / absorption features	Wavelength range (nm)	Notes and applications
Aluminum (Al)	High reflectance (90–95%) in 400–900 nm; weak absorption near 1200–1500 nm.	400–2500 nm	Common in aircraft alloys; bright optical returns in radar and optical.
Titanium (Ti)	Absorption peaks at 480, 780, and 1450 nm due to oxide film; emissivity increases in IR.	400–2500 nm	Used in high-temperature components; often forms TiO_2 layers.
Copper (Cu)	Distinct absorption near 580 nm (reddish reflectance); NIR drop above 1000 nm.	400–2500 nm	Characteristic reddish tone; conductive signature in XRF.
Magnesium Alloy (Mg–Al–Zn)	Broad reflectance plateau 400–800 nm; strong oxidation below 380 nm.	350–900 nm	Lightweight aerospace material; oxidizes rapidly.
Stainless Steel (Fe–Ni–Cr)	Multiple IR peaks at 1000–2500 nm; reflectance ~60%.	400–2500 nm	Common in aerospace structures and fasteners
Ceramics (Al_2O_3, SiC, ZrO_2)	Strong absorption in 850–1200 nm and 7–12 µm (FTIR).	NIR–MIR	Distinguishes thermal shielding materials.
Carbon Fiber Composite (CFRP)	Low reflectance (10–30%), broadband absorption.	400–2500 nm	Used in stealth materials; minimal radar signature.
Paint/Coating (Polymer-based)	Peaks vary by pigment; UV absorption below 350 nm typical.	200–1000 nm	Requires laboratory calibration for each color variant

Table 1.10 Reference spectral database - known plasma and thermal emissions

Source / Phenomenon	Peak wavelengths (nm)	Typical temperature (K)	Description
Lightning / Atmospheric plasma	337, 391, 427 (N_2, N_2^+ lines)	2000–10000 K	Standard reference for ionized nitrogen emissions.
Rocket Exhaust (LOX–RP1)	589 (Na), 656 (Hα), 777 (O)	2000–3000 K	Baseline for man-made plasma signatures.
Meteors / Bolides	520 (Fe), 589 (Na), 777 (O), 844 (Mg)	1500–6000 K	Common atmospheric entry emissions.
Hypersonic plasma (Mach >5)	Continuum emission 300–800 nm	>7000 K	High-energy boundary layer radiation.

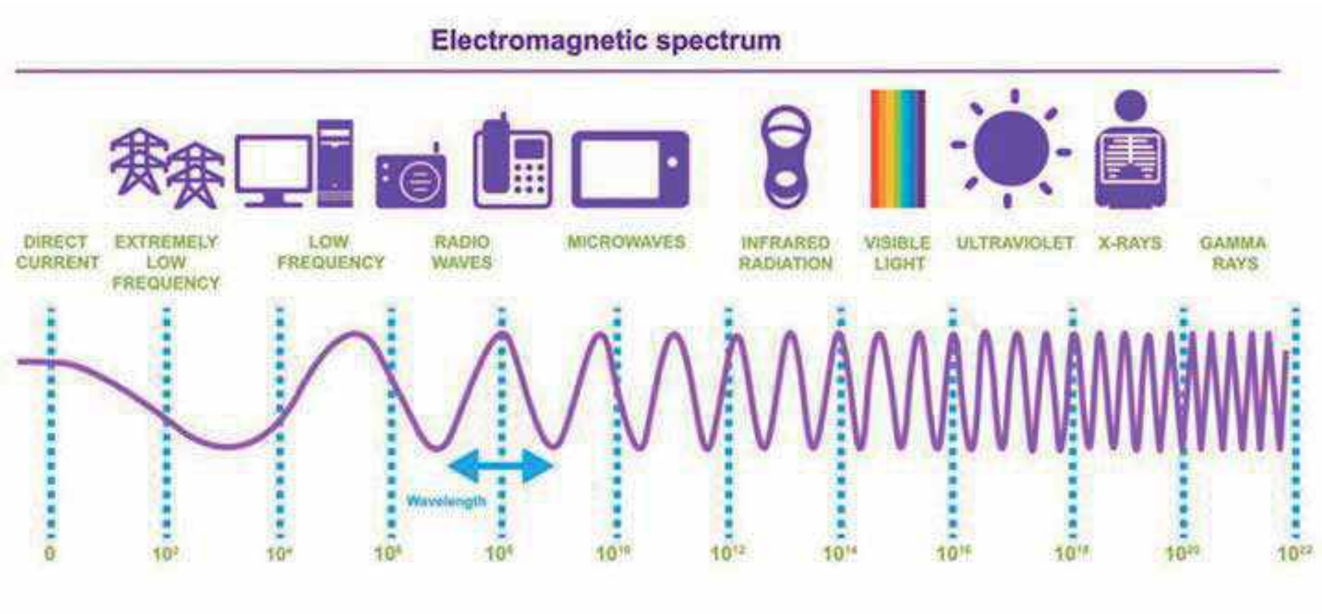


Fig.1.48 Electromagnetic spectrum (M. Alam, Z. Hasan)

Table 1.11 Recommended Metadata fields for spectral entries

Field Name	Description
Sample ID	Unique identifier for each material or spectral file.
Date of Acquisition	UTC timestamp of observation or sample testing.
Instrument Type	Spectrometer or imaging system used (model, serial).
Calibration Reference	Standard (e.g., NIST SRM 2035a).
Wavelength Range (nm/µm)	Full range of measurement.
Resolution (nm)	Spectral resolution or dispersion.
Environmental Context	Laboratory, field, or airborne conditions.
Cross-Verification ID	Link to correlated datasets (optical, radar, physical sample).
Data Integrity Hash	Cryptographic checksum for authenticity verification.

Integration into AI systems:
- Each verified spectrum should be stored in a machine-readable format (CSV/JSON/HDF5) compatible with AI training datasets.
- ML models (e.g., SpectralNet, CNN–LSTM hybrid classifiers) can be trained to automatically distinguish known materials from unknown anomalies.
- Data normalization: reflectance values standardized to 0–1 scale; wavelength interpolated to uniform 1 nm resolution.
- Cross-domain linking: tie each spectrum to radar cross-section, material density, and physical composition metadata.
- Expand the database to include high-altitude aerosols, plasma phenomena, and stealth materials.
- Integrate the dataset into the AI monitoring annex for real-time spectral anomaly detection.
- Establish international open-access repository for academic and defense collaboration.
- Develop automated spectral comparison API for field investigators using portable spectrometers.

Insights from Electronic Warfare (EW) demonstrate that manipulation, denial, or saturation of the spectrum can distort sensor data and alter apparent object behavior. Therefore, accurate radar, optical, and infrared correlation requires continuous monitoring of electromagnetic environment (EME) activity to distinguish genuine phenomena from electromagnetic interference or countermeasure effects.

In the study of Anomalous Aerospace Phenomena (AAP), no single sensor area can provide a complete physical description of an observed event. While the spectral and materials database supports the identification of material signatures and surface reflectance properties, radar and spectrum analysis extend this by offering independent measurements of object dynamics, range, and scattering behavior. The integration of these area - optical, spectral, infrared, and radar - is essential for establishing a cross-verified evidence chain. A phenomenon recorded simultaneously in multiple bands (e.g., visible and radar) allows for the extraction of mutually constrained parameters such as real velocity, temperature, emissivity, and radar cross-section (RCS).

Such data fusion increases analytical confidence and provides the foundation for automated classification models and physical hypothesis testing. This correlation process should always include: temporal synchronization of all sensors to a unified UTC timestamp; cross-comparison of spectral and radar profiles for consistency of motion and reflectivity; error propagation analysis to quantify multi-sensor uncertainty; AI-based correlation scoring to evaluate coherence between independent modalities.

The convergence of artificial intelligence, electronic warfare analytics, and multi-sensor AAP research underscores the necessity of integrated, automated monitoring infrastructures. As AI-driven classification and data fusion systems mature, their deployment within physical observation complexes becomes not merely advantageous but essential. By merging spectral, radar, and environmental datasets into synchronized monitoring architectures, it becomes possible to transform theoretical frameworks into operational instruments. The next section outlines how such integration is realized in practice through the design and application of the monitoring complex, serving as a bridge between analytical modeling and empirical observation.

1.10. Using the monitoring complex

The stationary monitoring complex (SMC) is a stationary, relative to the Earth's surface, autonomous automated complex of technical means for recording physical manifestations with minimal or no operator participation. The automation of the complex is caused by both the fundamental possibility of non-trivial spontaneous and permanent impact, and the large volume of data, the manual processing of which is not prompt, not effective and requires a significant staff. Another requirement for a complex of this type is autonomy. This is dictated by both the need to remove personnel from a potentially dangerous zone, and the reliability requirements due to work in a zone of possible anomalous (that is, not studied at this stage) impact. The possibility of the need to use non-standard operating modes also requires the implementation of an operational version of the complex. This implies the possibility of visual control of instrument readings, if necessary, manual control of both scientific and support equipment, the presence of communication facilities (at least emergency ones), the presence of means of protection and life support for personnel. It is advisable to place the SMC in rural areas, away from natural sources of electromagnetic interference, to eliminate false triggering. The only natural sources remaining are: thunderstorms, earthquakes and AAP.

The list of recommended equipment that can be placed in the SMC and connected autonomously to each other to output information to a computer, to perform complex monitoring of phenomena that have anomaly factors with digital recording of the received data:

1) Video-photo installation with a sufficiently high resolution and mechanical zoom optics for increasing without loss of quality, with the ability to automatically program tracking of moving phenomena at sufficiently high speeds.

But at night, any light is visible at great distances. It is impossible to determine the distance to a UFO at night visually without reference to stationary objects. We can see any moving satellites at great distances. Even if we see them directly above us, it is not at all necessary that they are directly above us - they can be over another country, but it will seem that it is over a neighboring area. Yes, satellites can move very quickly and not only in a straight line - when entering orbit, they can change the direction of movement, "hang in place", maneuver. No military-type UAV emits unnecessary light. No UAV "takes pictures with a flash", they are equipped with thermal imaging cameras and do not need backlighting to navigate. You can identify a UAV only by sound.

If you see something flying but do not hear it - it is either not a UAV, or it is very far from you. If you see a light on the horizon that is not moving, it could be anything. Under normal conditions with "ideal" terrain, an object that is 25 meters above the ground (communications stations, CHP pipes) will be visible at a distance of almost 18 kilometers. An object that is 50 meters high - at a distance of more than 25 kilometers.

2) An installed thermal imager, or on video-photo installations diffraction gratings for spectral observations or a spectrograph coaxial with the optical axis of the video-photo equipment.

It is worth noting that it is much more difficult to identify objects that are not moving with a thermal imager, while an infrared (IR) camera, like a night vision device (NVD), can see UFOs when they are not visible to the naked eye. But if you can see light without the NVD, you will only see more light with the NVD.

3) Small-sized passive radar station (PR) with moving target selection (MTS).

We do not use active radar, as it may interfere with the operation of other radars; we will have enough reflection from UFOs due to the operation of other radars.

4) Small meteorological station with: anemometer, hygrometer, barometer, thermometer, compass, wind direction measurement, etc.

5) Other devices are used in accordance with the tasks set: GPS navigator for measuring the coordinates of the observation site, angle measuring devices for measuring the azimuth and angular height of the AAP, night vision devices in the infrared range, thermal imagers, scintillating radiation sensors, magnetometer, interferometer, LIDAR, portable wide-range radio, two-mirror resonator, etc.

Fig.1.49 Example of the "Blue Box" SMC for recording AAP in the Hessdalen Valley and well as time-lapse photography, Norway (AMS, Project Hessdalen)

Fig.1.50 Automatic detection and registration stations UFOCatch-1 and UFOCatch-2 are installed on a freely rotating mounting system (UFO-science)

Fig. 1.51 All Sky Cam used in modern meteorology is also a kind of budget-class SMC (AllSkyCam.com)

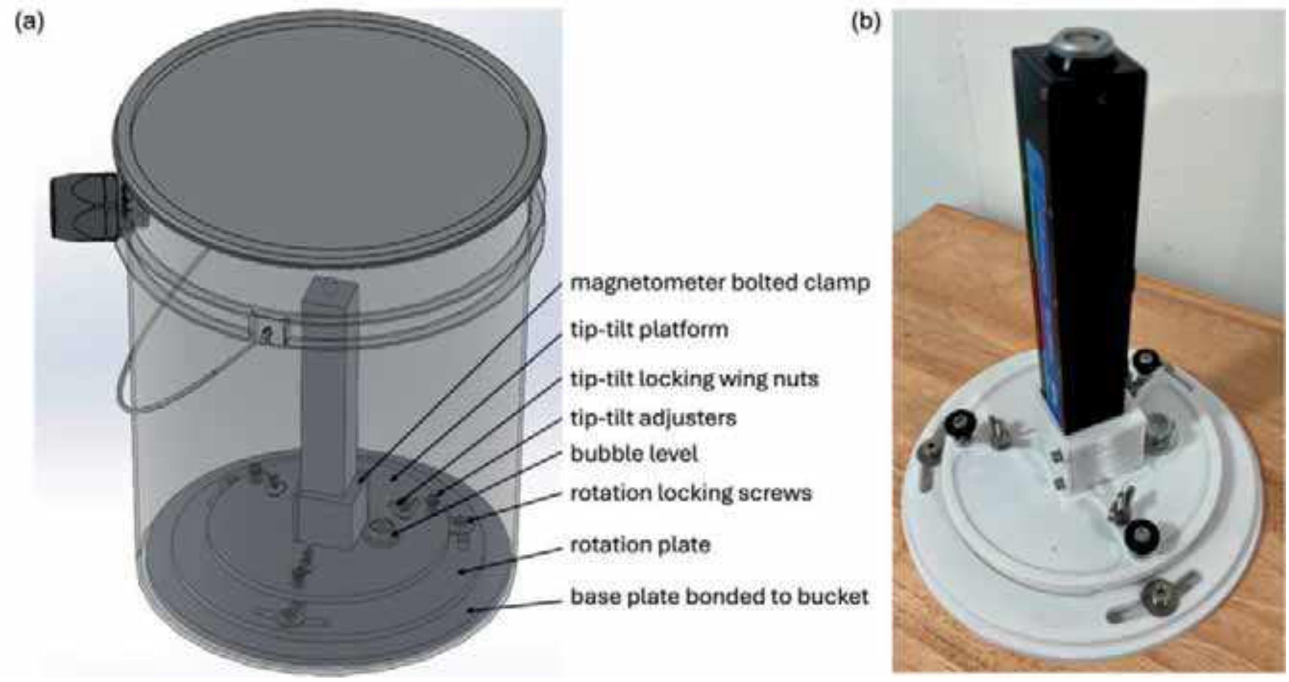


Fig. 1.52 Geomagnetic variometer (Galileo Project)

In modern monitoring frameworks, a geomagnetic variometer station functions as an auxiliary diagnostic instrument that continuously tracks subtle fluctuations of the ambient magnetic field. The process begins with a high-precision fluxgate magnetometer, which is first calibrated against a reference scalar magnetometer to account for temperature-dependent drift and instrument offsets. Once deployed - typically underground to ensure thermal stability and isolation from human-made interference - the sensor records three-axis magnetic field variations at high sampling rates, while a dedicated acquisition system digitizes and stores the data. Throughout operation, the station establishes a baseline shaped primarily by Earth's internal geomagnetic sources and natural ionospheric currents. Any departures from this baseline are then compared against independent magnetic observatory data to distinguish environmental disturbances, such as geomagnetic storms, from localized anomalies. When integrated into a multi-sensor monitoring complex, these magnetic measurements become a complementary channel that can highlight transient perturbations coincident with optical, IR, acoustic, or radar detections - thereby strengthening event validation, enabling cross-modal correlations, and providing a controlled physical context for interpreting potential anomalous signatures.

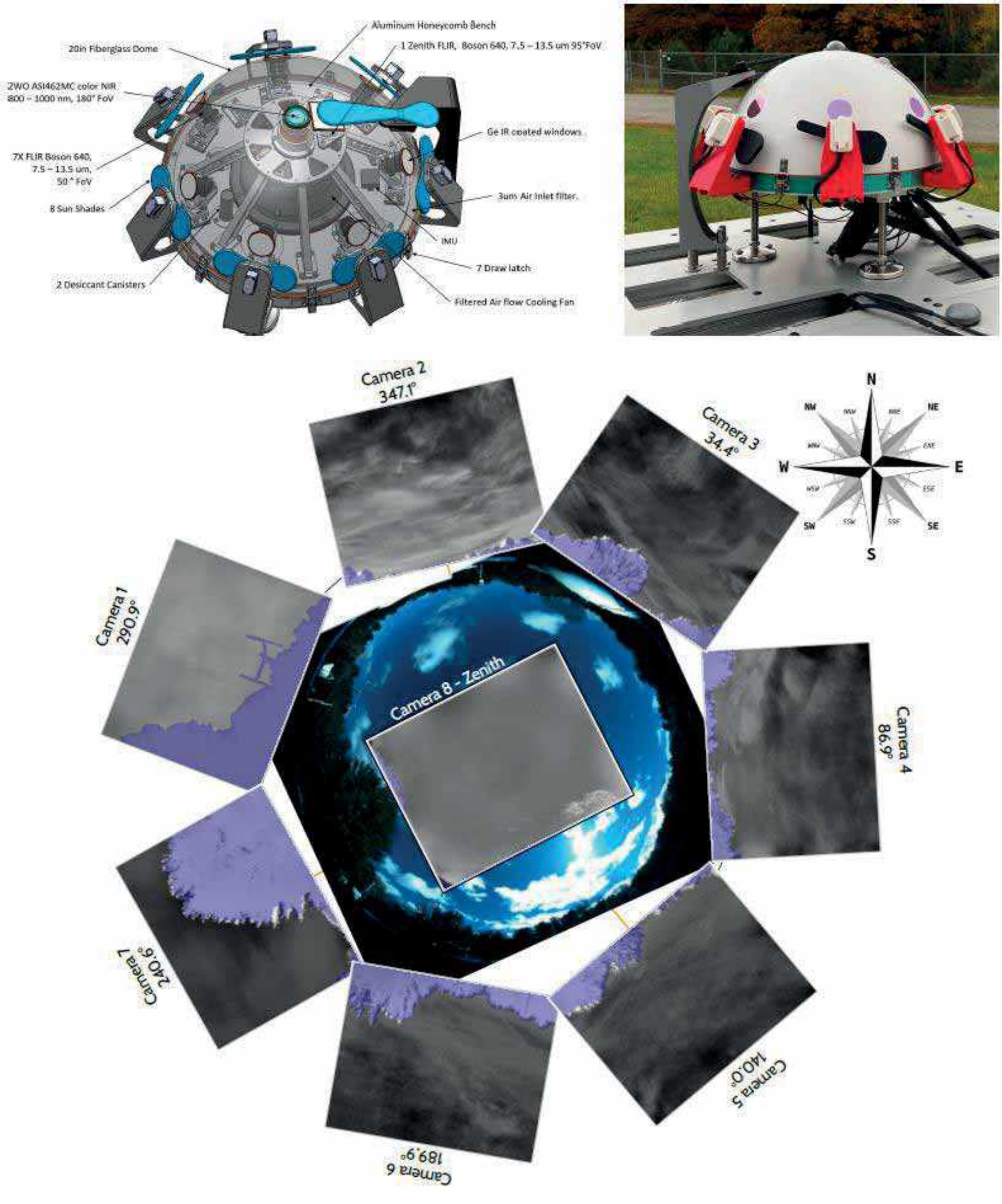


Fig. 1.52 Map view of a mosaic of images from the seven hemispheric cameras and the one zenith Boson IR camera (Sensors, Galileo Project)

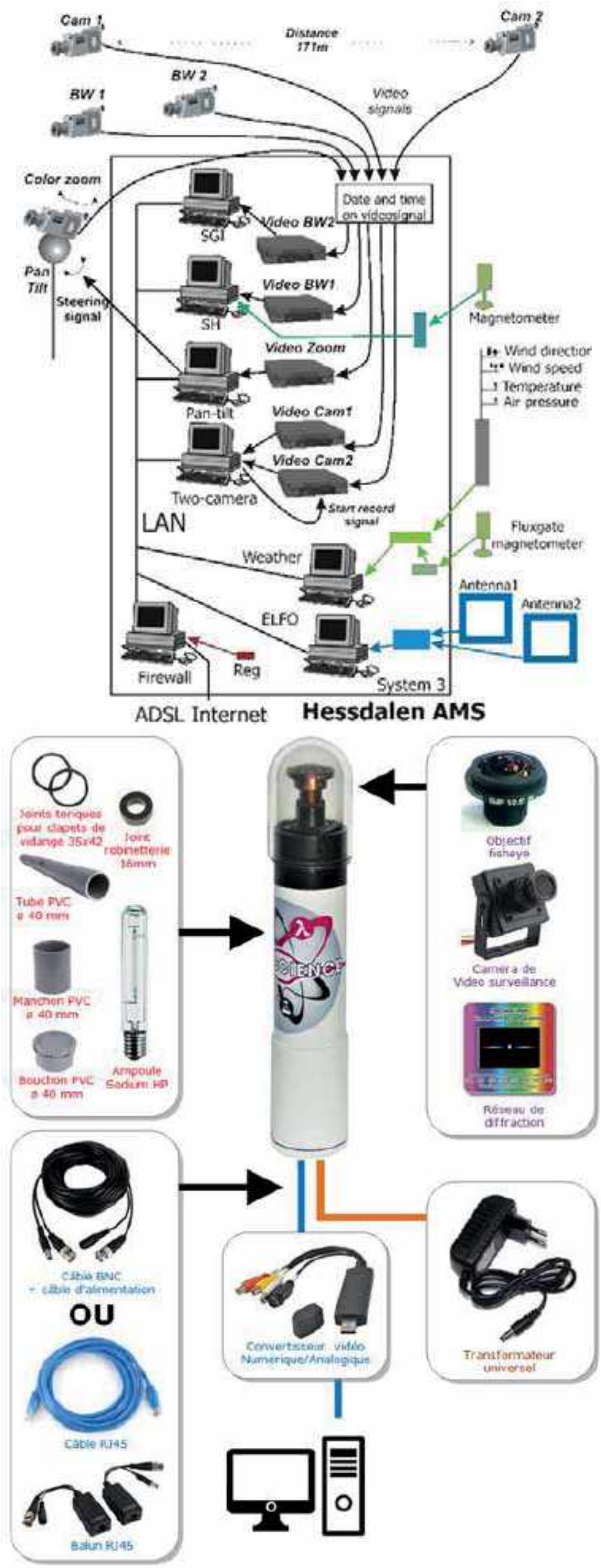


Fig. 1.53 The structure of the SMC, united into a single whole by means of a computer network and automatic detection programs (AMS Project Hessdalen, UFO-science)

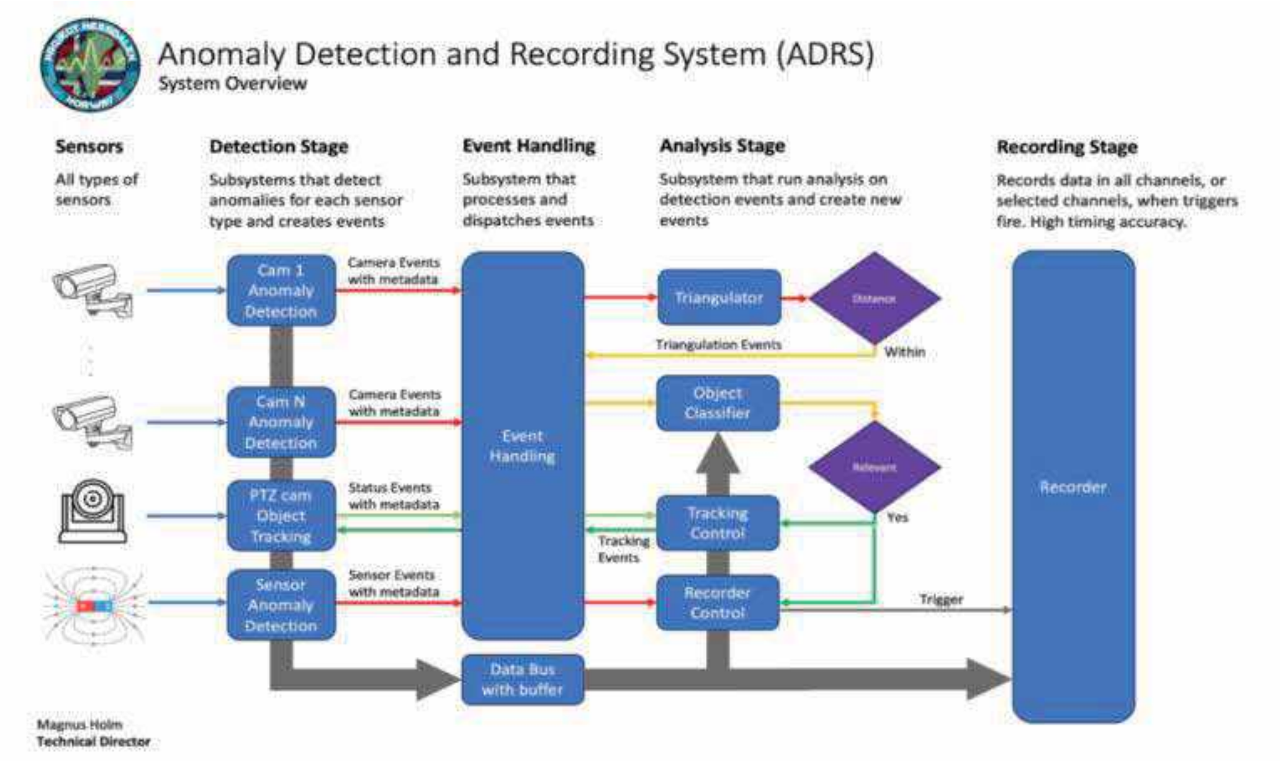


Fig. 1.54 The basic technical composition of the Blue Box UAP monitoring station: Two highly sensitive synchronous Bosch UHO-POE-10 optical range cameras. They have an automatic heating system for operation in extreme cold. - One highly sensitive camera Reolink RLC-823A-16x with the ability to move (PTZ) and change the zoom; Two directional antennas for detecting electromagnetic radiation; Weather station (measuring pressure, air humidity, wind speed and direction, temperature); Raymarine RD418HD 18 "4 KW HD COLOR RADOME microwave civilian radar; Wireless equipment. A Wifi bridge is used to the nearest houses in the valley, where a connection to a dedicated channel has already been arranged; Server, regular PC, laptop, router and uninterruptible power supply; Despite the fact that the station is capable of operating in autonomous mode, it has an operator's workstation (Project Hessdalen)

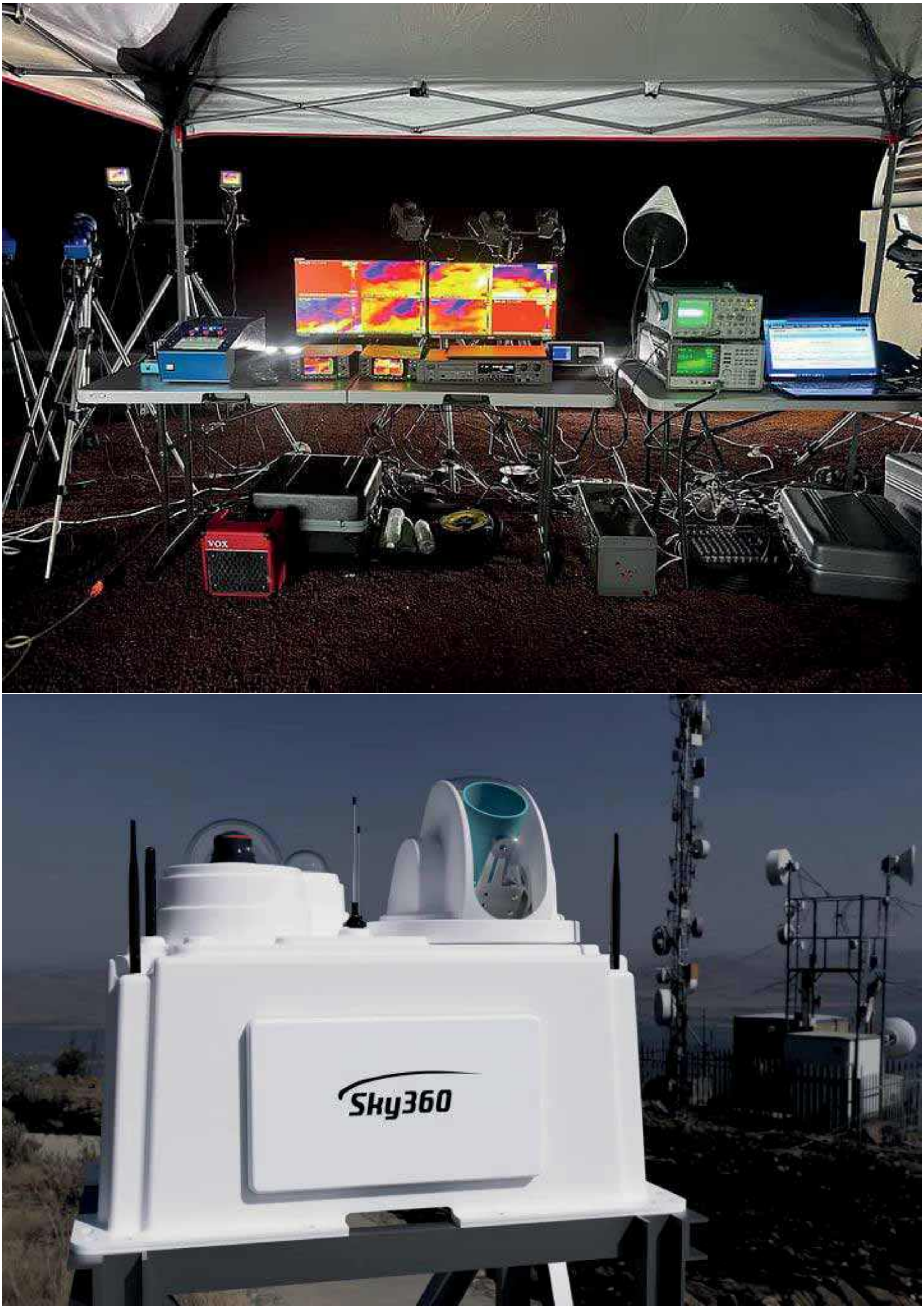


Fig. 1.55 Infrared cameras and associated equipment UFODAP and Sky360 station

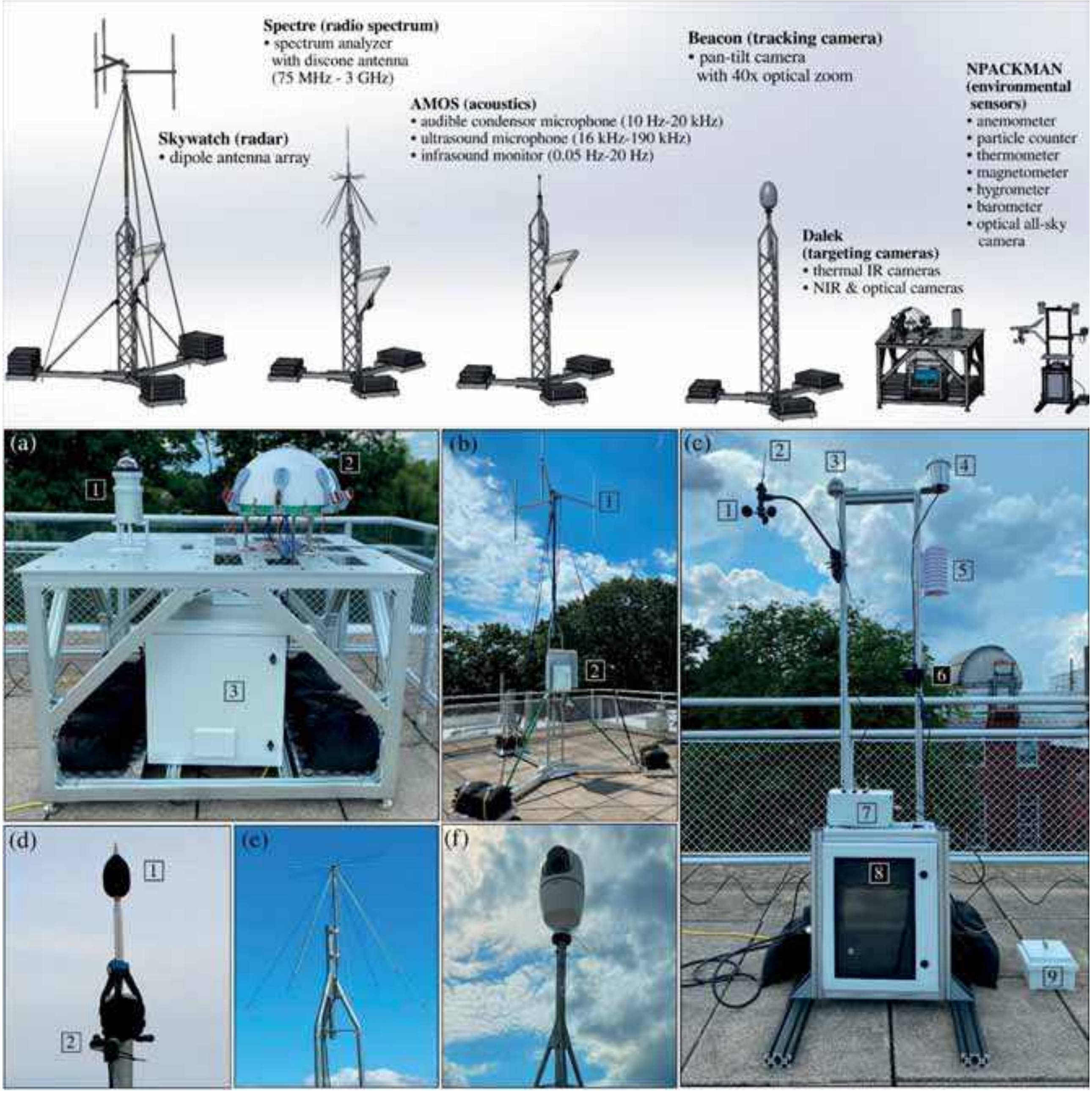


Fig. 1.56 Mechanical designs of the Phase 1 Observatory-class instrumentation suite on the rooftop of the Harvard-Smithsonian Center for Astrophysics (CfA).

Photographs of Phase 1 Observatory-class instrumentation suite on the rooftop of the CfA. (a) 1. ALCOR OMEA 9C allsky camera; 2. Dalek hemispherical array of 8 LWIR microbolometer cameras (covered) and single optical + near-infrared all-sky camera; 3. Weatherproof enclosure for instrument computers. (b) SkyWatch radar tower: 1. dipole antenna array; 2. Electronics enclosure. (c) NPACKMAN environmental monitoring system: 1. anemometer; 2. wind vane; 3. rain sensor; 4. optical all-sky camera; 5. temperature and pressure sensors; 6. camera fuse/switch box; 7. scintillation particle counter; 8. power and data module; 9. °uxgate magnetometer. (d) 1. GRAS audible microphone; 2. Wildlife Acoustics ultrasound microphone; infrasonic sensor not shown. (e) Discone wide-band antenna for spectrum analyzer (Spectre). (f) Beacon 8 narrow-feld pan-tilt-zoom camera.

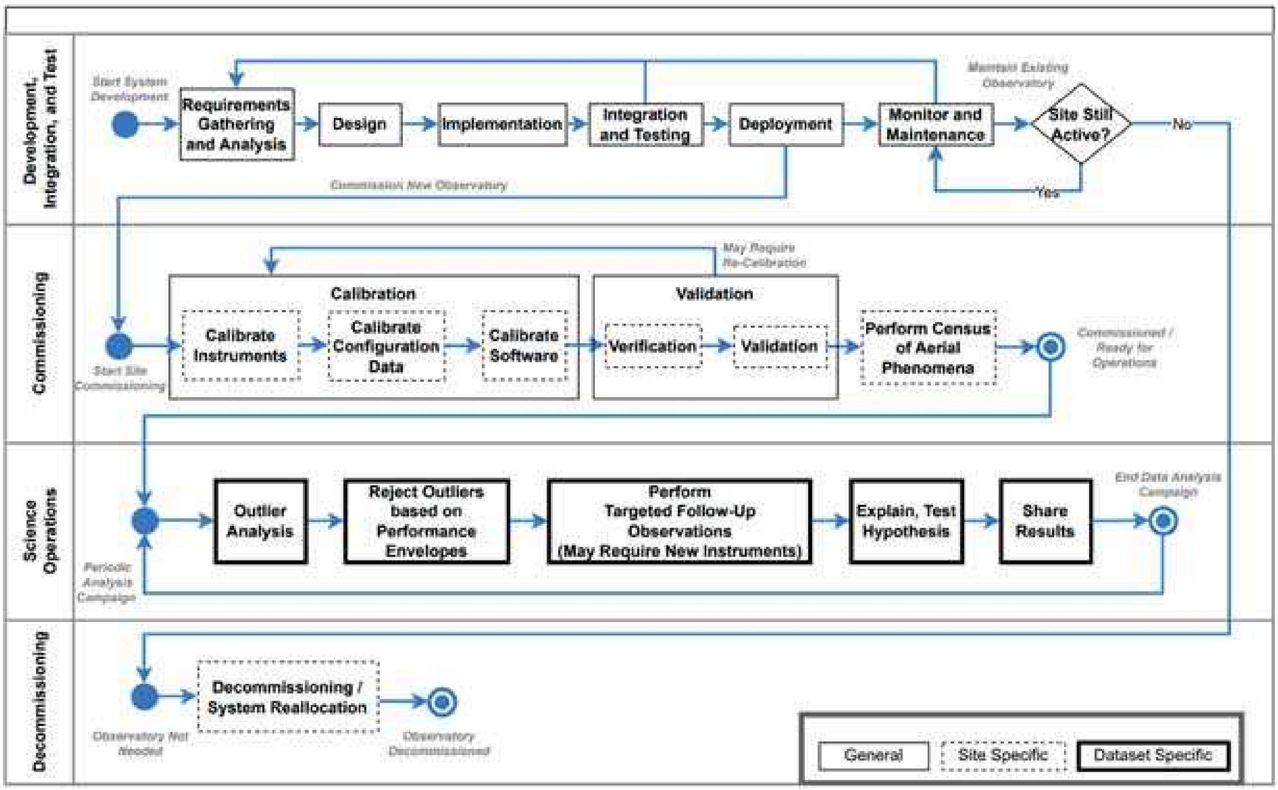


Fig. 1.57 Observatory Class Integrated Computing Platform (OCICP) system life cycle diagram depicting the key activities across the four system life-cycle phases (Galileo Project)

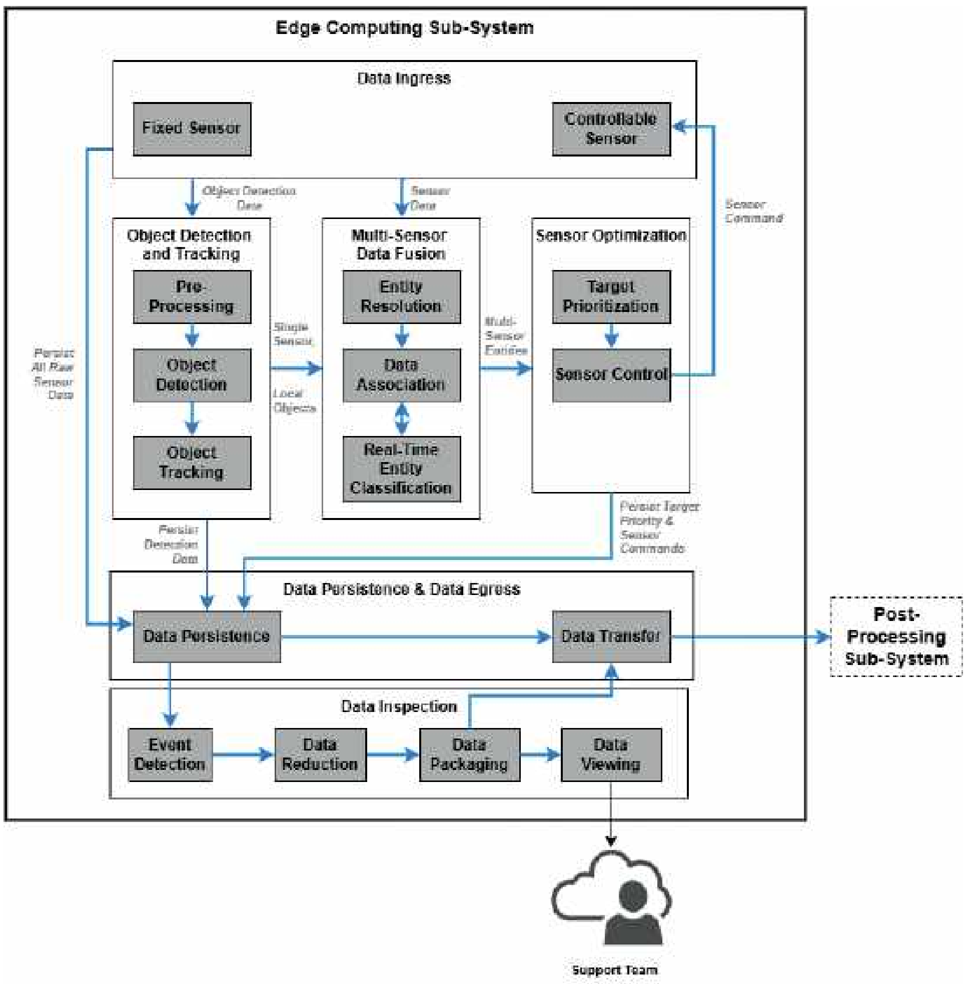


Fig. 1.58 Edge Computing Subsystem design diagram depicting the functional decomposition of the Edge Computing Subsystem and the primary interactions (Galileo Project)

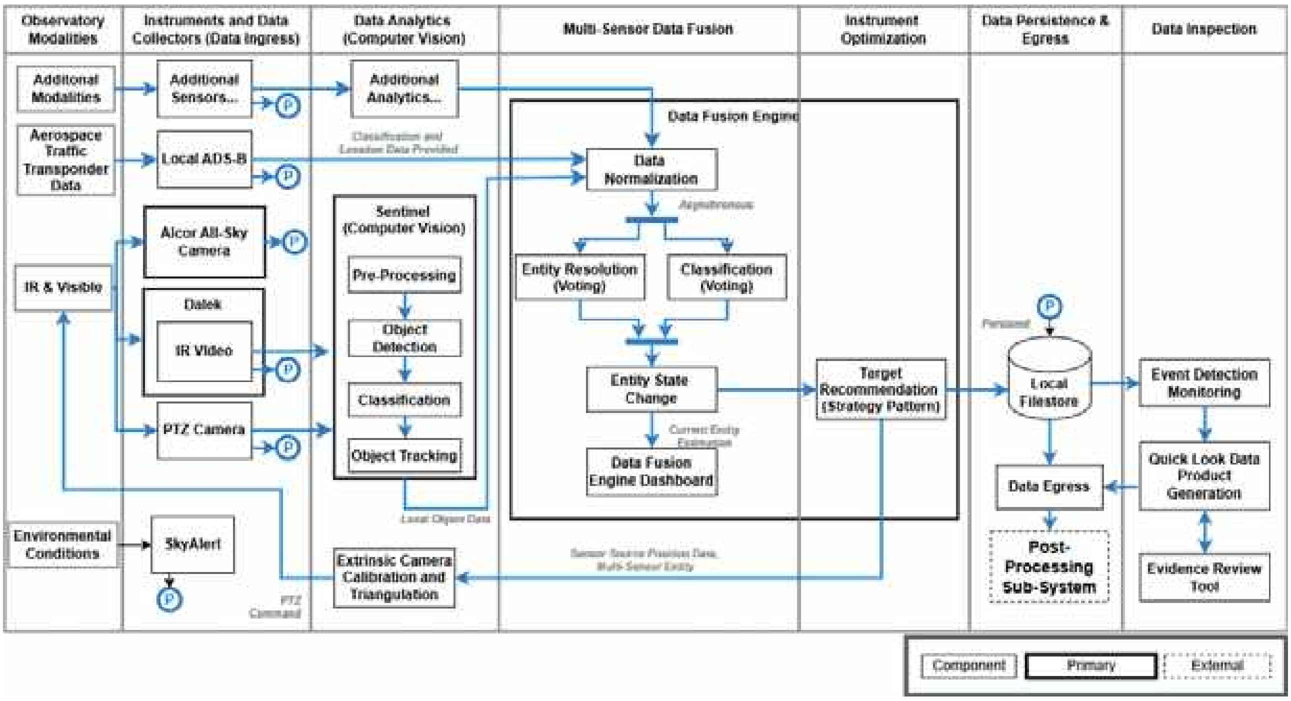


Fig. 1.59 Edge Computing Subsystem Component interaction diagram depicting the implemented components and primary interactions, organized by capability categories. (Galileo Project)

Contemporary airspace observation methodologies increasingly rely on integrated, multi-source monitoring frameworks in which visual, radar, radio-frequency, and acoustic data are analyzed jointly rather than in isolation. Such approaches emphasize the assessment of observable characteristics, behavioral patterns, and signal consistency, while explicitly accounting for uncertainty and sensor limitations. The inclusion of expert evaluation within the analytical loop remains essential, as automated systems alone cannot reliably resolve all ambiguous cases. This methodology enables structured handling of unidentified observations by focusing on measurable effects, data quality, and operational relevance, rather than speculative attribution.

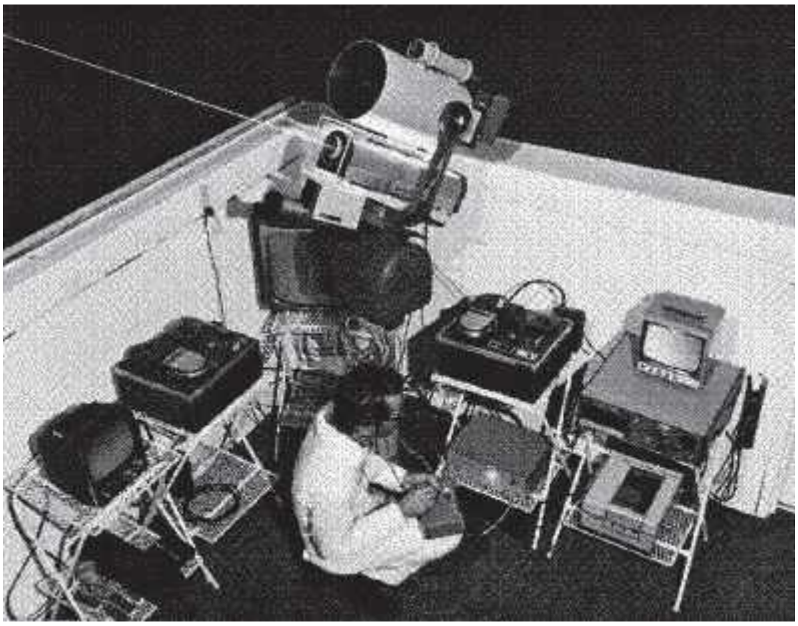


Fig. 1.60 One of the very first SMC, called UFO/Video Experiment Console for Transitional-Overt Response (Journal of Instrumental UFO Research Vol1 No1 October 1975)

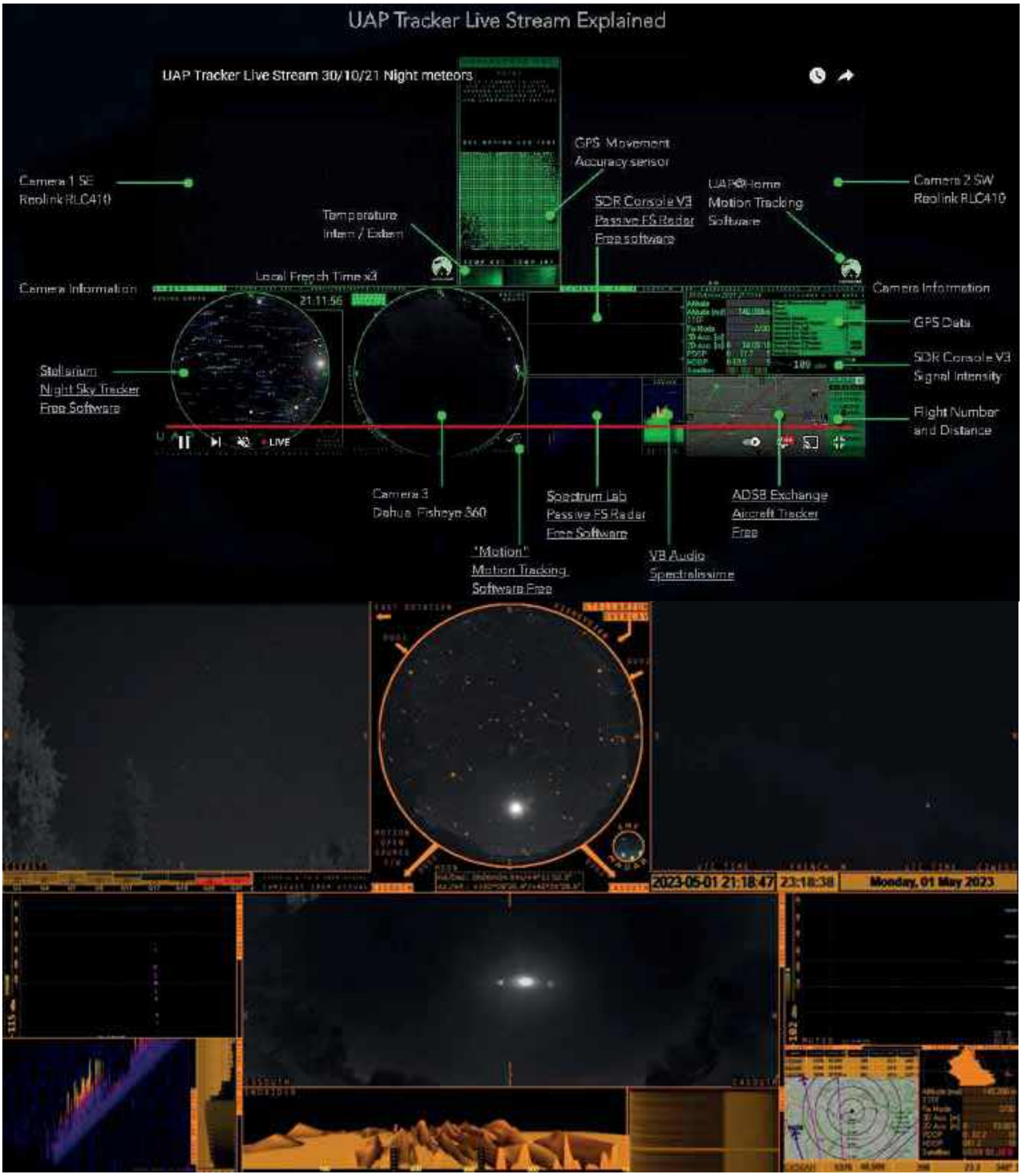


Fig. 1.61 UAP Tracker, Sky360

A mobile monitoring complex (MMC) is the installation of equipment of a static monitoring complex (SMC) as an option on a vehicle platform, to perform tasks of recording and measuring some characteristics of phenomena in which anomaly factors are present, as well as delivering the necessary equipment directly to the places where the phenomena impact the environment, with the possibility of conducting primary laboratory analyses of both collected samples and SMC data inside the vehicle.

Fig.1.62 UFOTOG project - for performing complex monitoring tasks (D. Trumbull)

Fig.1.63 One of the first MMC, Lancashire, 1968 (R. Winstanley, BUFORA)

Fig.1.64 One of the first MMC with installed thermal imaging equipment, Nightcrawler "Eye on the Sky" (J. Tedesco, G. Tedesco)

A field mobile laboratory (FML) is required to perform tasks on delivery to the impact site and collection of samples, as well as for primary laboratory analysis.
List of necessary equipment that can be placed in the FML:

1) For laboratory analysis and collection of material samples at the site of the phenomenon: camera, voice recorder, journal and pen for notes, thermometer, microscope, luminoscope, pH meter, magnifying glass, equipment for obtaining data from the spectrum, chromatography, cyto-histological studies of plants, geological and chemical studies of the soil, compass, 50-meter tape measure, marking pins, marking tape, scotch tape, clothespins, sterile containers, plastic bags, sample collection shovels, permanent felt-tip markers, scissors, stationery knife, refrigerated container with dry ice, etc.

2) Protective equipment: insulating chemical protection or radiation protection suits, latex gloves, gloves for dry ice treatment, rubber boots, a mask and a box with filters for a gas mask with the maximum possible filters from various types of gases, or an autonomous oxygen supply; means of protection from wild animals - gas canisters, electric shock, firecrackers or starting pistols; personal hygiene products, car first aid kits with a first aid manual and drugs (check expiration date), fire extinguishers, etc. If necessary, the FML can also be combined with the MMC, making the car platform more universal.

See also applications of wideband radio receiver: exact time at 77 kHz; conversations of train drivers and dispatchers at 2130-2150 kHz; sea and river vessels 150-300 MHz; signals of airport beacons at 400-600 kHz; pilots and dispatchers, ATIS and ACARS at 117-137 MHz; signals of NOAA weather satellites 137 MHz; 1-5 GHz signals of GPS, Bluetooth, Wi-Fi, DECT; radio broadcasting 66-108 MHz; analog television 40-820 MHz; SSTV 14 MHz; CiB radios 27-28 MHz; LPD radios 433 MHz; PMR radios 446 MHz; police, firefighters, ambulance 144-170 MHz, security 450 MHz; mobile phone conversations 850-900 and 1800-1900 MHz; neutral hydrogen radiation in space 1420 MHz (21.1 cm); hydroxyl ions 1665 MHz (18 cm). The radio receiver can be used as a metal detector, tuning it to maximum amplitude modulation (AM). In civilian radio receivers: long waves 148.5-283.5 kHz (LW, AM), medium waves 526.5-1606.5 kHz (MW, AM), short waves 3.95-26.1 MHz (SW, AM), ultrashort waves 62-108 MHz (VHF, FM frequency). There are also quite a few frequencies used by the military, including for controlling drones, and they can often be on civilian frequencies: UVB-76 "The Buzzer" 4625 kHz; GNSS navigation band 1170–1260 MHz and 1500–1620 MHz etc.

Fig.1.65 Operation Baronne - not only monitoring, but also a field laboratory (UFO-science)

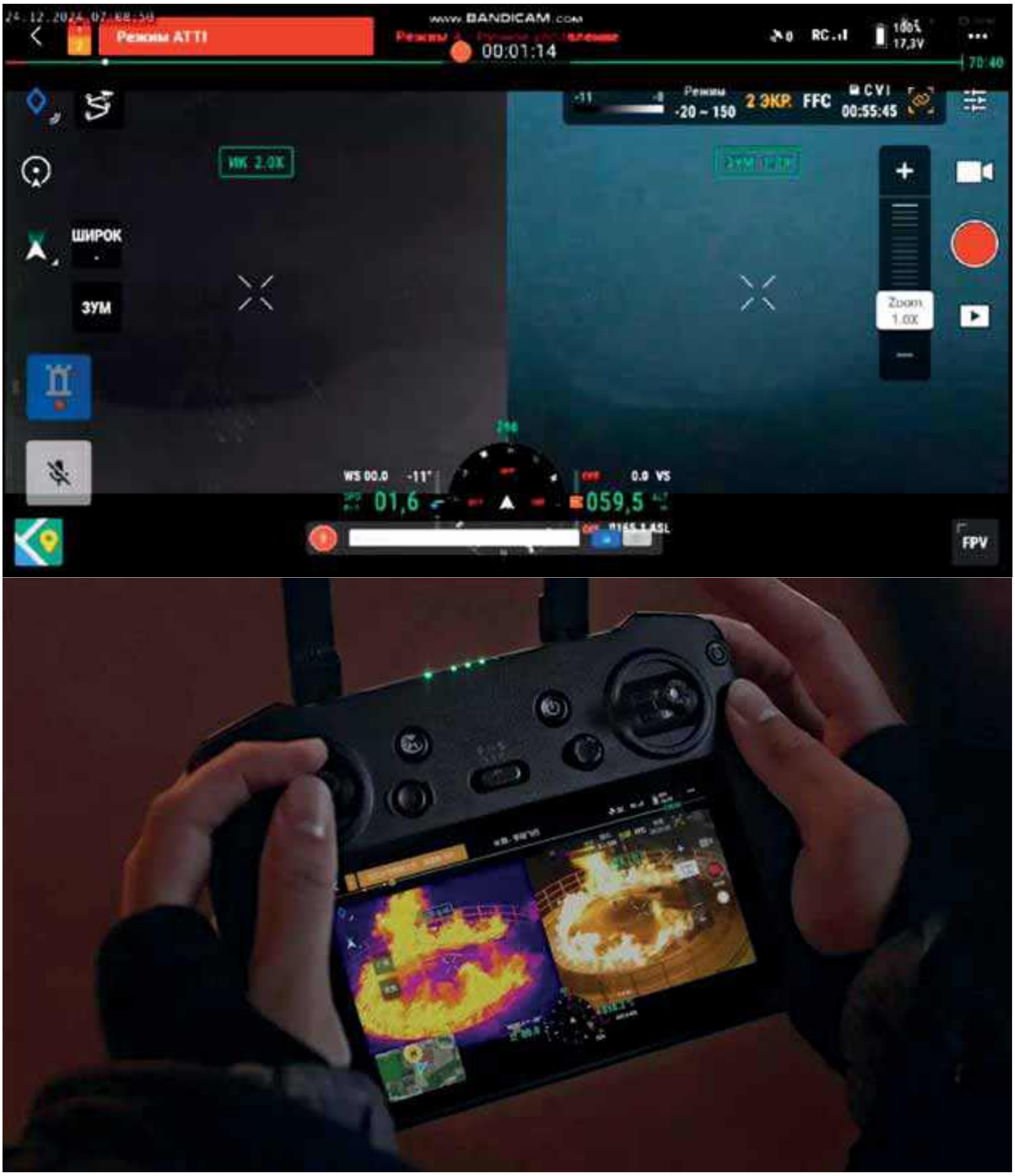


Fig.1.66 Shooting from a Mavic 3T drone in a ukraine war zone, SPLIT mode, in conditions of limited visibility (fog). The objects in the video in infrared mode are a group of 5 spherical or elongated bodies with blurred contours, followed by a distinct thermal plume, which may indicate jets during movement (it may also be inertial fractals of pixelation due to matrix lag and reduced video quality). To analyze this kind of video, you need to know in detail all the performance characteristics of the drone and at least take a course on controlling such drones. In essence, drones with such performance characteristics are miniature MMC. (SRCAA "Zond")

1.11. Automated monitoring network

Automated monitoring network (AMN) is a semi-autonomous automated monitoring network, where the identification process is performed by a computer. AMN can include both SMC and MMC, as well as monitoring complexes placed on UAVs, balloons, satellites, etc. AMN can also be integrated into existing monitoring systems, obtaining satellite images or aerial photography, and used together with a network of meteorological stations for continuous monitoring of the air situation, which will allow implementing the possibilities of environmental monitoring, early detection and prevention of forest fires, border protection, military perimeters and other urgent tasks.

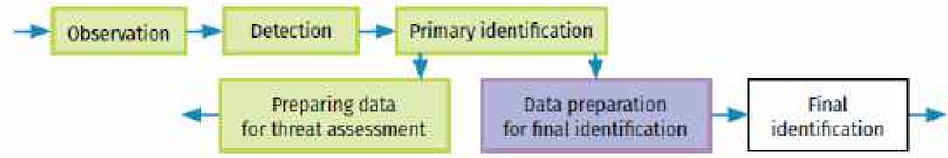


Fig.1.67 Main stages of aerospace objects and phenomena monitoring (A. Bilyk, SRCAA "Zond")

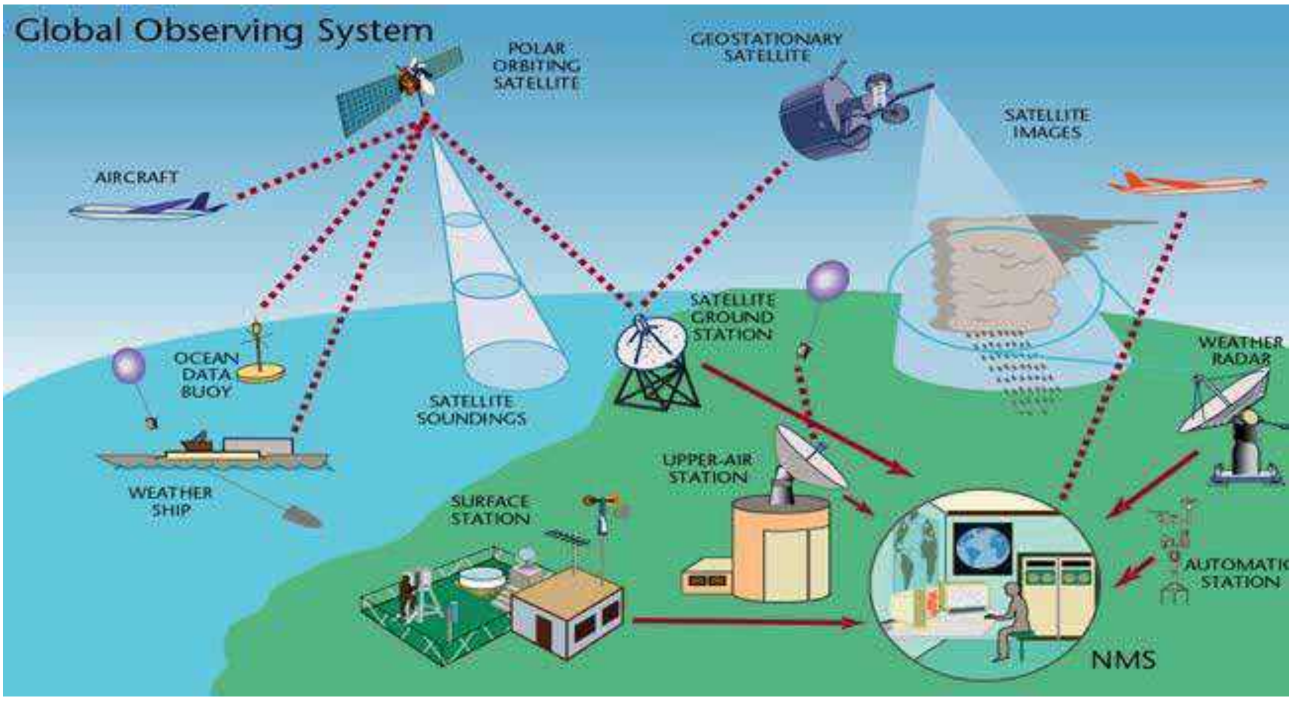


Fig.1.68 Scheme of the automated monitoring network (World Meteorological Organization)

Further unification of registration systems into the Global Worldwide Network of Near-Earth Monitoring is inevitable. Thus, at least over the greater part of the globe, tracking of events on its surface, in air and outer space will be established, with registration of parameters that are accessible to known technologies. This will allow solving problems not only of early detection, localization and collection of information about AAP, but also the problems of forecasting their appearance and their development in time.

The urgent need for such a system has long been ripe in ecology, astronomy and other industries, regardless of the source of origin of objects, registration of their physical parameters for research purposes is of considerable value for the creation of new technologies, development of security programs and sustainability of our civilization. The unification of observation systems into the Global Worldwide Network of Near-Earth Monitoring is already possible now on the basis of existing space monitoring systems, which have land, sea and space basing and are located in different countries. This can resolve the situation that has arisen now, when a huge amount of data is collected, most of which is not analyzed and even destroyed due to storage limitations. This is another challenge for civilization, but also an opportunity to increase knowledge about the world around us and our influence on it.

Fig. 1.69 An example of one of the implemented global monitoring systems in the world, to which AMN (GEOSS) can be connected

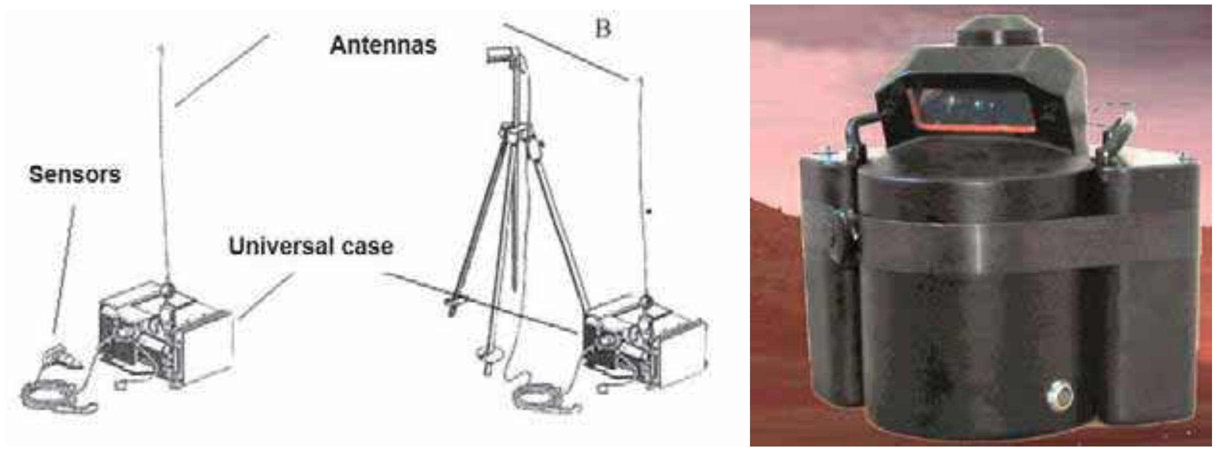


Fig.1.70 Example of a set of equipment for monitoring in unfavorable terrain (REMBASS, UGI)

Capabilities of the AMN Public control and access to such systems are very important, which allows to avoid their use for surveillance by exclusive states or organizations for the purpose of population control. Undoubtedly, the formation of the Global World Network of Near-Earth Monitoring will lead to an even greater increase in information flows. This aspect requires an improved procedural part, in particular, it challenges the algorithms of signal and image processing systems. However, this will primarily allow centralized processing of a priori information and obtaining homogeneous and transparent data in real time, timely development of reaction and research strategies.

The option of the existence of a decentralized AMN is also possible - this system consists of a network of equal and non-hierarchical elements. Each element is built according to the modular principle. The center and the most important part of the element is the processor unit, to which a set of sensors and a communication module are connected. All modules communicate with the processor using the same protocol, which provides the ability to increase the number of modules or replace some sensors with others. The processor unit has a database (DB), which contains a certain number (on the order of several hundred or thousands) of imperatives – elementary instructions for a particular event, as well as a combination of events.

Using sensors, elements monitor the environment and, if a detected event matches an imperative embedded in the DB, act according to the instructions, for example, transmit a message to a specific address. Using communication modules, elements build a network where each element has its own unique address. An information packet can be transmitted either directly to another element or retransmitted by one or more elements to the final addressee.

This eliminates the need to install powerful communication modules and solves the problem of failure of one or more network elements. To detect flying objects at night, an optical monitoring system of the starry sky can be used. The principle of operation is based on the fact that the module uses a video camera to observe the stars and the Moon, recording their eclipse by flying objects. In the event of detection of a successive eclipse of two or more stars, the processor unit is also able to estimate the course and angular velocity. Flying objects with their own sources of light or other electromagnetic radiation can be detected more easily and from a greater distance. Such a system can be used as a universal environmental monitoring system. The described system can have a low cost and high fault tolerance, minimal and extended configurations. The use of this system is possible both in everyday urban life and in open adverse areas.

Measuring the brightness is an important method of complex observations of space objects (SO) using the photometric method. Thus, based on the analysis of photometric observations of SO, it is possible to solve a wide range of problems: study their orbital behavior, changes in spatial orientation, establish optical characteristics of their surface, evaluate their geometric shape, and identify them. It is noted that in the case of photometric observations of SO in integral light, the recognition coefficient increases to 70-73%.

If colorimetric and polarimetric observations are also carried out, the recognition coefficient increases to 85-87%. The curves of the change in brightness of SO obtained using photometers display instantaneous features of the reflection of sunlight from various details of the SC surface, which are associated with its spatial orientation at the time of observation. Due to the rather large amplitudes of the change in brightness and velocity, photometric observations of SO differ significantly from photometric observations of stars.

1.12. Local combined monitoring with the possibility of interception in a war zone with the aim of copying technologies

Where it is difficult AMN due to constant shelling and hostilities actions that it is also possible to use combined monitoring, not only radars and complex equipment, but also the involvement of civilians for group surveillance. An unidentified object is a legitimate target in the country's aerospace space if: the object's identity is unknown and it is not an intelligence object of allied countries, it does not establish contact and ignores all requests to establish contact, the object does not resemble a known aircraft that may have problems with communication and navigation. Timely identification of UFO is an urgent need for the safety and provision of troops (forces) with modern monitoring means. Primary identification of UFO is carried out directly by an eyewitness conducting observations, in particular with the help of technical systems. After primary identification, UFO that could not be identified with objects/phenomena of known origin are classified as unidentified (unrecognized) air (aerospace) objects and phenomena (hereinafter referred to as UFO). Information on UFO is subject to investigation in order to clarify their true origin.

To build a network not only for monitoring but also for intercepting unidentified anomalous objects with man-made features, it is necessary not only to integrate all available military and civilian assets into the AMN, but also to involve civilians for group monitoring of the sky, this is relevant in places where there are gaps in defense (civilians do not necessarily know where the gaps are, so the network should be built as global as possible). In essence, this requires building a deep, echeloned defense, and decisions must be made in a matter of seconds depending on the circumstances, each time you need to look for new ideas and work on mistakes, that is, there is no such universal solution. Since it is known that there is a serious threat to the lives of civilians, historical heritage, energy and military facilities, as well as the risk of radiation contamination for many decades.

At the moment, it is known that while ballistic and hypersonic missiles can only shoot down the latest anti-aircraft missile systems or similar complexes, cruise missiles are shot down by jet fighters. In the case when the enemy first performs satellite reconnaissance and additional reconnaissance with reconnaissance UAVs, then the first combined attack takes place, where the first waves will include weather probes with reflectors, as well as decoy UAVs, or with smaller explosive charges, 50 to 50 with more dangerous high-explosive and cluster UAVs, followed by UAVs that will fall from a height, that is, descend only when approaching the target, as well as drop cluster bombs and camouflaged decoy mines, they go with old missiles, it is also known that some UAVs have cameras that, using cellular and satellite communications, can evade interceptors, maneuver, blind the interceptor or fire back, launch missiles in response, use machine vision with additional guidance, navigate by stars, maps, etc., at the end, UAVs with signal repeaters and/or be carriers of a swarm of UAVs of various types may go. For these purposes, fighters and anti-aircraft drones-interceptors are used. Although one should be prepared that hypersonic and ballistic missiles will also be used in a combined attack. Nowadays, combat lasers and kinetic weapons are very rare, and a swarm of anti-aircraft drones is already a reality and is a much cheaper alternative to expensive fighters. Where the enemy (line of contact or border with the enemy, occupied territories) use high-speed anti-aircraft drones, which are not always kamikazes, but can be armed with machine guns, shotguns, net guns, etc. Gunfights between several swarms of drones controlled by artificial intelligence are no longer science fiction, but a reality of today.

Combat and civilian (converted into combat) helicopters are used to intercept UAVs, the helicopter must be level with the target, then the onboard gunner works on the target, but not closer than 300 meters so as not to be hit by fragments during an explosion. The helicopter crew has only 5 minutes to assemble and 5 minutes to take to the sky after the alarm signal. When several helicopters are operating, the interaction of evading the missile in different directions must be practiced. Helicopters operate mainly at night; their crews are equipped with night-vision device and thermal imagers. Light aircraft also uses machine gun fire to reduce the cost of shooting down UAVs. Anti-aircraft portable missile systems and mobile fire teams (MFT) are also used, these can be both pickup trucks and heavy air defense equipment.

Each MFT and helicopters have their own area of responsibility, and if it is not possible to intercept, the target is passed on to the next group. There can be thousands of such MFT in total, depending on the territory. If a jet fighter takes off, then helicopters and light aircraft land so that the missile launched from the jet fighter does not hit their own.

The air defense command headquarters must always be constantly moving and disguised as a civilian bus to minimize risks. The command must be taken independently if an order is received from the command headquarters that the target is theirs. Since the enemy target can maneuver, emerge from a ravine onto a hill, can fall on a ballistic trajectory, dodge, be erased, drop cluster explosives.

When applying these recommendations in practice, it is necessary to refer to the current, official and approved orders, guidelines and standards of the Armed Forces of the relevant country, as they always take precedence over open or scientific and theoretical sources.

Fig.1.71 Software complexes like "Virage-Planchet" include monitoring of the sky by networks: video surveillance cameras, radar complexes, acoustic sensors, data from civilians via the "ePPO" application, and much more. In real time, you can see enemy, allied, and unidentified targets. Various types: airplanes, UAVs, interceptor drones, missiles, guided aerial bombs, weather probes, hang gliders, unidentified acoustic targets, etc. (Kharkiv National University of the Air Force)

Such software platforms support standardized multi-sensor data fusion, confidence assessment, and temporal–spatial correlation across heterogeneous inputs, reducing misidentification and improving observation traceability. In war-zone environments, local combined monitoring systems may incorporate automated radar, optical, acoustic, and radio-frequency detection to continuously track low-altitude and low-signature aerial targets, supported by operator-assisted classification.

The integration of portable digital command-and-control tools enables real-time visualization, georeferencing, time synchronization, and secure transmission of observation data, facilitating rapid localization, informed operational decisions, and coordinated assessment under dynamic conditions. This digital architecture enhances situational awareness while preserving structured datasets for subsequent technical, statistical, and scientific analysis, including controlled documentation and examination of advanced aerial systems.

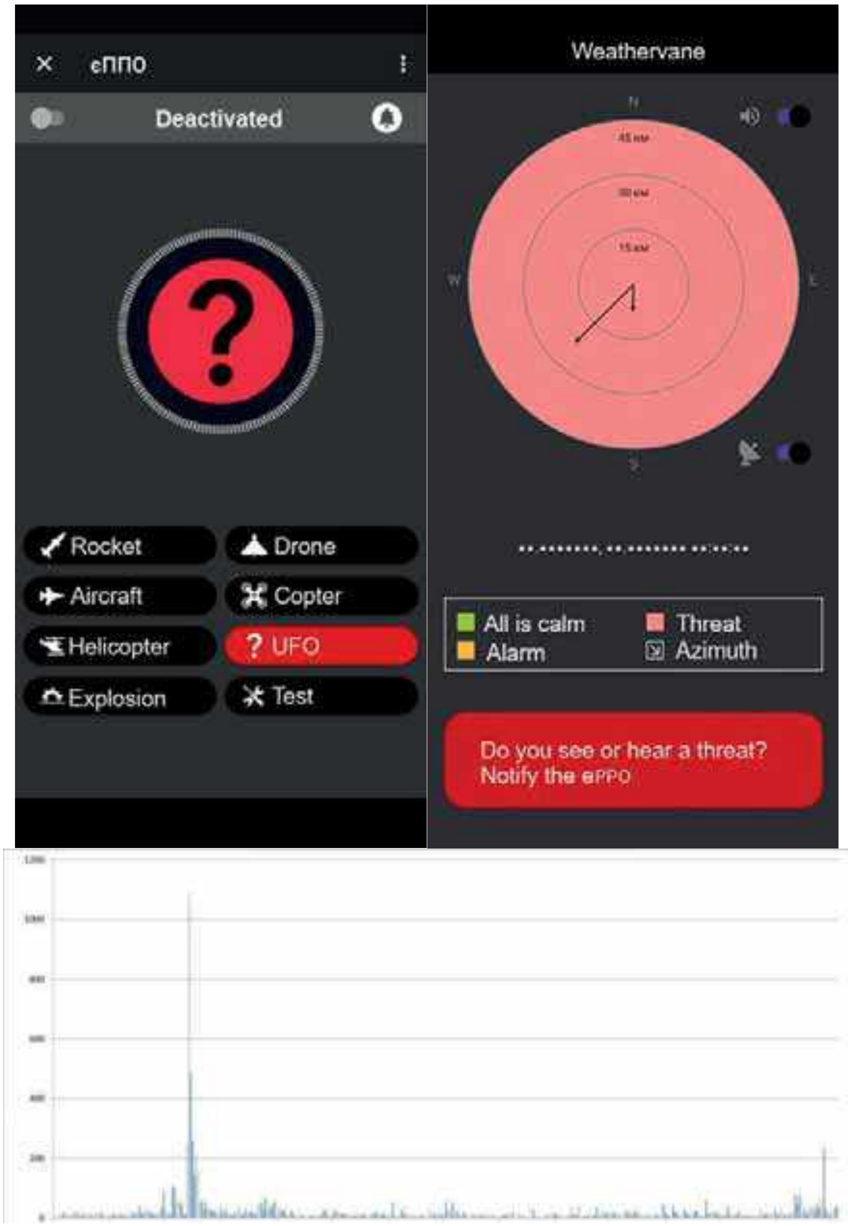


Fig.1.72 Applications of the "ePPO" and "Weathervane" and the number of records of UFO sightings, excluding alarms (ePPO, SRCAA "Zond")

For example, you can closely integrate specially developed applications for civilian gadgets with intelligence assets and mobile fire groups, as well as with the crews of high-altitude interceptor drones and aviation. When installing the application, you must allow tracking only geolocation and passport data. In the application, eyewitnesses report all enemy objects from the sky. If the eyewitness cannot identify the target, whether it is an airplane or a missile, there is an option where you can indicate that this target is not identified by the eyewitness, i.e. a UFO. That is, everything that the eyewitness could not recognize. This data is transmitted to mobile fire groups, which must first fix the object, in thermal imagers or IR cameras or by illuminating it with searchlights, and shoot down the object outside large settlements, using machine guns, anti-aircraft missile systems (AMN), high-altitude high-speed drones, kinetic weapons and combat lasers, etc. In support of the fire groups, if possible, fighters, helicopters, high-speed maneuvering UAVs, with thermal or IR cameras, also armed with missile, kinetic and laser weapons, as well as, if possible, a swarm of FPV drones (for example, on carrier UAVs, supported by UAV repeaters).

UFO pose a danger (threat), which can be direct and indirect. The direct danger from UFO is associated with the incorrect identification of the enemy's actions and means, which can lead to collateral and fratricide losses, untargeted expenditure of ammunition, etc. The indirect danger is associated with the incorrect (or untimely) identification as UFO of certain phenomena of natural origin, which can cause damage to munitions, impair direct visibility, mobility of troops (forces), etc. and lead to unforeseen costs, disruption of logistics, etc. The study of information on UFO entails the use of a number of methods for their final identification, as a result of which they are recognized as finally identified as objects (phenomena) of natural or anthropogenic origin, or are recognized as anomalous aerospace phenomena (AAP).

Timely and correct identification and research of information on UFO are urgent tasks, the solution of which makes it possible to detect the latest developments of the enemy and non-trivial natural phenomena, as well as AAP, which may pose an unidentified threat due to their constant presence in the controlled and limited zone, where special operations forces operate, and to carry out reverse engineering to reproduce innovative technologies demonstrated by AAP.

Among the materials of unknown origin found on the Earth's surface, there is a high probability that there should be fragments of technology made by human civilization (satellites, drones, etc.). Their affiliation can be determined by state symbols, inscriptions and drawings, but this is not always possible. Any debris that looks like artificial may be dangerous (radiation, chemicals or explosives). During the initial inspection of the place of discovery, you should not touch them or even approach them, it is better to call the emergency services.

Fig.1.73 EOD9 suit for self-contained oxygen supply, protection against explosion, overpressure, shrapnel, heat and open flame (MED-ENG, The Hurt Locker)

Fig.1.74 The special vehicle KrAZ "Shrek One RCV" has a crane-manipulator, and the armored vehicle's protection at the STANAG 4569 level withstands high-explosive anti-tank mines and fragments of 155 mm artillery shells at a distance of 80 meters (State Emergency Service of Ukraine).

If the object was intercepted, a specially trained emergency rescue team of the pyrotechnics and demining unit (which has undergone special training) will go to the crash site and, using special equipment and personal protective equipment, will collect and remove debris from the crash zone for further study and possible copying of technologies. It is worth noting that by involving a team of chemists-dosimetrists, background measurements can be carried out, and at a high level of radiation exposure, by involving unmanned remotely controlled ground complexes with a crane-manipulator, with protection against explosion. Collection, packaging and transportation of debris is carried out in personal protective equipment (PPE). Manipulators, remote tools, unmanned ground platforms are used in case of radiation or explosion risk. The debris is marked, packed in lead or steel containers (shielded if necessary).

Then the debris should be removed by a specialized vehicle certified for the transportation of hazardous materials for transporting sources of ionizing radiation and radioactive sources. And the vehicles used to remove the debris must have a level of protection sufficient to prevent personnel from being irradiated by debris and survive if the vehicle is blown up by a mine, and if necessary, have protection against FPV drones. The crash zone of the object with anomalous signs of environmental impact is preserved and fenced off for further study. That is, existing emergency response equipment and personnel can be used to collect debris, after conducting additional training and practice.

If the object could not be intercepted, artificial intelligence capabilities should be used to synchronize these reports on a timeline and filter out observations that coincided with missile and air alerts. Allied countries should also be notified of the invasion, and an attempt should be made to establish a single AMN and protocols for intercepting unidentified anomalous objects with them.

One should try to consider:

- Integration of radar/Radio Technical Intelligence (RTI) and optical/IR systems: incorporating data from radar (high-speed targets), RTI (radio emissions, UAV control channels) and thermal/IR cameras (low-flying/low-visibility targets) into a single 4D real-time airspace model. This is critical for combating waves of decoy UAVs and maneuvering targets.
- AI for signature classification: AI should automatically compare the received signatures (radar, thermal, electronic warfare) with a known database (own, allied, enemy). This will reduce the risk of "friendly fire" and quickly distinguish between UAV repeaters, decoys, and reconnaissance wings.
- Triangulation: UFO data received from a civilian application must be confirmed by at least three independent sources (civilian eyewitnesses, military assets, meteorological data) before declaring full combat readiness.
- Fighter-Aircraft Scenario: the current rule that helicopters and light aircraft land when a fighter is taking off is correct, but it should be supplemented with a safe corridor protocol and clear radio codes. The CS should immediately report the area of the fighter's air-to-air missile launch so that the helicopters can make an emergency landing outside the trajectory.
- Combat lasers and kinetic weapons: include in the recommendations safe distances and areas for the use of lasers (especially considering the risk to civil aviation and vision) and kinetic weapons (projectile trajectory).
- FPV drone swarms: define swarm activation protocols (only after confirming that the target is high priority or otherwise cannot be hit) and friend-or-foe identification methods for FPV drones to prevent them from hitting their own UAV relays.
- EW resistance: all MFT should be equipped with portable EW (control/navigation channel jamming) as the first stage of countering UAVs, before using fire.
- Radio-electronic intelligence and acoustic sensing can be incorporated into the monitoring system as complementary channels that extend situational awareness beyond optical and radar domains.
- Protection from FPV drones: mandatory installation of mesh dome (anti-drone) barriers or EW domes on MFT vehicles operating in the frontline zone to protect against FPV drone strikes
- “Golden Hour Principle”: introduce a protocol emphasizing the need to collect debris from high-tech targets (UFOs, hypersonic missiles) as quickly as possible, as sensitive electronic components, batteries, and fuel can degrade or evaporate within hours.
- Establishment of quarantine zones: after collection, debris must be immediately placed in specially equipped, sealed containers with temperature and humidity control to preserve background radioactivity and chemicals until detailed laboratory analysis.
- Interdisciplinary expert group: formation of a permanent group that includes not only pyrotechnicians and dosimetric chemists, but also electronic engineers, materials scientists, and aerodynamicists. This will ensure full reverse engineering of technologies, not just safe disposal.
- Feedback: the results of the analysis (e.g., determination of a new UAV control frequency) should be immediately integrated into the EW system and pilot/MFT training.

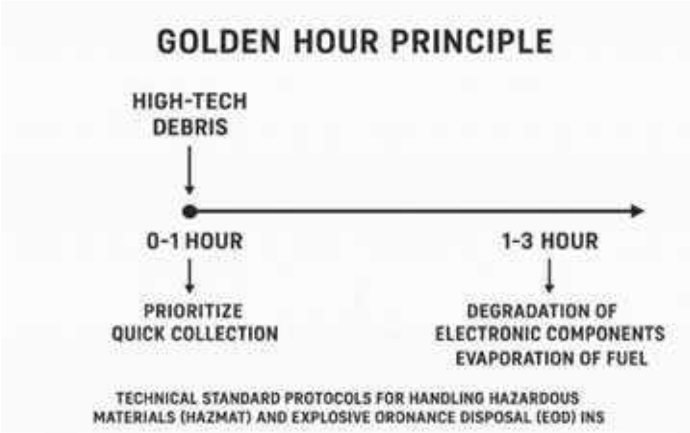


Fig.1.75 "Golden Hour Principle" (HAZMAT & EOD)

We are moving into an era when monotonous human labor will be replaced by robotic complexes in the sky, on land, at sea, underground, and in space. And these robotic complexes will be self-replicating, and will constantly scale. And how this automation will be applied will depend on the presence or absence of human morality and decency.

In wartime, when the situation is critical, the probability of creating a commission to investigate and intercept UFOs increases several orders of magnitude, since any UFO, until it is identified in wartime, poses a danger. There is a high probability of showing your professionalism in the military sphere and becoming part of the special services and intelligence to have access to all instances and archives. Otherwise, if you fail to mobilize military connections, it is worth trying connections in the aerospace agency or civil aviation.

When you have such experience, it is worth maintaining a very high methodological level, and implementing such experience to create similar commissions in allied countries, this will significantly improve the capabilities AMN and cooperation between allies. However, you should respect national security, think carefully about what you publish so that it does not reveal the developments and their place of manufacture in your country, so as not to get into trouble with counterintelligence.

Modern airspace has become increasingly congested, contested, and technologically complex, characterized by the proliferation of unmanned systems, electronic warfare, hypersonic platforms, and hybrid civil–military activity. In this environment, traditional classification models and single-sensor observation methods are no longer sufficient to reliably distinguish between conventional objects, natural phenomena, and genuinely anomalous events. This framework provides a standardized, evidence-driven approach to handling uncertainty, enabling institutions to extract scientific, safety, and security value from unresolved observations without resorting to speculation.

By integrating multi-sensor data, transparent methodologies, and reproducible analytical processes, it responds directly to contemporary operational needs and supports informed decision-making in an era of rapid technological and geopolitical change.

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Section 2. Collection of material samples at the impact site

2.1. Purpose and basis for collecting material samples

Collection of samples of the impact of anomalous aerospace phenomena on the environment is done in order to obtain material traces for their further study.

The basis for this collection of material samples may be a statement from eyewitnesses about the impact of anomalous phenomena on the environment, in order to confirm or refute the presence of material evidence of what was seen, to establish the true cause of the appearance and disappearance of the alleged anomalous phenomenon, the time and nature of its manifestation, the reasons for the changes in the environment.

Traces of impact on the environment are distinguished:

1) Mechanical, in the form of depressions and dents in the soil, crushed vegetation, damaged trees and shrubs.
2) Thermal, in the form of scorched soil, induction heating of plant roots, the appearance of dried vegetation, changes in the color of plants, melting of minerals and metals.
3) Other material traces: the appearance of fossils on trees, the anomalous presence of substances not typical for a given area, the appearance of liquid and oil stains of unknown origin, unknown objects and unknown plants, inhibited plant growth, very strong fragmentation of sand into small fractions, soil samples that do not sink in water, the absence of insects, increased uncharacteristic radioactivity, residual magnetization in metals, and much more that can be found in different combinations.

2.2. Primary search and collection of information

Search information

When searching for sources of information, one should first of all adhere to known principles, namely:
- the principle of relevance - the information found must actually reflect the state of the research object at each available moment in time;
- the principle of reliability - proof that the search result is true, truthful;
- the principle of objectivity - the information found must accurately reproduce the true position and development of the object;
- the principle of information unity, that is, the presentation of the found information in such a system of indicators that would exclude the likelihood of contradictions in the conclusions and inconsistency of the primary and obtained data;
- the principle of data relevance, that is, the correspondence of the information to the request, excluding work with data that are not related to the study.

It is possible that the observed phenomena were recorded on various equipment (photo, audio or video) and disseminated through the media (press, radio and television, etc.) or on the Internet. In this case, several search methods can be used to identify information about the AP. The simplest method is to search for information in the physical archives of periodicals or the Internet. Archives can be checked for mentions of certain possible phenomena in the past. Publicly accessible archives of periodicals can be found in the libraries of institutions and organizations or in publishing houses, editorial offices of the relevant publications. Electronic catalogs of publications are also becoming increasingly accessible; if the publication is functioning, you can contact it regarding a specific case, find the journalists involved, persons involved, etc.

When searching the Internet, it is necessary to specify keywords (tags), set priorities for a particular word (quotation), and filters (hyphens), taking into account the specifics of different search engines, since the result of the same request in them can differ significantly. If, for example, the task is to find information on the key phrase "UFO Kharkiv", then it is possible to specify similar keywords when entering in the search engine "UFO in Kharkiv", "UFO over Kharkiv", "UFO in the Kharkiv region", "In the sky over Kharkiv", "Aliens in Kharkiv", "Aliens in Kharkiv", "UFO landing in Kharkiv", "Anomaly in Kharkiv", "Strange object over Kharkiv", "Something over Kharkiv", etc. It can also be effective to enter names when searching in other languages, for example: "НЛО Харків", "НЛО над Харьковской областью", "НЛО в Харькове" and others. Or the form of the observed object itself can be indicated: “Flying saucer over Kharkiv”, “Balloons over Kharkiv”, “Cigar over Kharkiv”, “Strange lights over Kharkiv”, etc.

To expand the search, you can enter the names of the city districts, for example, "UFO over Saltovka", since the names of photographs and videos may not indicate the city itself, but only its districts or local landmarks, unofficial names of territories that are understandable only to local residents. Sometimes the necessary information is provided not by direct photographers and witnesses of probable phenomena, but by certain intermediaries - bloggers, relatives, amateurs. This should be taken into account when asking for clarification of the parameters of observations of probable phenomena and determining primary sources. To do this, you should use several search methods to find the operator.

The easiest way is to search the Internet using contact information or nicknames in social networks. If the source is unknown, you should contact the administration of the Internet resource for clarification or through the personal data of the authors, if any, by writing a letter to an email address or in social networks with a request to receive the original, introducing yourself officially from your research organization. If a "friend" request is required in social networks to activate a dialogue with the source of information, then the appropriate actions should be taken in the settings.

If the material found on the Internet can be valuable to the researcher, then first, if possible, it should be downloaded (copied), and only then contact the sources of information (operators), since there is a risk of losing it forever, due to the deletion of all content for unknown reasons and without the ability to contact the direct source of information.

If eyewitnesses shared their testimonies in any of the groups or on the forum, then it is better to immediately write them a message directly through the account with clarifications, since sometimes messages on forums are deleted during administration, thereby excluding access to eyewitness contact information.

When searching for photos, you can use, for example, the keywords "UFO + search area", enter "UFO pictures + search area" or "UFO image + search area" in the search field. For example, if a photo with probable anomalous phenomena was found on a site without specifying contacts for feedback, you can try to copy the picture and add it to the application with photo search functions, since the photo can be taken from another site that will have feedback, and also go to the operator's social media pages. The same method is effective for identifying hoaxes, when a photo of another phenomenon or event is used to illustrate the alleged message. If the areas where probable phenomena are recorded are known, then, if possible, you can visit them, organizing on-site research, and sometimes even expeditions to search for additional information. In this case, on-site, you should conduct a maximum survey of local residents to observe probable phenomena in this area.

Interview

Before starting a dialogue with potential witnesses or residents, you should say hello and get permission to talk about the topic of interest to you, specifying the convenience of the time of the dialogue. You should formally introduce yourself as a "researcher of anomalous phenomena" from your organization in order to win over the interlocutor and gain trust for an effective interview. It is necessary to take into account the fact that not every real eyewitness of a probable phenomenon will want to share what they saw or heard, as they may be afraid of being ridiculed and the like.

Also, to gain the trust of potential eyewitnesses, you can use the following techniques: present, if you have one, an ID or business card of an employee of an organization studying anomalous phenomena; preferably a regular uniform; you can also demonstrate examples of real photos or videos recording probable phenomena, assure them of your personal experience in the past with the anomalous. Eyewitnesses of probable phenomena should be asked to both share the details of the observation and identify the contact information of other possible eyewitnesses. If necessary, assure the eyewitness that the information received from him will be used for scientific purposes and his name will not be mentioned without his consent. Depending on the conditions of the eyewitness interview and the availability of time, the eyewitness's employment, you must choose both the method of disposing the interlocutor to you and the reception of the invitation to a frank conversation. Facial expression, timbre of voice and even the manner of holding hands during a conversation will tell you much more than the desire to immediately conduct an express interview, as a result of which you risk losing the most valuable details. Therefore, do not rush to start the interview and try to build a psychological portrait of the interlocutor, to penetrate his mood and understand the person, his state at the moment. It will not be superfluous to talk about general topics or about what interests the interlocutor at the moment.

In cases where there is more than one witness, you should try to interview different witnesses separately, partly to avoid the witnesses influencing each other's accounts, and partly to avoid a situation where one witness tells the story and the other merely agrees (which can happen in pairs). If this is not possible at the outset of the interview, you should try to have separate conversations later, especially if one of the witnesses has not told what happened in his or her own words. The investigator (interviewer) can also influence the collection of information in a certain direction.

It is essential that the interviewer is well aware of the processes that can lead to distortion of the initial observation. In an observation interview, the goal is to obtain information about an external event. Relationships that influence and distort the information can be:

• Likes/dislikes expressed between the interviewer and the interviewee.
• The general human desire to be recognized, accepted, and liked.

One way to achieve recognition is to please others, to behave in a way that is expected to be appreciated by others. During an interview, this can lead to a tendency to answer in a way that the author believes will satisfy the interviewer. Knowing the purpose of the interview, the interviewer's behavior, and the way the questions are phrased can give the interviewee clues about his or her expectations and hopes.

It is therefore always important to make it clear that we are sympathetic to listening to the story, but also that our task is to try to find an explanation for it. One way for the interviewer to avoid any "control" or feeding expectations is to avoid formulating values and interpretations of the information during the interview. In the way the questions are asked, one should avoid such formulations that in themselves contain the expectation of a specific answer (leading questions). In addition, the interviewer should avoid overtly rewarding or reinforcing certain tasks with smiles, increased attention, etc. A fundamentally incomprehensible observation can thus be conveyed as a specific task because it elicited positive attention from the interviewer.

Phases of conducting an interview

An interview about an observation involves a conversation about an external observation and the reactions that the event has caused in the interviewee (physically and mentally). We always assume that he/she has seen something real and unusual, while in some cases the event has made a very strong impression. The knowledge of meeting someone who listens and takes what happened seriously is normally a good starting point for a rich flow of information. Especially if the observer has not previously told anyone about the event, or perhaps only to a few people, the observer may have a need to talk about it and the flow of information then increases during the interview.

The process of interviewing witnesses can be divided into several phases. The PEACE model provides an approved framework that serves as the basis for investigative interviewing. The model defines a five-step process that guides the interview. It enables interviewees to testify freely and without coercion in a mutually respectful atmosphere and requires the interviewer to behave in a respectful, open-minded, and neutral manner. The model describes the five stages: Preparation, Engage and Explain, Account, Closure, and Evaluate. These five stages can be divided into three main phases, the relationships between which are illustrated in Figure 2.1. These are the planning and preparation phase before the interview begins, the actual interview phase, with the introduction, explanation, reporting phase, questioning, and conclusion, as well as the final evaluation phase.

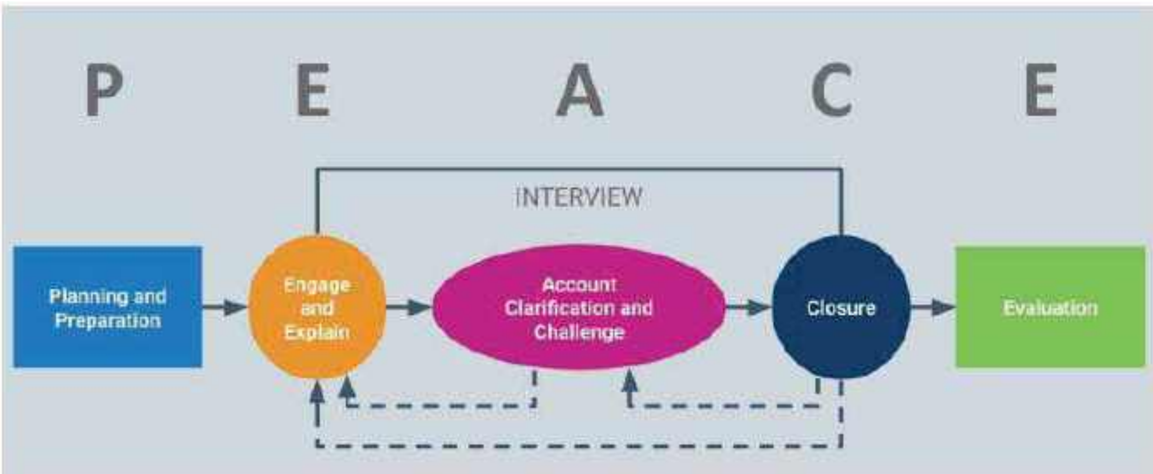

Fig.2.1 Illustration of the PEACE model (United Nations Office on Drugs and Crime, 2024, p. 17)

Investigative interviewing

The investigative interview, often described in connection with the PEACE model, as well as the related cognitive interview, reflect these phases, with the account phase usually being further differentiated. As an interrogation method in a criminalistic context, it is also recommended by the UN as an evidence-based, ethical, and human rights-compliant interrogation method. In addition to compliance with ethical guidelines, particular emphasis is placed on the individual characteristics of the interviewer in relation to their interaction with the interviewee. Essentially, this means communication skills and an open-minded, respectful, and empathetic attitude.

- Preparation: The basis for the interview is the preliminary information available in the case, usually in the form of a report on the observation or perhaps an initial telephone conversation. Plan the interview and prepare yourself by carefully familiarizing with the information available about the event. If the information comes from different sources, there is reason to pay special attention to discrepancies and vague details in the stories.
- Engage and explain: At the beginning of the interview, create a relaxed and trusting atmosphere to ensure the best possible quality of testimony (build rapport). This can be done by starting the interview as a normal discussion and with general social conversation. Explain the purpose and procedure of the interview to the witness. It is necessary to clarify with eyewitnesses about the possible recording of the observed events on audio, photo or video equipment for the possible receipt and subsequent copying of the originals or copies of the footage. Also consider that the person who is going to tell you will want to do it quickly, often immediately

after you have entered the home or where you are. Make sure that the person does not do it before you have sat down and you have been able to take out the recording equipment. There is only one chance for a first interview. The next time it is repeated, the witness will rule out things because he/she thinks you have heard them before. Each interview is a new situation for both the observer and the interviewer. Be enthusiastic and positive without being flattering. Show that you are a good listener.

- Account/free report: Having gained trust, lead the eyewitness to the story unobtrusively, almost imperceptibly: it is necessary that he himself wants it. Therefore, it is better to continue the conversation about the weather on that day (or evening, that night) that preceded the event; that is, try to simulate the beginning of the event, put the eyewitness in the mood before observing the phenomenon. Always ask the person who is telling the story to start their story a good while before the observation itself took place. This provides important information and also makes the event itself more natural to tell. Separate the witness's free account of the event from the subsequent structured questioning. Separating and combining the free account and subsequent questioning is considered effective for obtaining comprehensive details.

Based on the enhanced cognitive interview, it is recommended that the witness make a sketch of the event at the beginning of the free account, which he can then use to orient himself in his narrative. Drawing as a form of expression circumvents verbal limitations and involves fewer confabulations than purely question-led interviews. The interviewer should always have access to a map (preferably printed) so that the witness can draw in where the event took place and how the object moved. This is also to be able to adapt the questions to details in the surroundings. Bring a compass! Many observers do not have a sense of direction and what is written in the report form may need to be double-checked.

The interview should be a conversation and not an interrogation. By using your own restraint and neutral encouragement, you give the interviewee the greatest possible space to speak. Neutral encouragement means that you avoid controlling the information through comments, facial expressions, increased or decreased interest in relation to what the interviewee is saying, and the like. Show understanding, tolerance and generosity - and a well-timed word of sympathy, a smile of support will help to establish contact. Therefore, state your point of view less and in no case suppress the erudition of the interlocutor. One of the strongest desires of a person is the desire to be (and not just seem) significant. Active Listening is essential at this stage. Therefore, listen with all attention to every word of the eyewitness. Encourage the witness to continue talking during the free report, but avoid asking questions. Only take notes occasionally and maintain eye contact for the most part. By recording the story on tape or camera, you avoid having to write everything down, which can distract or irritate the witness. At the end of the free report, comprehension questions can be asked as open questions.

- Structured questioning and clarification: Once the witness has finished their free narrative and you have gained an overview of the event, move on to asking detailed questions and addressing things that the witness may have missed, that are unclear or seem contradictory, and then also address the points in the report form or questionnaire. In the case of a personal interview, avoid sending the witness a questionnaire in advance so that they are not potentially influenced by the questions and possible answers. Remember, questions should be formulated so that the personal opinion of the person being asked is not revealed, that is, questions should be asked neutrally.

If the event lasted longer than just a few seconds, is more complex, involves multiple details or a group of witnesses, then additional retrieval techniques from cognitive interviewing can be applied. These include a change of perspective, in which the witness describes the event from the perspective of another person, and a change of order, in which the witness describes the event in reverse chronological order. These retrieval techniques provide the recall of further details, as different retrieval paths are used for memory content.

- Closing the interview: Conclude the interview with a summary and, if necessary, with written statements and notes. Give the witness the opportunity to add or correct anything. Explain the next steps to the witness and assure that he will receive the information about the investigation results to remain transparent. Stop audio recordings, if applicable. During this phase, you can discuss the findings with the witness and also express your own opinion. You should avoid making any definitive statements at this point, as not all of the research results are usually available yet.

- Evaluation: In the final evaluation of the interview, the information and notes obtained from the interview and the accompanying investigation are assessed. All steps and results must be documented in a comprehensible manner. To this end, it is advisable to prepare a report on the interview process in a timely manner, containing the essential findings and statements of the witness as well as your own observations and impressions.

Figure 2.2 provides an overview of the six steps of the investigative interview described above.

Fig.2.2 The six steps of the investigative interview, according to the UN (United Nations Office on Drugs and Crime (2024, p. 16)

Aspects to consider

A danger in investigations can be the interviewer's own enthusiasm for the subject. In such cases, you should take care not to show such enthusiasm for certain answers during the interview that the interviewer might make associations with other known cases or typical conditions within the UFO phenomenon. On the other hand, be enthusiastic about the meeting itself and make sure that the observer feels that what is happening is important.

Talking about such associations during an ongoing interview, making references to previously investigated cases, or giving quick explanations is not a good method. Starting to discuss the UFO issue in general before the interview has ended is equally unwise. All such tendencies involve control on the part of the interviewer. The interviewer may wish for a certain kind of answer and show open positive encouragement when details emerge that may possibly have certain parallels with previously known patterns. This naturally also entails a risk that factors that might contradict the associations and interpretations that the interviewer has made are not sufficiently noted or are completely overlooked.

Someone who is convinced of the existence of a genuine UFO phenomenon can thus, through their desire to confirm these phenomena, deceive themselves by seeking specific information and thereby perhaps miss out on details that may contradict the desired information. The same risk naturally exists with someone who believes early on that the case has a known natural explanation and in their search for information concentrates on facts that confirm this hypothesis and avoids or attaches little importance to facts that might be thought to contradict their own assumption. In such a situation, the interviewee can easily become a victim of the interviewer's expectations. By the interviewer showing excitement about certain elements and perhaps even encouraging answers in a certain direction through his questions, the interviewee can be suggested to shape his story in a way that is appreciated by the interviewer. The interview must be kept without prejudice at all times.

Interpretations from both the interviewer and the interviewee must be distinguished from the facts. The aim should be to obtain as much and unadulterated information as possible and to pay attention to all details and all possibilities. Interpretation belongs to a later stage in the investigation work. When the interview is over and all essential information has emerged, however, there is no obstacle to informing the observer about any similarities between his story and other cases.

It is important that the interviewee can feel that the exchange of information is mutual and does not feel that the researcher has only conducted the interview for his own purposes and then ignores the observer's question about whether his experience has similarities with other reports (something that is not at all unusual and the question of whether other people have seen similar phenomena to the interviewee often occurs during interviews).

Notes and Recording

Taking notes constantly during an ongoing conversation is disruptive and distracting for both the interviewee and the interviewer. Only occasional notes should be taken during the interview. Instead, the interviewer should record the entire interview using a dictaphone or similar device. Things that may still be good to note down may be information that you want to have quick and easy access to later, so that you do not have to listen through the recording to get the details. Also note down any questions that arise and that you want to clarify later (follow-up questions).

Recording the interview is usually not a problem at all. The observer usually does not object to the recording if the interviewer points out that the recording is only made with the aim of getting all the details correct, and so that the interviewer can concentrate on the story without having to sit and write down what is said. It is best to have two researchers present: one who just listens and one who takes notes.

Formulation of questions

- Overview questions: For example: “Would you like to tell me what happened?” and “Please start the story before you got to the place where it all happened”. Questions of this open type give the interviewee the opportunity to provide independent answers in a spontaneous and coherent manner.
- Open answer options: Questions should, as far as possible, be formulated so that they cannot be answered with just “yes” or “no”. A good rule is to consistently begin with a question word such as when, where, how, why, what, who.
- One question – one piece of information: The question should be constructed in such a way that it seeks specific information. If different circumstances are touched upon in the same question, the risk of misunderstanding increases and you risk getting less precise answers (example: “How big was the object and how long did you see it for?”). Never be chatty, but ask clearly and consistently.
- Avoid leading and suggestive questions:

Leading questions are questions that, through their wording, give the interviewee a hint about what answer the interviewer expects.

Example: "Was the craft you saw disc-shaped?" If that question is asked without the observer having previously described any shape of what he/she saw, the question is leading. Furthermore, it is inappropriate to use the word "craft" as it implies an interpretation - use “object” or “phenomenon” instead. Or try to phrase the question in a largely neutral way, such as “Did it have a shape?” or “Describe what it looked like.”

Suggestive questions are leading questions with a more compelling character. Example: "Did you see the object for more than two minutes?" The interviewee is in practice encouraged to answer "yes". Leading questions and suggestive questions are best avoided by starting with a question word where possible.

Checking the reliability of the information

It can sometimes be good to ask several questions about the same circumstances, either to avoid misunderstandings or to check the reliability of information. It may be advisable to start with a general question that then becomes increasingly specific and concrete. Follow up the time course carefully. Check the different stages of the observation to get the correct time sequence. Gaps or vague information should be given extra space.

Information about the time and place of the observation is very important and should therefore be checked especially carefully:

- The exact observation location should be determined with a map or, if possible, with a visit to the site.
- The day of the week or date can sometimes be determined (in case of uncertainty) by asking the observer if anything else happened on the same day, e.g. a radio or television program, an event in the outside world, a telephone call or the like. If the observer took a picture at the time of the observation, the camera's internal data (metadata) can provide the date and time.
- Regardless of the equipment used to determine the time of the observation, it may be necessary to check whether the clock in question is actually running correctly. Analogue clocks can be wrong and sometimes clocks are not set correctly for summer and winter time.

Other information that should be obtained

The interviewee's general reaction to the experience? Previous experiences? Knowledge of the UFO phenomenon? How then? Attitude to the phenomenon? Changed attitude after the observation? How many people know about the experience, that is, how much has the observer conveyed and discussed with other people? Reactions from these people?

Previous knowledge of the UFO phenomenon entails a certain risk that the interviewee makes certain interpretations of what he/she saw that the person would not otherwise have done. It also entails a risk that the observer has been influenced in both the original interpretation and in his/her later memory based on his/her previous knowledge of the UFO phenomenon. Such a description has of course an obviously irrational meaning, but in almost all such cases the person has perceived the classic saucer shape of what he/she saw. It is important that the interviewer does not settle for such a description but encourages the observer to give a more specific description, but it is also important to note the observer's initial description as it suggests a certain knowledge of the phenomenon in advance.

Always pay attention to what is fact and what is interpretation of the experience. Someone who is well-informed about the UFO phenomenon can also fool themselves by seasoning the story with details that they know from previous observations without being convinced that they are relevant to their own case. In the story, the event can be unconsciously "styled" in some detail rather than according to what they have previously read or heard rather than according to what was actually observed. How much the interviewee has talked about the event with others is important for the accuracy of the information. Both the time factor and the fact that the event has been discussed on several occasions always involve a certain amount of involuntary "censorship". More and more interpretations emerge, certain details are obscured, others become more prominent, etc.

Recording information

If video clips with probable anomalies were recorded on VHS video cassettes with an analog processing signal, then they need to be digitized (converted to a digital processing signal) and archived in several copies on various storage media. If necessary, you should print out maps of the areas and ask eyewitnesses to indicate the locations of possible anomalous phenomena on the map.

If, after questioning eyewitnesses, what they saw or heard may have anomalous factors, then they can be asked to fill out special questionnaires with the most detailed description of the observations, where the contact information of the eyewitnesses, the place and time of the anomaly, as well as its form and behavior are indicated. If the eyewitnesses did not record the exact time of the observation (date and time), then in the process of filling out the questionnaire it is necessary to clarify any events occurring during the observation periods, which can be reference points for the exact time of the observations. For example, a UFO could be observed on the day of an important event, shortly after or after the manifestation of special weather conditions, astronomical phenomena, a calendar holiday or a funeral, where it is possible to calculate the exact date, determining the date of the event, celebration or funeral. In cases where an eyewitness reports information not provided for in the questionnaire. They should be recorded separately and not as a summary of their main content, but in the first person and, if possible, verbatim, in the words that the eyewitness said.

Examples:

1) an eyewitness remembered that he saw a UFO in the sky before a heavy rainfall over Kharkov, which caused a flood and inundation of the Dikanevsky treatment facilities, it is known that this happened on June 29, 1995;

2) other eyewitnesses remembered the date of the UFO observation, since they celebrated a wedding anniversary outdoors on that day, the date of the marriage registration observation was determined; 3) an eyewitness remembered the period of the UFO observation, since on that day there was a wake for her husband who died the day before, the date of the observation was determined by the date of the deceased on the tombstone in the cemetery. It is also possible to use calculations to determine the exact dates of anomaly observations, if the intervals of work shifts of enterprises, security services, and other events are known that allow you to tie in observations of a probable phenomenon. After questioning an eyewitness, he may be recommended to use recording equipment at the times of possible future observations, and not to delete unsuccessful photo or video files, the properties of which contain the exact date and time of the observation.

See also: Questionnaire on observation of an unidentified object or phenomenon

The sources of distortion of information about what was seen may be: subjective and psychological characteristics of the eyewitness, objective conditions of observation, pathological deviations in the psyche of the eyewitness, deliberate falsification.

Subjective and psychological characteristics of the eyewitness may manifest themselves in inattention, fatigue, fixation on something, a state of alcoholic intoxication at the time of observing the event, etc. Perception is also affected by impaired sense organs (blindness, deafness, color blindness, etc.), professional qualities, range of interests, lifestyle, degree of awareness of UFOs, etc. In order to minimize the influence of subjective and psychological characteristics on the reliability of information about what was seen, one should become sufficiently familiar with the lifestyle, range of interests, biography of the eyewitness, find out the state of health, the nature of the illnesses suffered and other data that may be necessary during the conversation.

Objective conditions - natural conditions of perception, manifested in the weather, degree of illumination, duration of observation.

The exclusion of information determined by pathological deviations in the eyewitness's psyche should be based on knowledge of his biographical data (facts of visiting a neurologist, psychiatrist), analysis of the eyewitness's behavior at the time of presenting information about what he saw, the sequence of events described, the presence or absence of an internal connection, and the eyewitness's involvement in the event described. In particular, it is important to establish the reason that prompted the eyewitness to tell about what he saw, his attitude to the disclosure or non-disclosure of his name, and to find out whether there were similar cases with him before. The following techniques can be used to protect information about what was seen from deliberate falsification: asking questions, the correct answers to which have already been established; asking detailed questions that are not related to the essence of the phenomenon, but are aimed at clarifying information that can be carried out; presenting the "eyewitness" with materials that refute his testimony; clarifying the motives for falsification (when it becomes obvious).

In all cases, it should be remembered that:

- the reliability of information increases when, comparing different elements of the same testimony, it is established that its independent details relate to the same event and at the same time reinforce each other;
- identifying the reasons for changes in the story is an important source of assessing their veracity;
- to assess the reliability of information, a repeated interview after a certain time is of great importance;
- in the case of a collective UFO observation, the most important means of establishing reliable information is a comparison of the testimonies of different eyewitnesses.

2.3. Safety precautions

Risks at the site of impact:

- Risk of radiation exposure
- Risk of poisoning by unknown chemicals and gases
- Risk of infection by unknown viruses and harmful bacteria
- Risk of body burns by chemicals and toxic plants
- Risk of bites by ticks, spiders and other insects, and snakes
- Risk of attack by wild animals

Fig.2.3 Types of military mines in open terrain. Mines are not very visible, or they can be disguised in household items, toys, wallets with money - this is very dangerous. Do not approach such objects - you should immediately contact specialized demining specialists, military sappers and rescuers. (*SRCAA "Zond"*)

It is strictly prohibited:

- Collect fruits from bushes and trees, and especially eat them.
- Drink water from surrounding bodies of water or drink beverages, including alcoholic beverages.
- Eat in the affected area or stay in it for too long.
- Take any things that at first glance seem ownerless or without the permission of their owner.
- To conduct trips to places where it is not known whether the area was cleared of mines after military operations, as well as places where there is a risk of military operations or mining!

Since this will require not only specialized equipment with MRAP protection, electronic warfare (EW) and camouflage, but also specially trained armed specialists who can recognize indicators of the presence of improvised explosive devices and the characteristics of a potentially dangerous area.

Relations with the local population:

- Make sure that scientific and technical equipment or transport are not stolen.
- Respect local views, customs and traditions.
- If you are asked to help with something and you have such an opportunity, do not miss it, this will significantly increase your chances of establishing good neighborly relations. You can offer help yourself, but you need to be able to feel when and in what cases it is appropriate, and within the limits of your competence.
- Avoid political and religious topics, it is during such discussions that disagreements most often emerge and conflicts arise, which are then resolved by force. If your interlocutor tries to start such a conversation, it is best to immediately change the subject. And, even more so, do not try to convince your opponent, even if you are an experienced speaker, remember that you are not at a rally. And the goals of your stay in this area are still somewhat different. Because if you do not follow this rule, you can run into the mobilization of the entire village, and several neighboring villages, often with the use of small arms.
- For obvious reasons, you should not show off your intellectual or other superiority. Of course, you need to act independently, it is even useful to look a little taller, but remember that you will be most successful in any communication if you are seen, first of all, as an understanding interlocutor and a like-minded person. Imagine that you are an intelligence officer and are carrying out a mission in a foreign country, then a lot will become clear.
- But even if your group is treated quite favorably in the locality, it is not recommended to drink alcoholic beverages with the local population.
- You cannot disturb the peace of the local population, because the reaction to such behavior will be quite unambiguous, and most importantly, quite fair.
- You should not even hint at interest in local female representatives, this is almost a 100% guarantee of a future very serious conflict. For the same reason, you should not attend local entertainment events, even if you are invited there.
- For the same reason, girls taking part in the expedition should not get carried away by local guys and especially not appear before their eyes in an overly attractive form.

2.4. Training of specialists

It should be understood that this type of research requires a group of qualified specialists who are constantly ready to go to the site. Before going to the site, it is necessary to collect as much information as possible about the event and the place.

Fig.2.4 Example of the view of deployed positions of a motorized camp during an expedition (SRCAA "Zond")

Requirements for a member of the information collection group:
- Good orientation on the terrain, the ability to draw up a terrain plan, an observation scheme, and conduct primary calculations.
- Be sociable, attentive to the eyewitness, even if the observation is questionable, do not miss details, be able to subtly ask clarifying questions, but without pressure and imposing your judgments on the eyewitness of the phenomenon.
- Have a good memory and a capacious vocabulary, the ability to stylistically correctly present information.
- Quickly switch attention.
- Be able to determine with high accuracy, both large and small angles, and angular velocities.
- Be able to reproduce colors and shades both verbally and with pencils, paints.
- Be able to remain calm and observant under unfavorable conditions.

It should be remembered that the quality of preparation largely affects the quality of the entire study; unqualified participants can ruin the entire study and make further study of the impact site impossible.

Rules of conduct within the research team:
- Comply with the previously agreed upon work schedule, follow the instructions of the immediate supervisor, comply with the subordination specified in the documents, and the agreed formalized agreements and rules for the duration of the expedition
- Coordinate, if possible, the dates of the work with cosmophysical factors and weather conditions
- Do not make loud sounds, do not shout, do not swear, do not turn on music, use a walkie-talkie and sign language according to the instructions
- Show mutual respect, politeness, tolerance, balance to all expedition participants
- Agree on the research area with possible places of hunting, fishing, deforestation, other human activities, take into account the boundaries of private property
- During the expedition or on-site research, do not drink alcohol, drugs or strong medications, do not smoke, drink the required amount of water per day (at the rate of 40 milliliters of water per kg of body weight per day)
- Use only products with the declared composition of ingredients, in order to avoid allergies and the like. All participants provide medical certificates in advance about the presence of allergies, chronic diseases, etc. with the described symptoms, according to which the first aid kit should be supplemented during the expedition and a procedure for providing assistance or evacuation should be developed
- Do not wear bright or shiny clothing colors that may irritate animals in their potential habitat area
- Do not use aromatic substances or perfumes with a strong, especially pungent odor, in order to ensure the purity of the perception of odors in the area, in order to avoid blocking receptors and other possible effects on participants, fauna and flora
- Do not touch unknown and poisonous plants and avoid contact with animals (including poisonous ones)
- Do not eat any products outside the base camp or inside the impact zone without the consent of the immediate supervisor. Eat only products that you brought with you. Wash store-bought vegetables, fruits, etc. before eating or cooking. Any products purchased, received or taken on time, or during an expedition or on-site research must have only the declared composition, labels, inscriptions, etc., in their absence, it is not allowed to eat them.
- Do not allow micro-objects (dust, dirt from the ground, etc.) to enter the body.
- Do not make excessive fires, especially under trees or near anthills, burrows or nests of animals, or other designated objects of flora and fauna, take into account the wind rose, do not direct smoke in the direction of the impact zone or populated areas, highways.
- Protect nature, do not litter and clean up all the garbage after yourself, restore landscape damage before breaking up the camp.
- Make a fire only from collected dry branches, brushwood, cones, etc.

Preserve flora objects as much as possible during work. Breaking branches of living trees is unacceptable. At the end of use or before breaking up the camp, the fires must be completely extinguished and the site must be reclaimed (covered with Earth, camouflaged if necessary).
- Before starting work, before entering the research area, and after each stage of work, as well as upon completion of work, biomonitoring is carried out for all expedition participants or on-site research - measuring pulse, blood pressure. If significant deviations from standard and initial indicators are detected at any stage, measures will be taken to evacuate the participant from the research area, ensuring safety from the next work, and, if necessary, providing medical assistance and / or evacuation to medical care facilities
- Adhere to a strict daily routine, alternating work time with rest, eating, washing and sleeping
- Carry out duty in the camp by at least two people, also moving out in groups of at least 2 people. Groups moving out to probable impact sites must be equipped with means of operational communication, location recording and personal protection

- Show maximum attentiveness while at the impact site and monitor instrument readings, as well as your own well-being. Maintain psycho-emotional stability, and if you feel any changes, contact your immediate supervisor
- If you detect unknown symptoms, immediately use the available safety equipment, leave the danger zone, warn the surrounding people and your immediate supervisor. Symptoms are diagnosed by a physician or a person with appropriate training and experience
- Collect samples of vegetation or soil only in the minimum quantity stipulated by the plan of research activities, and in places that are not critical for the local flora and fauna, in the manner stipulated by regulatory documents, with the prevention of direct contact
- Minimize the use of electronic devices with active radiation, lighting equipment
- Do not use a player, headphones, headset, etc., do not use glasses that greatly narrow the field of view
- Preserve fauna objects as much as possible during work, any interaction with them is prohibited. In extreme cases of danger - use personal protective equipment and weapons, the procedure for using which is announced separately by the immediate supervisor. When meeting with wild animals - act in accordance with the instructions given, do not make sudden movements and sounds, move away in a safe direction to the base camp
- When meeting with unfamiliar people, creatures - act according to the instructions provided
- Place the base camp taking into account the convenience of the location, light, wind rose, as well as the relief, hydrogeological conditions, and safety. In this case, the opinion of all specialists without exception is taken into account, which is summarized and presented to the expedition leader and their internally authorized representative (or their immediate leader in the expedition)
- Provide in the base camp the routes of advancement and evacuation routes, as well as scenarios for action in case of emergency. The location of the camp and the route of advancement cannot be selected only by external signs of flora and fauna or relief (anthills, plants, ravines, etc.), since they can be modified by primary or secondary impact sites, as well as a result of anthropogenic activity
- Do not touch objects and objects at the impact site with unprotected hands and other parts of the body (plants, trees, earth, dirt, etc.), use personal protective equipment - disposable gloves, gauze, respirators, gas masks, protective suits, capes, shoe covers, boots, etc. in accordance with the tasks and conditions of the work. Contaminated or used disposable protective equipment must be disposed of, and their contact with clothing or body parts, equipment is prohibited
- Do not transfer dust and dirt from the impact site beyond their boundaries. Use appropriate means to collect samples
- Do not touch or activate unfamiliar objects, or familiar but foreign objects at the impact site, without the consent of the immediate supervisor
- Avoid contact of clothing elements with objects or dust at the impact site and around, use personal protective and hygiene equipment, if necessary, placing disposable protective elements made of polyethylene or other insulating materials for work in a sitting or lying position. Contaminated or used disposable protective equipment must be disposed of, their contact with clothing or body parts, equipment is prohibited
- Be appropriately equipped when moving out of the camp and have means of communication
- Adhere to appropriate safety on the water, have and be able to use life jackets, means
- Adhere to appropriate safety when working at height, in the mountains, in buildings, etc.
- Approach hills, if possible, in separated groups from opposite sides of the slope. Approach the probable impact site and objects so that the wind is in the direction of the research group, checking the instrument readings in accordance with the established regulations (in order to identify signs of possible chemical air pollution in advance)
- After completing the work, dispose of contaminated or used safety equipment (gloves, respirators, raincoats, etc.) in a separate, environmentally friendly manner, avoiding their contact with clothing or other objects. Transfer the devices and equipment to a neutral state, clean them and hand them over to the immediate supervisor according to the register. Inspect visible areas of the body and clothing for possible lesions and contamination
- Upon returning home, take a shower, carefully inspect the body, informing your immediate supervisor if there are any changes. If you feel worse, immediately inform your immediate supervisor and contact the appropriate medical institutions.

<u>Motor transport or walking</u>:

Modern motor transport combines mobility with comfort, can serve as a place to spend the night and protect from many dangerous factors, be a storage for equipment and supplies, have on-board sources of heat and electricity, etc. To implement these capabilities, it is necessary to maintain the units in good condition, ensure their timely maintenance and accordingly equip the vehicle for uninterrupted autonomous operation. The basic equipment includes supplies of fuel and lubricants, food, drinking and industrial water, hygiene products for the entire expedition, a spare wheel, a towing rope, shovels and other accessories for confident off-road movement. In expeditions, it is advisable to use cars with all-wheel drive and sufficient ground clearance, at least suitable for confident movement on dirt roads. The use of two or more vehicles, even if all expedition participants could be accommodated in one, facilitates movement in difficult terrain conditions and expands organizational capabilities - in particular, dividing personnel into several separate search groups, establishing a base camp away from populated areas and danger zones without losing efficiency, triangulation and courier functions, etc. If, due to unfavorable circumstances, it is not possible to use motor transport, in particular for the purpose of evacuation or achieving the research goal, all expedition participants must be prepared for long walks. In this case, it is necessary to take into account the distance, season, terrain and spend energy on movement as efficiently as possible. It is necessary to determine the route and speed of movement, time of halts, medical care, possible changes in the meteorological situation. When planning a route, it is recommended to avoid various natural obstacles (hills, mud, bushes, etc.). For this purpose, clear landmarks are applied in advance on the working map of the expedition.

Also, when moving on foot, it is necessary to constantly monitor the route by compass and celestial landmarks. The main secret of maintaining a high speed on foot is a reasonable combination of movement and rest. It is necessary to maintain the rhythm and depth of breathing through the nose. The rhythm of movement must be smoothly increased at the beginning and decreased 3 ... 5 minutes before the stop. When moving on level terrain, it is necessary to take 10-minute breaks every 2 hours. At halts, it is necessary to check shoes, shake out dust and stones, adjust equipment and clothing, which should be comfortable and not cause unnecessary sounds when moving. Drink water only after reaching a state of rest, first wetting your lips, and then in small sips, so as not to lose excess moisture.

The average speed of walking without a load on flat terrain is approximately 4 ... 5 km / h, with a load - 3 ... 4 km / h. In winter, the speed of movement decreases and depends on the depth of snow and wind speed. When climbing, move evenly, with your hands behind your back and your body slightly tilted forward. On steep slopes over 20°, without a load, the movement can slow down to no more than 300 m per hour, and with a load - no more than 200 m per hour, while making short stops every hour. On steeper slopes, you will have to use your hands. In highlands, you need to adapt to the lack of oxygen and dry air, temperature changes, and increased solar radiation. When moving through swampy areas, you should look for hummocks and rhizomes that you can step on, or lay branches, poles, reeds crosswise and move on along such a flooring. If you fall into a swamp, do not despair and make sudden movements, but be careful, leaning on a pole and pulling yourself up on it - reach the reeds, grass, branches; and having climbed to the surface - crawl "on your belly" to the shore. Moving on ice on water bodies is possible if its thickness is at least 5 ... 7 cm, and the air temperature is not higher than minus 5°C. In this case, a distance of at least 5 m between people is observed.

If the ice begins to break, then it is necessary to throw off the load, spread out on the surface of the ice, and pushing off with your feet - carefully move to the shore. If you fall through the ice, you need to pull yourself up over the edge of the ice, or throw your hand onto the ice first, and then your leg, moving the center of gravity onto the ice. It is better to move through deserted and arid areas at night, in the evening and early in the morning, avoiding walking on deep sand. It should be remembered that due to the heating of the air, the distance to the landmark can be approximately 3 times greater than it seems.

A location that can serve as a temporary shelter should be dry and slightly elevated, so as not to end up in a puddle during rain. The shelter should be protected from the wind, close to a water source (but without the risk of being flooded during a flood), with a good supply of firewood nearby (in forested areas, you should stick to the edges of the trees, from which there is a good view). You should check that there are no dry branches among the trees above your head that can fall in a strong wind. Under no circumstances should you set up a camp on an animal trail or any other path. It is worth remembering that the splash of water can suppress other noises that may indicate imminent danger. Shelter from rockfall can be provided by protrusions and bends of slopes.

In a thunderstorm, you should not hide under trees due to the risk of lightning, keep your feet close together and move with small steps. On completely open plains, you should sit with your back to the wind, placing all your gear behind your back to protect yourself from the wind. Even a shallow depression can provide shelter from the wind, but it should also provide protection from water flowing from above if the shelter is located on a slope. A roof should be built over the depression to protect from rain and retain heat. Several strong branches will support the weight of a thin log placed on top, on which shorter branches are placed like rafters, covered with turf, branches and leaves. The final type of shelter is determined by local conditions and materials. If the clothes are wet, they will quickly take heat from the body. Therefore, first of all, you should wring out and put on your hat again, since 50% of the heat leaves the body through the head. Then you should wring out and put on other clothes again. The less water remains in the clothes, the faster they will warm up and begin to retain heat. If the body cools down, movement will help - chop or saw wood, squat, etc.

The hearth is a source of heat and protection at the same time. To make a fire, you can use the rotation of a hardwood rod in a hollow made in a softwood base. Under the influence of friction, air-ignitable wood dust and heat are formed. It is better to choose a place for a fire protected from the wind, not closer than 5 ... 6 m from tents, trees, bushes, so that sparks do not fly on them. It is better to use the lower dry branches of spruce, pine for kindling. You can scrape resin from spruce trunks. Birch lights up well - however, when it burns, burning drops of tar may be emitted. If there is significant humidity, dry branches should be split and planed from the middle of the kindler. More firewood should be stored for the morning. Wild animals, as a rule, are afraid of the sight and smell of fire.

Water. The absence of water for 24 hours has a very negative effect on a person's morale, reduces their performance, and causes rapid fatigue.

In hot areas, a person can die without water in 5 ... 7 days, and without food, if there is water, a person can live for a long time. Even in cold zones, a person needs about 1.5 ... 2.5 liters of water per day to maintain normal performance. At the same time, it should be taken into account that the water in the environment can be polluted. Any body of water should be a cause for concern if there is no greenery or scattered animal bones around it. In arid regions, lakes with stagnant water become salty, and the water from them must be distilled. You should avoid drinking raw water (except spring water and clean mountain streams), especially from bodies of stagnant water, or downstream from populated areas. Water from any body of water must be disinfected. The most reliable method is boiling (from 8 to 30 minutes). If you tie a tree with cloth during rain, the water will flow down the trunk, be absorbed by the cloth and drip into a container placed underneath. A hole in the ground, coated with clay and covered on top, will retain water well.

2.5. Arrival at the impact site

Before leaving, check the functionality of the equipment. Always request written permission signed by the land owner for measurements, as well as for sampling, specifying all tasks that will be carried out.

Delivery of equipment to the impact site is carried out by a mobile laboratory as part of a mobile monitoring complex, or by another vehicle if such resources are not available.

Upon arrival at the impact site, before proceeding to the direct collection of material samples, all unauthorized persons are removed from the site and the availability and readiness for operation of all scientific and technical means at your disposal are checked once again. Do not trample the area, do not litter and do not forget anything.

Then a second interview of the eyewitness is conducted in order to verify and clarify his initial testimony on the spot. The eyewitness, with his consent, is asked to repeat his story on a voice recorder or video camera taking into account the specific situation, and if he wishes, you can promise that his face will be hidden (pixelated) and his voice will be changed. In this case, the eyewitness must be in the same place from which he observed the event and preferably in similar lighting conditions of the area. If the eyewitness moved during the observation, he shows exactly how he moved. During the eyewitness's story, goniometric measurements of the parameters of the observed phenomenon are made together with him, the illumination and mental state at the time of observation are taken into account.

Fig.2.5 Application with presentation of certificate and consent of the land owner with presentation of documents for the land (I. Kalytyuk)

It is important to understand that during the survey, it is worth paying attention to the gestures and facial expressions of the eyewitness when telling the story, and also bluffing a little to determine the motivation for the story. If possible, record the entire story on video or a voice recorder.

The next step is a general overview of the impact site. The purpose of such an overview is to get your bearings on the site, which is inspected from several points. During the overview, the boundaries of the territory to be surveyed are determined. They are set in such a way as to cover the entire area where traces of the impact of the anomalous phenomenon can be found.

As new information is received, the boundaries may change and new areas of the area may be surveyed. When determining the boundaries, you should be guided by the rule - it is better to expand the boundaries than to leave some part of the territory without inspection. After the survey and definition of boundaries, a specific research plan is drawn up, correlations are made indicating the movement of the phenomenon on satellite images of the area, if there are none, then a map of the area is drawn by hand with the scale preserved, in order to then transfer the correlations to satellite images, overview and orientation photography is carried out, orientation and overview plans are drawn up. After the general survey, they proceed to collecting and examining the area of impact.

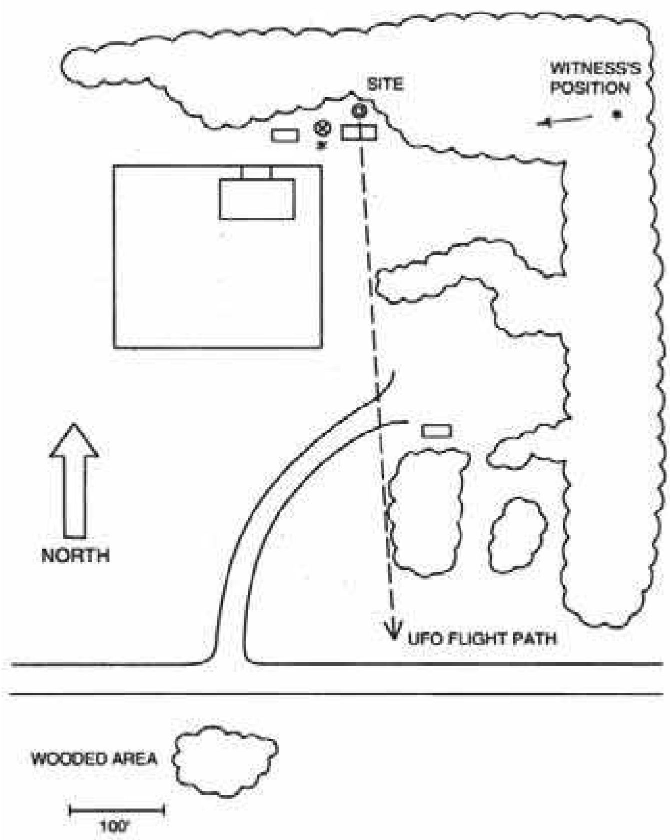

Fig.2.6 Sketch of the impact site by hand (MUFON)

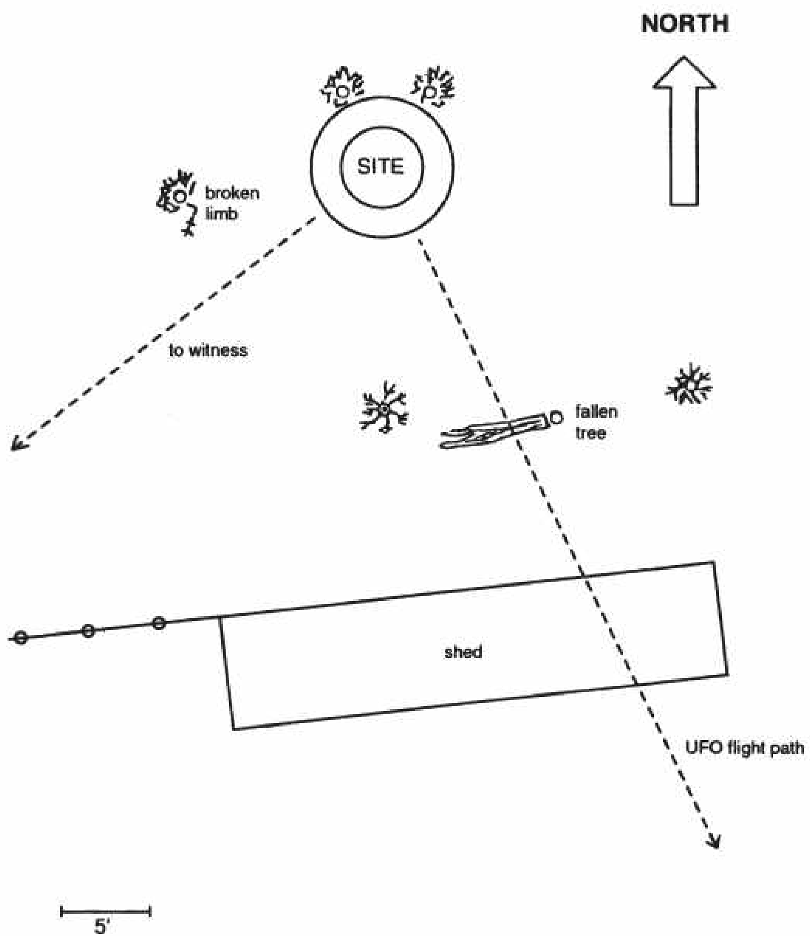

Fig.2.7 Specifying elements for georeferencing (MUFON)

2.6. Inspection of the impact site

The area is inspected in accordance with the plan outlined by the group leader during the survey.

The survey includes a number of successive stages: inspection and examination using scientific and technical research methods - measurements and collection of samples. The entire territory within the established boundaries is subject to a thorough inspection, if necessary, divided into sections for each participant in the inspection.

The following methods of movement of participants can be used:

1. *Concentric* - conducted from the periphery to the center in a spiral, moving clockwise. This method of movement minimizes the risk of damaging traces.

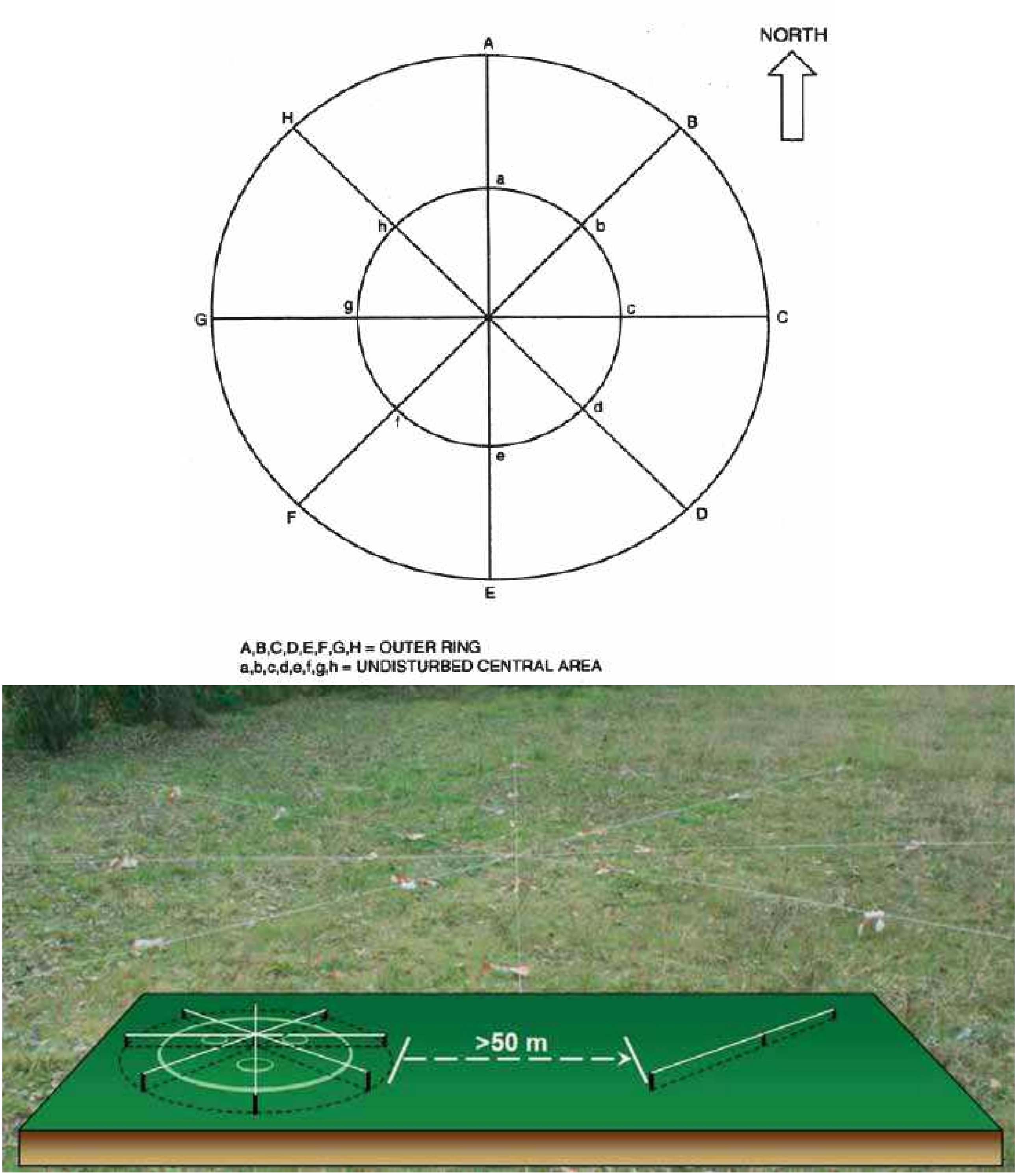

Fig.2.8 Circular marking (MUFON, UFO-Science)

2. *Linear* - conducted when examining large areas, when the location of the impact is not precisely determined, on very rugged terrain and in the forest. Conducted from the selected starting point along straight lines of sectors or squares from edge to edge within the area being examined.

Marking the place and collecting samples

The marking itself can be applied both to the terrain and to a printed or electronic satellite image of the area where the impact occurred, also drawing the locations of traces on the surface and the finds of liquids or artifacts. It is necessary to indicate the scale of the drawing, or the distance measurements in meters, and also indicate the direction to the north by checking the compass (the compass needles may slightly deviate due to the magnetization of the surface near man-made objects).

The results of measurements by radiometric, magnetometric or other equipment in the sectors or axes of the survey should be indicated on a separate sheet of paper for the drawing.

Collection of control samples at least 50 meters from the site, if possible.

Also take a soil sample at the epicenter. Indicate on the marking drawing the sample number, where from the "impact zone" and where "control". Marking into sectors - if the impact site is not very stretched along the entire surface

Marking into squares - if the impact site is stretched along the surface

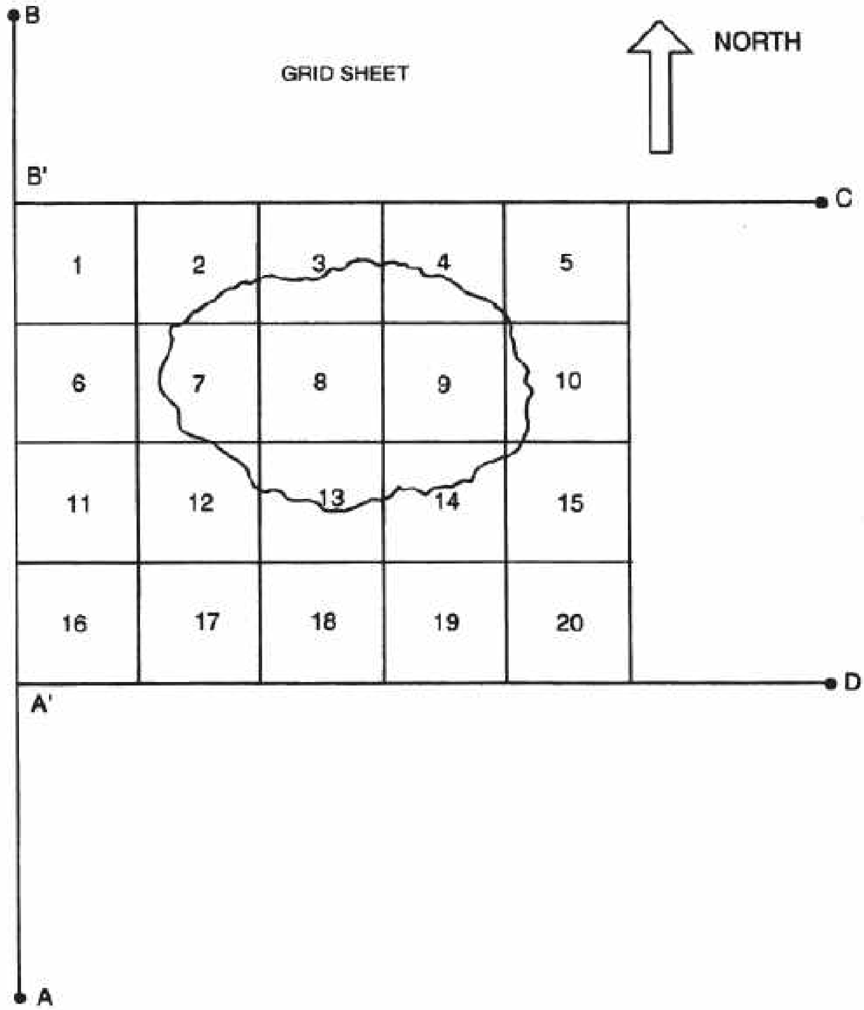

Fig.2.9 Marking into squares (MUFON)

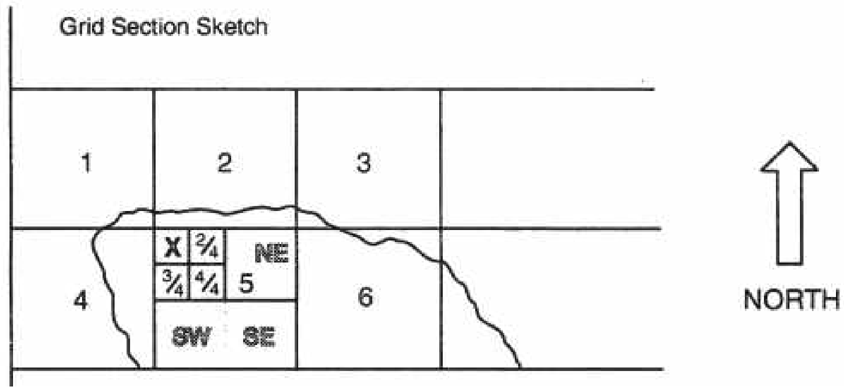

Fig.2.10 If necessary, additional squares can be specified (MUFON)

When any objects are discovered that may be related to the event under investigation, the following research methods are used:

1. *Static* - the object is not touched or moved until it is recorded using scientific and technical means.
2. *Dynamic* - a subsequent method of studying the object, in which the object is moved.

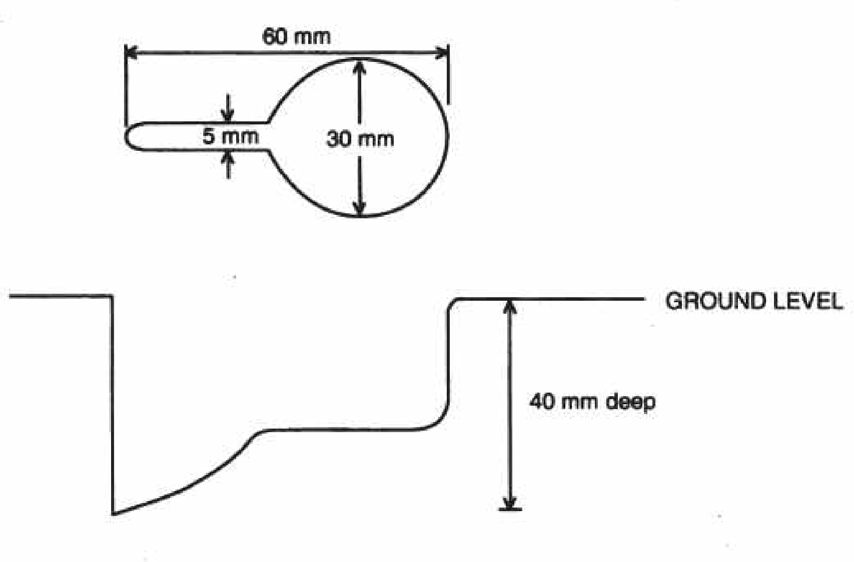

Fig.2.11 Sketch of the impact site in plane and depth (MUFON)

During the inspection, special attention should be paid to the presence of traces with characteristic anomalies. It is also necessary to take into account changes that may have been made to the environment during the time that has passed between the event and the arrival of the group. These changes may appear as a result of human actions, as well as animals that have found themselves at the site of the impact for one reason or another, and under the influence of natural factors (rain, snow, wind, avalanche, etc.).

Fig. 2.12 Basic equipment for work at the impact site (I. Kalytyuk, A. Bilyk)

Equipment and gear directly at the impact site: a tablet for questionnaires, two pens and a permanent pencil, a ruler and a triangle (Bradis tables), an azimuth compass, a 50-meter tape measure or a laser rangefinder, an inclinometer (an eclimeter, a theodolite), a scales-canter, marking pins, marking tapes, scotch tape, clothespins, sterile containers (entries on containers should only be made with a permanent pencil, or the containers should be numbered), plastic bags, sample collection shovels or a pick-shovel, permanent felt-tip pens, scissors and a knife or a Swiss knife, a voice recorder, radios or a mobile phone, a refrigerated container with dry ice, a multifunctional radiometer with the ability to dump data to a computer, multifunctional magnetometers and other equipment depending on the tasks. It is desirable to have a UAV with a thermal imaging camera.

Own devices and equipment - are permitted only with the consent of the expedition leader. It is also very important to provide preliminary training to the personnel on the use of devices, safety precautions and agreed actions in emergency situations.

Individual set of tools for a participant in an expeditionary study:

- A supply of drinking water at the rate of 40 milliliters of water per kg of body weight per day
- A notebook, pencils and ballpoint pens
- A sleeping bag, hammock, tent (optional)

- Personal medications and hygiene products
- A change of waterproof high-top shoes
- A windbreaker jacket with a high collar, a hat with a visor, change of trousers and underwear, thermal underwear, socks, etc.
- A smartphone with a normal camera always charged and ready
- A flashlight and spare batteries for it
- A compass, dark glasses
- A set of disposable gloves, shoe covers, garbage bags
- Other means according to the recommendations of the manager and methodological materials

It is also recommended to have: large backpacks, spare batteries, a lighter, binoculars, a fire extinguisher, an umbrella or rain cape, mosquito and fly repellents, a moving star chart, a laser pointer, reference books and manuals depending on the tasks at hand.

Fig.2.13 Advancement to the impact site (M. Ader, J.-C. Dore, UFO-science)

Fig.2.14 Inventory for collecting impact samples (M. Ader, J.-C. Dore, UFO-science)

Equipment in the mobile laboratory: camera, video camera, computer, thermometer, microscope, luminoscope, pH meter, magnifying glass, equipment for obtaining data from the spectrum, chromatography, cyto-histological studies of plants, geological and chemical studies of the soil and other equipment depending on the tasks.

Main and backup power sources - chargers for devices, extension cords.

There must be a first aid kit - universal (check the expiration date), which contains: a first aid guide, a kit for stopping bleeding and applying bandages in case of injuries, remedies for chemical burns and poisoning, antiemetics, radioprotective and antibacterial agents, painkillers and drugs, antiseptics and water disinfectants.

Personal protection:

Equipment required for each participant:

- Latex gloves
- Petal mask or respirator, if necessary mask and filter box for gas mask, with the maximum possible filters for various types of gases
- Clean shoes or rubber boots
- Chemical protection suit, if necessary radiation protection suit

Equipment for dry ice handling:

- Special rubberized cotton gloves for dry ice handling
- Goggles, protective

Other: protection against wild animals, self-protection.

Sample transportation criteria:

- Continuous measurement of sample temperature
- Improvement of insulation
- Reduction of high absorption temperature
- Avoid risk of explosion due to retention of dry ice

Dry ice retains cold for 24 to 36 h after sample collection

Precautions for handling dry ice:

- Avoid direct contact with skin and eyes, may burn (-78 ° C).
- Wear suitable gloves. - Ventilation from the environment during transportation.

Geographic and Geological Data

Example of Geographic Data

- Mountains or plateaus with elevations. Forest edge slopes north 15°.
- Dense grass on 300m2 (10m×30m).
- Presence of provincial road 198 to 50 (low traffic).
- Transformer EDF 300m to the east.
- No housing in the immediate vicinity or livestock in the locals.
- 5000m2 pond about 100m to the west.

Example of Geological Data

Volcanic massif: granite, basaltic lava 500m to the north-east (from the geological map). Soil: clay (from the soil map).

After the inspection, they proceed to examine the impact site, using special scientific and technical methods:

- geochemical soil sampling
- biological plant sampling
- cytological sampling for the presence of protozoa
- metrological studies of magnetic fields and radiation emissions

It is advisable to carefully photograph each stage of the research, if necessary, record it on video.

2.7. Soil collection for geochemical analysis

Soil samples are taken at the impact sites and can be placed in small sterilized jars or other sterile containers. Soil samples are taken with a plastic tool (spatula or knife), and if the soil is too hard, then with a painted shovel, but so that there is no contact with metal. It is also possible to take samples using a special sampler (a metal tube with a piston rod, having a sharpened edge), if the soil allows. In the case of stony-sandy soil, the best method will be subsequent analysis of the fine sediment obtained after evaporation of the solution used to wash away impurities from the soil samples. It is possible that this method can be used to clarify the presence of individual elements at the impact site, if surface samples are taken from fixed areas inside and outside the impact site.

Also, do not forget about control samples outside the impact zone, using the envelope method, i.e. at least 5 samples, one of which is closer to the center, and four - closer to its periphery. With a complex configuration of the site, there may be more than five sampling points, and they are evenly distributed throughout the site. The distance between individual envelope points should be approximately the same and range from several meters (home plot) to several hundred meters (for large areas).

The selection of forest areas to be surveyed is carried out depending on the goals and objectives of the research. At the site of soil sampling, litter samples are first taken. A site measuring 0.25x0.25, 0.5x0.5; 1x1 m is selected on a typical section of the territory. The mass of samples taken using the envelope method should be at least 2 kg (dry-air mass).

Soil collection for geochemical analysis is done to analyze finely dispersed sediment, after evaporation of the solution, which is used to wash away impurities from soil samples. In this way, we learn the presence of individual elements, their quantitative ratio, for example, manganese (Mn), lead (Pb), yttrium (Y), titanium (Ti), vanadium (V), cobalt (Co), barium (Ba), zinc (Zn), tin (Sn), niobium (Nb) and others. If necessary, spectral analysis can be carried out during combustion, this is also used for metal artifacts. Other chemical analyzes and methods can also be used. If necessary, a penetrometer, geological radar, etc. are used.

2.8. Collection of natural waters for determination of mineralization microelements

Table 2.1 Sensitivity of chemical and physicochemical methods for determining microcomponents of mineralization of natural waters

Defined element	Methods of determination	Sensitivity based on pure element (μl/l)	Amount of water for analysis (ml)
B	Colorimetric with carmine	10	100
Br	Volumetric determination with hypochlorite	250	50
V	Colorimetric with phosphorus-tungsten reagent	2,5	1000
Ge	Colorimetric with phenylfluorone	0,25	1000
Au	Stone-colorimetric with dimethylamidobenzylideneprodanine	0,02-0,03	3000
I	A) Colorimetric by iodine-starch reaction B) Volumetric determination with hypochlorite	100 250	20 50
Co	Colorimetric with nitro-R-salt	0,5	1000
Mn	Colorimetric in the form of MnO_4	10	500
Cu	Colometric with DDC Na, DDC Pb and dithizone	2-2,5	200-1000
Mo	Colorimetric with ammonium thiocyanate	0,5	500
As	Colorimetric with mercury chloride or mercury bromide	1	250
Ni	Colorimetric with glyoxime	1	1000
Nb	Colorimetric with ammonium thiocyanate	1	1000
Hd	A) Colorimetric with Polezhaev reagent B) Colorimetric with dithizone	0,2 0,5	100 200
Pb	A) Colorimetric with pluibon B) Polarographic determination	2,5 0,5	200 200
Ti	Colorimetric with disodium salt of chromotropic acid	1	1000
U	A) Luminescent B) Colorimetric with uranium	0,5 1	200 500
Fe	Colorimetric with zircon-alizarin	200	25
Zn	A) Colorimetric with dithizone B) Polarographic determination	5 15	100 1000

Before collecting water samples, you should prepare a sterile container. Hands should also be disinfected or sterile gloves should be used. The container should be opened immediately before filling it with water. Do not touch the inside of the walls or lid of the container with your fingers. After collecting, close the container tightly to prevent contaminants from entering from outside. When collecting water samples for chemical analysis, the container should be filled "to the brim" and (unlike when taking samples for microbiology) pre-rinsed with the same water that is being taken for analysis.

2.9. Collection of samples for biological analysis

First of all, it is worth paying attention to whether there is inhibited plant growth, changes in color, growth height, destroyed roots and the appearance of burns on the surface of the bark of trees, as well as dried trees that rot relatively quickly.

Such samples are subject to study, in addition, control samples of identical plants are collected outside the place of impact.

Fig.2.15 Numbering of packages (M. Ader, J.-C. Dore, UFO-science)

The grass is cut with scissors, but not at the root, but at a height of 2-3 cm (above the contaminated soil) from the soil surface. The weight of a spot sample is 0.5-1 kg. Samples should be taken from agricultural crops diagonally across the field or along a broken curve. A combined sample is made up of 8-10 spot samples taken from the above-ground part of plants, or separately from stems and leaves, fruits, grain, and root crops. The weight of a mushroom sample should not exceed 2 kg, and berries - 1 kg.

The container for collecting samples is tied with a bright ribbon to two bags and secured with a clothespin. To avoid subjectivity in analyzing samples, each bag from the freezer will be given a completely random number. Even numbers: young leaves. Odd numbers: old leaves.

- Close the bags for freezing and clamp the ribbon.
- Store so that the number is visible. Fasten everything with clothespins.

Do the same for all the other bags

- After that, put them in numerical order in the box.

Growing Plants. Collect 2 plants per planting area, take the most damaged ones. Everything should be strictly of the same species for comparison. Collect distances to the epicenter and azimuth. Write this information on the labels.

Herbarium. Collect some leaves or plants (depending on size). Samples should be larger and include: roots, stems, leaves and flowers. Leaves and flowers should be distributed as much as possible. Place them between two sheets of newspaper.

Conditioning example. After a few minutes: Collect all samples and place them in dry ice. Ensure proper distribution. Set the temperature sensor in the freezer and close, indicating: date and time of closing, genus of plant species.

Place all documents in a file and tape the place of moisture, make photocopies later.
Cultivation of plants should be carefully monitored, regularly use spraying with clean water.

Sending for examination. Samples should be sent as soon as possible to a mobile laboratory, or to another analytical laboratory, in order to conduct a study on the presence of chemical elements such as potassium (K), nitrogen (N) and phosphorus (P), under normal conditions the presence of these elements in plant tissues does not exceed 2-3%.

You can also conduct chromatography of chlorophyll pigments, biochemical studies: photosynthetic pigments, cell tissues, sugars, cofactors, plant hormones and nucleotides, etc. And if there is such a need, it is possible to conduct an examination of the growth rings and the cut of the tree trunk.

Fig.2.16 Collecting plant samples in a test tube (UFO-science)

Fig.2.17 Storage of biological samples in a refrigerated container
(M. Ader, J.-C. Dore, UFO-science)

Example Chlorophyll extraction followed by chromatography: we start by finely chopping the leaves using a food processor. Then it is ground in acetone in the presence of fine quartz sand, possibly by buffering the medium with chalk ($CaCO_3$). The addition of calcium chloride $CaCl_2$ also helps to promote extraction by permeabilizing the chloroplast membrane. By filtration, a crude acetone extract of chlorophylls is obtained. Deposition using a Pasteur pipette onto a strip of chromatography paper. Preparation of an eluent: petroleum ether, acetone, cyclohexane, or toluene (proportions 85%, 10%, and 5%). Migration in a tank protected from light lasts about thirty minutes, because that strong exposure to light is likely to cause oxidation of the Chlorophyll and thus generate an additional grayish spot.

Example, for the study of tree rings (dendrochronology) involves counting rings on a cross-section of the trunk or extracting a core using an age drill from a living tree. Each annual ring consists of light (spring) and dark (summer) areas, which are formed due to the seasonal activity of the cambium. The study allows you to determine the age of the tree and study climatic influence in past years.

2.10. Collection of samples for cytological analysis

The primary indicator is the protozoan type of rotifers, which are always present in the soil, have a fairly complex structure and a nervous system, which makes them very accurate indicators. The number of protozoa (pcs/ml) in relative standardized units (1 unit = 2500 pcs/ml) is as follows:

Table 2.2 Number of rotifers

Samples	Background	Active points
from the soil surface	1-0,8	0,35-0,2
at a depth of 30-40 cm	1-0,8	0,15-0

For analysis, it is necessary to take samples in clean test tubes filled with soil from the required points of the impact site to a depth of approximately 1 cm. It is important that all containers are of the same size. At least 3-5 samples are usually taken from one point, which helps reduce the influence of random factors on the development of protozoa. An accurate picture can be obtained if samples from the upper soil layer are taken over the entire area and at control points outside the impact site at least every 10 cm. In the laboratory, the test tubes are filled with water, covered with cotton wool and placed in a test tube holder for further analysis.

2.11. Collection of soil samples for determination of bacterial flora by using next generation sequencing (NGS) technology

New molecular biology technologies have made it possible to sequence the so-called 16S rRNA segments of uncultivated microorganisms in soil and other complex ecosystems. In this guide, DNA sequencing of 16S rRNA of the bacterial genome is discussed which could help to characterize the bacterial population of UFO (UAP) exposed soil material both qualitatively ("Which bacterial genera are present?") and quantitatively ("How many bacteria of a genus are present?"), and to compare it with control samples (i.e. non-UFO exposed soil material). Soil microbes are among the most abundant and diverse organisms on Earth but remain poorly characterized. Soil microbial communities are incredibly diverse with a bacterial diversity predicted around 4×10^6 taxa in the soil.

The application of phenotypic and genotypic techniques plays a complementary role in understanding bacterial communities. For instance, microscopic examination of bacteria reveals their morphology, size, and spatial arrangement, whereas Gram staining aids in the differentiation of bacterial cells into two classifications based on their cell wall properties, thereby facilitating the identification of specific bacterial species. Although phenotypic data provide valuable information, molecular techniques, such as genotypic analyses, are increasingly being utilised to complement and enhance bacterial characterisation, offering a more comprehensive understanding of microbial communities.

Currently, the most prevalent approach in environmental studies is to sequence specific hypervariable regions of the 16S rRNA gene. This 16S rRNA gene is highly conserved in bacteria and archaea but contains unique hypervariable regions that allow for taxonomic identification, from genus to species level. By sequencing these fragments from a sample, researchers can identify which bacteria and archaea are present, providing insights into the diversity and composition of microbial ecosystems.

Due to the heterogeneity of soil environments and their microbial communities, high spatial resolution of field sampling and sufficient biological replication within soil experiments is required. Along with the impact of environmental sample storage and batch effects in metagenomics, these factors necessitate the reproducibility and efficient throughput of sample preparation.

DNA extraction. In general, soil DNA extraction involves microbial cell lysis via mechanical, chemical, and/or enzymatic methods to break open cells, followed by purification to remove soil inhibitors like humic acids. Various commercially available kits offer pre-optimized protocols for this process, while do-it-yourself protocols often combine physical disruption (e.g., sonication) with chemical agents (e.g., detergents, buffers). Here, we present an extraction protocol from the company Macherey-Nagel (NucleoSpin ® Soil kit, Fig. 2.18) which is designed for the isolation of high molecular weight genomic DNA (gDNA) from microorganisms like Gram positive and Gram-negative bacteria, archaea, fungi, and algae in soil, sludge, and sediment samples. The NucleoSpin ® Soil kit can be used for DNA extraction from soil samples, which can then be used for downstream applications like nanopore sequencing. The kit is providing high-yield and high-purity DNA suitable for molecular analysis. After extraction, the DNA can be prepared for nanopore sequencing leading to results which provide detailed insights into the composition and structure of microbial communities.

Fig. 2.18 Components of the reagent kit specifications from the Company Macherey-Nagel, which can be used for genomic DNA extraction from soil (D. Thormeyer).

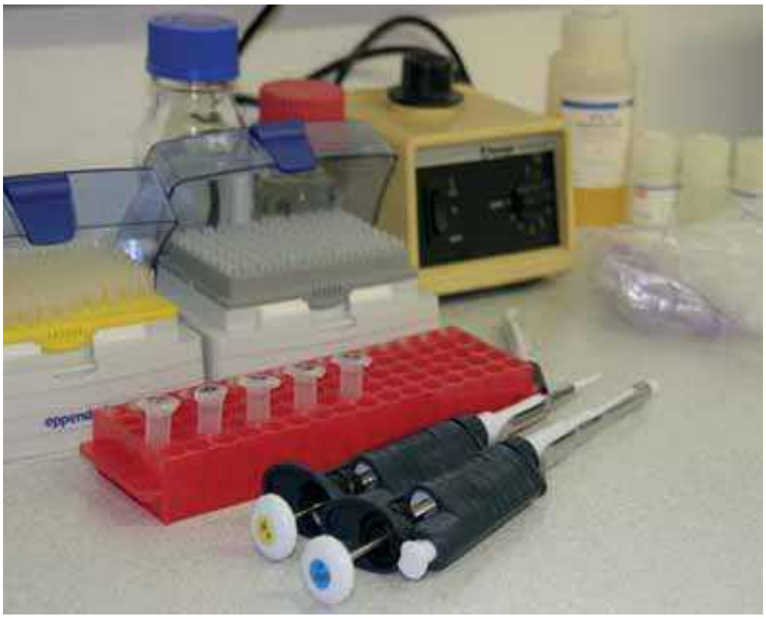

Fig. 2.19 Laboratory equipment (e.g. microcentrifuge *tubes, pipettes, disposable pipette tips, sample vortexter) (D. Thormeyer)*

Additional equipment and consumables

Reagents

- 96 – 100 % ethanol (wash buffer)

Consumables

- 1.5 mL microcentrifuge tubes
- Disposable pipette tips

Equipment

- Manual pipettors
- Centrifuge for microcentrifuge tubes
- Personal protection equipment (e.g., lab coat, gloves, goggles)

Kit specifications at a glance

Table 2.3 Kit specifications based on company´s manual (Macherey-Nagel, February 2023 / Rev. 12)

Parameter	**NucleoSpin® Soil**
Format	Mini spin columns
Sample material	< 500 mg soil or sediment
Typical yield	2 – 10 µg
Elution volume	30 – 100 µL
Preparation time	90 min/10 preps
Binding capacity	50 µg

Table 2.4 Overview of the most commonly encountered issues during DNA/RNA extraction and library preparation (Macherey-Nagel, February 2023 / Rev. 12)

Observation	Possible cause	Comments and actions
Poor or no DNA yield	Suboptimal lysis conditions	Too much sample material was filled into the Bead Tube. Too little head space does not allow the necessary motion of the beads to disrupt the sample. Use less sample material.
	Insufficient disruption and / or homogenization of starting material	Shaking of the Bead Tube was too weak or not long enough. Increase shaking time and velocity or use another shaking device. Make sure that the Bead Tube is fixed horizontally on the vortexer.
	Reagents not applied or restored properly	Always dispense exactly the buffer volumes given in the protocol! Always follow closely the given instructions with regard to order and mode of mixing (shaking, vortexing, etc). Store kit components at room temperature (18 – 25 °C).
DNA is degraded	Too harsh mechanical sample disruption	Reduce intensity or incubation time of mechanical sample lysis.
Suboptimal performance of DNA in downstream experiments	DNA yield was overestimated	If DNA eluates are not completely free of contaminants (e.g., RNA, protein, humic substances) UV-VIS quantification based on A260 is not reliable due to the contribution of the contaminants to the absorption at 260 nm.
	Carry-over of ethanol or salt	Make sure to dry the silica membrane and the NucleoSpin® Soil Column completely before elution to avoid carry-over of ethanolic Wash Buffer.
	Contamination with PCR inhibitors	The DNA purity can be increased by lowering the amount of starting material. Make sure to carefully follow the washing instructions. Dilute DNA 1:10 to reduce concentration of inhibitors.

Additional observations and actions are described in the company´s manual Macherey-Nagel, February 2023 / Rev. 12.

Key steps for using gDNA extraction kit from Macherey-Nagel (NucleoSpin® Soil):

Prepare the Sample

- Add your soil sample to a NucleoSpin® Bead Tube Type A.
- Add the specified amount of the SL1 or SL2 lysis buffer to the tube.

Adjust Lysis Conditions & Lysis

- Add Enhancer SX to the tube and vortex.
- Vortex the sample horizontally for 5 minutes at room temperature to break open cells and release DNA.

Precipitate Contaminants

- Add SL3 to the lysate and vortex.
- Centrifuge the mixture at 11,000 x g for 1 minute to precipitate contaminants and separate them from the soluble DNA.

Filter the Lysate

- Load the supernatant (the liquid containing the DNA) onto the red-ringed NucleoSpin® Inhibitor Removal Column.
- Centrifuge at 11,000 x g for 1 minute to remove inhibitors from the lysate.

Adjust Binding Conditions & Bind DNA

- Add the recommended binding buffer (SB) to the flow-through from the previous step and vortex.
- Load the mixture onto the green-ringed NucleoSpin® Soil Column.
- Centrifuge at 11,000 x g for 1 minute to bind the DNA to the silica membrane.
- Load any remaining sample onto the column and centrifuge again to bind all DNA.

Wash the Silica Membrane

- Perform the wash steps as described in the user manual to remove any remaining salts and inhibitors from the DNA bound to the column.

Dry the Membrane & Elute DNA

- Centrifuge to ensure the membrane is completely dry.
- Add the elution buffer to the center of the silica membrane to release the pure DNA.
- Centrifuge to collect the purified DNA in a clean collection tube

Details regarding the amount of soil sample material, buffer volumes, incubation and vortex times etc.) can be found in the company´s manual (Macherey-Nagel, February 2023 / Rev. 12). The eluted gDNA is ready to use for all standard downstream applications. In most cases the concentrated DNA can be used as PCR template without further dilution for highest sensitivity.

Limitations and recommendations for successful DNA extraction from soil samples

The list below summarizes the most commonly encountered issues, with some suggested causes and solutions.

It should be noted that DNA extraction kits are found to vary in their ability to detect microbial families. Previous studies have found the use of enzymatic lysis techniques to improve the DNA yield, while some protocols utilise both enzymatic and mechanical methods sequentially to improve lysis of diverse and resistant cells. Overall, these findings suggest that the choice of sample preparation method can dramatically impact the measured diversity of soil samples. Furthermore, the soil type had a significant impact on DNA yield and varied between 2 and 35 µg/g dry soil. It was also shown that that depending on the soil type, different soils required different purification steps to obtain amplifiable DNA. Miller et al. (in 1999) compared and statistically evaluated the effectiveness of nine DNA extraction procedures by using frozen and dried samples of two silt loam soils and a silt loam wetland sediment with different organic matter contents. The effects of different chemical extractants (sodium dodecyl sulfate [SDS], chloroform, phenol, Chelex 100, and guanidinium isothiocyanate), different physical disruption methods (bead mill homogenization and freeze-thaw lysis), and lysozyme digestion were evaluated based on the yield and molecular size of the recovered DNA. They evaluated four different DNA purification methods (silica-based DNA binding, agarose gel electrophoresis, ammonium acetate precipitation, and Sephadex G-200 gel filtration) for DNA recovery and removal of PCR inhibitors from crude extracts. Sephadex G-200 spin column purification was found to be the best method for removing PCR-inhibiting substances while minimizing DNA loss during purification. Their results indicate that for these types of samples, optimum DNA recovery requires brief, low-speed bead mill homogenization in the presence of a phosphate-buffered SDS-chloroform mixture, followed by Sephadex G-200 column purification.

The continuing challenge lies in the application of these methods to increase our understanding of the links between microbial diversity and maintaining and or bioengineering soil processes.

Library preparation and sequencing. Various method descriptions or protocols about library preparations from soil samples, PCR sequencing conditions, and bioinformatics analysis (e.g. DNA concentration used for PCR, primer design, PCR amplification cycles and settings, bioinformatics tool and microbiome database, etc.).

Here, the Ligation sequencing genomic DNA (gDNA) kit from Oxford Nanopore Technology (ONT) is presented which can be used to prepare gDNA libraries for nanopore sequencing. This protocol involves preparing DNA ends by fragmenting, optionally amplifying, and then ligating sequencing adapters to the DNA. Afterwards the prepared library is loaded onto an ONT flow cell (Fig. 2.20) to generate the sequencing data (Oxford Nanopore Technologies, Ligation sequencing gDNA. SQK-LSK110. VGDE_9108_v110_revX_10Nov2020):

Equipment and consumables

- Materials: 1 µg (or 100-200 fmol) gDNA
- Consumables: Nuclease-free water, 70% ethanol, various buffers (e.g. ligation buffer, fragment buffers, flush buffers, elution buffers, etc.), DNA control sample
- Equipment: mixer, microfuge, thermal cycler, pipettes and tips

Key steps for using ligation sequencing gDNA kit from ONT (Oxford Nanopore Technologies, Ligation sequencing gDNA, SQK-LSK110):

1. *DNA Extraction & Quality Control*: Extract your gDNA and perform quality checks for length, quantity, and purity, as these are critical for experimental success.
2. *Optional DNA Fragmentation & Size Selection*: While the default protocol does not include fragmentation, it can be beneficial for increasing throughput with low input DNA. Size selection can also be performed to enrich for long fragments.
3. *Adapter Ligation*: Attach the sequencing adapters provided in the kit to the prepared DNA ends.
4. *Flow Cell Preparation*: Prime the flow cell.
5. *Library Loading*: Load the DNA library onto the flow cell.

6. *Sequencing Run*: Initiate a sequencing run using *MinKNOW software*, selecting the appropriate kit control experiment.
7. *Data Analysis*: Use software like EPI2ME for data analysis, such as alignment to a reference genome

Details regarding the amount of DNA, buffer volumes per vial, incubation and vortex times, flow cell preparation etc.) can be found in the company´s manual (Oxford Nanopore Technologies, Ligation sequencing gDNA, SQK-LSK110).

As a flow cell example, the Oxford Nanopore Technology (ONT) MinION device can be used (Oxford Nanopore Technologies, MinION and flow cells, technical document, HWTD_5000_v1_revP_07March2025). It is a portable, real-time DNA/RNA sequencer that uses nanopore sequencing technology to detect single molecules as they pass through a membrane-bound pore, with results streamed directly to a computer for immediate analysis. The device's compact design (Fig. 2.20B) combined with its ability to generate long sequencing reads, allows for applications like field-based microbial surveillance, de novo genome assembly, and the detection of pathogens in remote locations.

Nanopore sequencing technology

Nanopore design. The concept of nanopore sequencing emerged in the 1980s and was realized through a series of technical advances in both the nanopore and the associated motor protein. α-Hemolysin, a membrane channel protein from Staphylococcus aureus with an internal diameter of ~1.4 nm to ~2.4 nm, was the first nanopore shown to detect recognizable ionic current blockades by both RNA and DNA homopolymers. ONT has continually refined the nanopore and the motor protein, releasing eight versions of the system to date (R6, R7, R7.3, R9, R9.4, R9.5, R10 and R10.3.

Nanopore sequencing determines DNA or RNA sequences by measuring changes in an electric current as single strands of nucleic acid pass through a nanopore. The principle involves a membrane separating two electrolyte chambers, creating an ionic current. As DNA/RNA moves through the nanopore, unique electrical signals generated by each nucleotide are captured by electrodes, amplified, and interpreted by software to determine the DNA or RNA sequence.

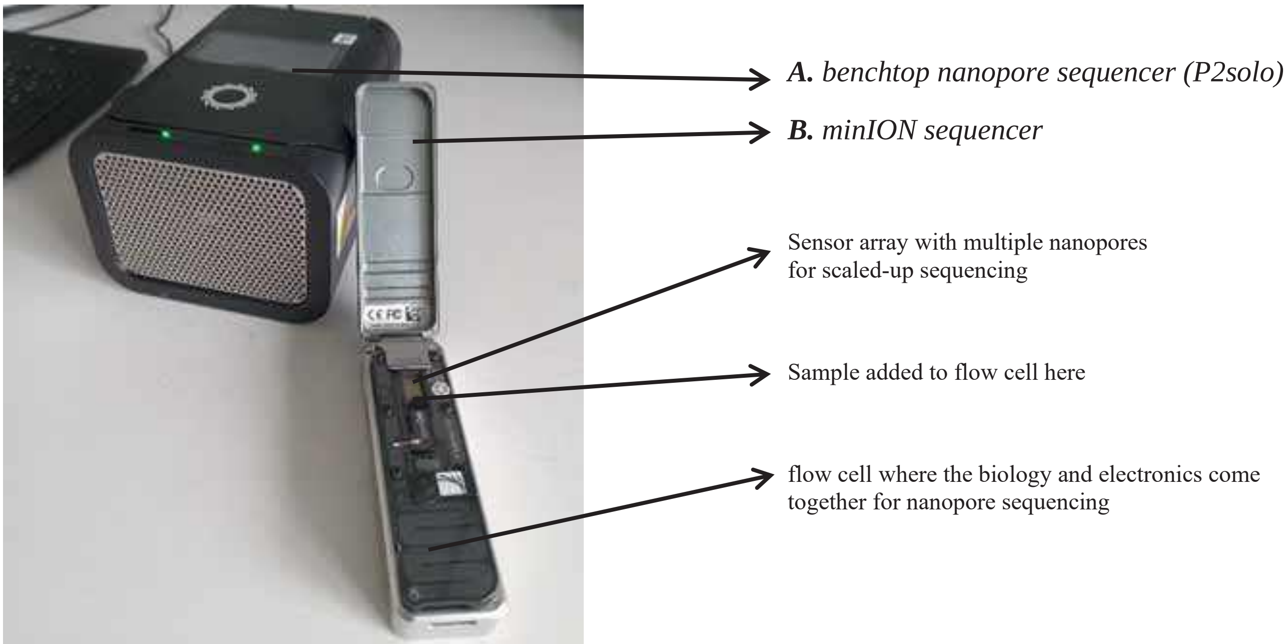

Figure 2.20 Nanopore sequencing devices (D. Thormeyer).
A. *DNA/RNA benchtop nanopore sequencer (P2solo, cube shaped equipment)*
B. *minION sequencer with flow cell device (bottom right corner) (picture kindly provided by O.A.). A minION flow cell contains 512 channels with 4 nanopores in each channel, for a total of 2,048 nanopores used to sequence DNA or RNA. The wells are inserted into an electrically resistant polymer membrane supported by an array of microscaffolds connected to a sensor chip. MinION identifies DNA bases by measuring the changes in electrical conductivity generated as DNA strands pass through a biological pore.*

Principle

- *Nanopore and Membrane:* A nanopore (a microscopic hole) is embedded in a membrane that separates two chambers containing electrolyte solutions.
- *Electric Current***:** An electric voltage is applied across the membrane, driving ions through the nanopore and creating a stable ionic current.
- *Nucleic Acid Translocation***:** Single-stranded DNA or RNA is pulled through the nanopore. Motor proteins help control the speed of this movement.
- *Signal Generation***:** As each nucleotide passes through the pore, it blocks the ion flow to a different degree, causing unique disruptions in a sequence specific fashion.
- *Signal Detection***:** Electrodes on both sides of the membrane detect these changes in the ionic current.

Resulting raw sequence data is processed by a bioinformatics analysis pipeline in order to obtain and extract meaningful biological information. The process involves steps such as quality control (e.g., using FastQC), taxonomic classification and statistical analysis (using R or Python) to determine the diversity and composition of the microbial community within the soil ecosystem. It is also relevant to note where and how 16S ribosomal DNA sequences can be retrieved for analysis. Sequences are generally submitted to and can be retrieved from the European Molecular Biology Laboratory (EMBL), Heidelberg, Germany; Genbank (NCBI), Bethesda, MD, USA; The DNA Database of Japan (DDBJ) Mishima, Japan, and the Ribosomal Database Project (RDP), University of Illinois, Illinois, USA. Sequences can be retrieved via the World Wide Web and new sequences compared with those held in the databases by using the basic local alignment search tool (BLAST).

Table 2.5 Overview of the most commonly encountered issues during DNA/RNA extraction and library preparation (Oxford Nanopore Technologies, Ligation sequencing gDNA, SQK-LSK110)

Observation	Possible cause	Comments and actions
Low DNA purity	The DNA extraction method does not provide the required purity	Please try an alternative extraction method that does not result in contaminant carryover. Consider performing an additional clean-up step.
Low DNA recovery	DNA loss due to a lower than intended beads-to-sample ratio	Beads settle quickly, so ensure they are well resuspended before adding them to the sample.
	DNA fragments are shorter than expected	The lower the beads-to-sample ratio, the more stringent the selection against short fragments. Please always determine the input DNA length on an agarose gel (or other gel electrophoresis methods) and then calculate the appropriate amount of beads to use.
MinKNOW reported a lower number of pores at the start of sequencing than the number reported by the Flow Cell Check	An air bubble was introduced into the nanopore array	After the Flow Cell Check it is essential to remove any air bubbles near the priming port before priming the flow cell. If not removed, the air bubble can travel to the nanopore array and irreversibly damage the nanopores that have been exposed to air.
	The flow cell is not correctly inserted into the device	Stop the sequencing run, remove the flow cell from the sequencing device and insert it again, checking that the flow cell is firmly seated in the device and that it has reached the target temperature.
Pore occupancy <40%	Not enough library was loaded on the flow cell	Ensure the correct volume and concentration as stated on the appropriate protocol for your sequencing library is loaded onto the flow cell. Please quantify the library before loading and calculate fmols choosing "dsDNA: µg to fmol".
Pore occupancy close to 0	The Ligation Sequencing Kit was used, and ethanol was used instead of LFB or SFB at the wash step after sequencing adapter ligation	Ethanol can denature the motor protein on the sequencing adapters. Make sure the LFB or SFB buffer was used after ligation of sequencing adapters.
Shorter than expected read length	Unwanted fragmentation of DNA sample	Read length reflects input DNA fragment length. Input DNA can be fragmented during extraction and library prep.
Large proportion of inactive/unavailable pores	Certain compounds co-purified with DNA	Known compounds, include polysaccharides, typically associate with plant genomic DNA. Clean-up using the QIAGEN PowerClean Pro kit. Perform a whole genome amplification with the original gDNA sample using the QIAGEN REPLI-g kit.

Issues during library preparation and sequencing. The list below summarizes the most commonly encountered issues, with some suggested causes and solutions.

Finally, it is critical for researchers to take into consideration the limitations of each sequencing platform, and choose a system appropriate for their experimental design. In addition, optimising 16S rRNA gene sequencing protocols will pave the way for more precise microbial research and diagnostics in the future.

Researchers have to bear in mind when using this technique that all known events (i.e. soil material exposed to the UAP) could have occurred weeks, months or years ago (depending on the eyewitness date of report, the difficulty to access the impact site, etc.), making it impossible to determine the original state at the time of occurrence. This is particularly true for short-lived traces (e.g. the presence of volatile isotopes, especially those with short half-lives).

2.12. Metrological measurements

Radiometric

The impact site and outside it are checked for radioactivity, having previously clarified the background radioactivity standards for the area. Considering that some areas may be irradiated even before the anomalous phenomenon occurs in the area. If noticeable fluctuations in radioactivity above the background level are recorded, it is necessary to conduct detailed measurements of the nature of radioactivity and take samples for analysis to clarify the sources of increased radioactivity or the reasons for its decrease.

Fig.2.21 Example of a Geiger counter. Description: measurement in microroentgens (mR/h), millisieverts (µSv/h) and CPM (parts/cm2 min); display of values in digital and graphic formats; recording of a log in the built-in memory with the ability to reset data to a computer; power supply and charging from USB and from a stationary and car electrical network, software for analysis and monitoring (GQ)

To determine the radioactivity of the soil, individual samples are delivered to the radiobiological laboratory, where they are dried at room temperature and weighed. Weighing is necessary to determine the concentration of radioactive contamination - activity per unit mass of soil (specific radioactivity). Based on the weighing results, the average bulk density of the soil is also determined.

All primary data on the sample, as well as the following data obtained during its examination and processing, are recorded in the sample and analysis log.

Individual samples can be subjected to preliminary radiometric control. If such preliminary control is not worth doing, then a mixed (average) sample is immediately prepared from individual samples after weighing. To do this, thoroughly mix individual samples on a plastic sheet or in a special vessel made of polymer material, spread out in an even layer 5 cm thick and take a part of the sample from an area of 30 cm^2 (5x6 cm). This part of the sample can be ground to a homogeneous mass and examined.

The soil sample in each individual case should be typical for the object, and the mass (volume) - sufficient for the study.

Soil activity is expressed in Bq/kg, Bq/m^2 or Ci/kg, Ci/km^2. In this case, the mass of a soil sample from an area of 1 m^2 with a thickness of 5 cm is taken to be equal to 69 kg (for clay). The found activity is compared with the average soil activity.

To determine radioactivity (in Bq/m^2 or Ci/km^2), it is necessary to take soil from the surface of the earth in the form of a frame measuring 100x100x60 cm, then weigh it, determine the activity of 1 dm^2, that is, calculate the activity on a radiometer and recalculate for 1 dm2 (when determining the activity per 1 km^2, it is necessary to take into account that 1 km^2 = 108 dm^2).

To determine the radioactivity of water, it is necessary to take into account the places where waste and industrial waters are discharged into the river, if they are located upstream. In any body of water, samples are taken from areas free of algae and other aquatic plants. In the case of centralized water supply, when water is taken from an open body of water, a sample is taken at the water intake points and from the water supply network - from the tap. If water is taken from a well, then the sample is taken only from the tap. Before starting to take water from the tap, tap water is released for 5-10 minutes.

Samples from wells are taken with a bucket, after mixing the water by immersing it several times. The average sample volume is 2-3 liters. Samples are collected in clean vessels (glass bottles, jars, polyethylene flasks, etc.) with stoppers or lids. To reduce the adsorption of radioactive substances, the water sample is acidified by adding 2 ml of a 2 N solution of nitric acid or 1 ml of concentrated hydrochloric acid per 1 liter of water. When transporting samples, the container must be hermetically sealed.

To determine the radioactivity of plants, grass samples are taken in open areas, at a distance of at least 50-100 m from the nearest buildings, roads, and forests along the perimeter of a triangle with a side of 100 m. At the grass sampling sites, at a height of 1 m from the soil, the radiation level is measured with a dosimeter or radiometer and recorded in a log.

Fig.2.22 Radiometric measurements of plants using GMC-300 and equipment: L-1, FK-5B A2B3E3AXR3, PPM-88 (I. Kalytyuk)

The measurement results are recorded or transferred to a computer with reference to sectors or squares. When radiometrically measuring plants, it should be remembered that the natural radioactivity of plants is predominantly 40K and averages values not exceeding, for example, for grass - 0.37 kBq/kg of wet weight, for moss - 3.7 kBq/kg.

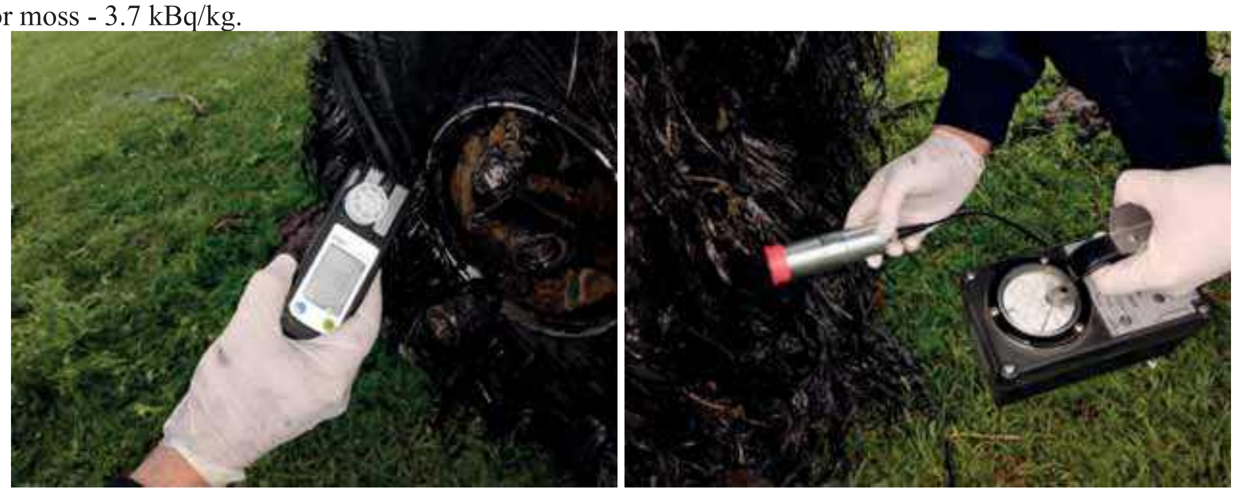

Fig.2.23 Measurements of hydrazine and radiation levels after the fall of an aerospace object (R. Lianza)

Fig.2.24 Example of a universal portable instrument set (UPIS) – "Elion", for metrological research. Kit composition: microwave field sensor (frequency 3 GHz, sensitivity 10 mW/cm2) and ultraviolet (0.38-0.01 μm) and X-ray radiation (mR/h) indicator; indication panel (1 unit = 1 mV); electrostatic sensor (working area of the antenna collector 100 cm2); two IR radiation sensors (spectral sensitivity range 0.8-2.0 μm and 2.0-10 μm); magnetic field sensor (50 μOe); plant biophysical activity sensor (LF generation frequency 10 kHz and HF 1 MHz); portable table; packing case; two connecting cables; power supply. (Soyuzufotsentr)

Magnetometric

A study of magnetic properties is carried out over the entire area of exposure and beyond it, for example, with a quantum magnetometer. Here, measurements are also required over the entire area of the exposure site and beyond it in mutually perpendicular directions. The measurement results are recorded in a protocol.

If necessary, the area can also be covered with a metal detector, soil samples can be taken using 24x24 plastic forms indicating the sample number and the north-south direction, and the measurements can be recorded. If necessary, the soil can be taken with a special magnetized corner, placed in a form made of thick paper of the same size and filled with liquid glass or "alabaster milk". Subsequently, the samples taken are subjected to special laboratory measurements on a rock generator, and on a magnetic susceptibility meter or other devices. With sufficiently large changes in the modulus of the residual magnetization vector and magnetic susceptibility, it makes sense to conduct further laboratory tests of the samples by specialists in paleomagnetism in order to determine the nature and magnitude of the magnetic field that affected them.

Gravitometric

Gravity measurements - measurements of local changes in gravity using gravity variometers, gradiometers, and gravimeters with an electric thermostat. It is advisable to carry out such measurements taking into account natural rhythms. The readings of gravitometers depend not only on changes in gravity, but also on changes in the temperature of the sensitive element due to possible thermoradiation effects. Therefore, for gravity assessments it is advisable to use devices for measuring gravity - gravity variometers and gradiometers. The method for measuring a possible gravity anomaly at the site of the impact of an anomalous phenomenon compared to a control zone comes down to comparing the calculated values of changes in gravity in three dimensions (in three azimuths). All measurements must be performed by a gravity survey specialist.

Spectrometric

Registration of the temperature field at the site of interaction with the AAP in the infrared frequency range. Such measurements must be carried out at night, and it is necessary to study the control areas adjacent to the impact zone. To view such fairly large areas, it is advisable to use a thermal imaging camera on a UAV, which will allow you to fly around the territory along a given coordinate grid.

If necessary, you can study the luminescent properties, which is carried out at night using field luminoscopes.

Other

Studying the surface of the impact site using a thermal imager or infrared night vision devices. This makes sense only in fresh places in order to clarify the structure of the impact.

Comparison of the boundaries of rock luminescence and the boundaries of the impact site in order to identify additional patterns.

Measurements of the electric field strength at a constant height, along a stretched cord. - electrometry can be performed using calibrated laboratory models or using industrial electrometric amplifiers connected to self-recording milliammeters. These measurements should be compared with the results of parallel measurements of soil conductivity (if possible) using a laboratory meter or a standard megohmmeter.

Studying the impact on electrochemical current sources to EMF - using a nano-ammeter or nano-voltmeter, to determine the difference in voltage between the impact site and the control zone. It is clear that careful passive thermostatting of the sources is also necessary here.

2.13. Conservation of the impact site

After the end of the research cycle, before the departure of the expedition, the impact site must be conserved for subsequent study. Conservation activities include the following:

- drawing up an official request to the land owners or authorities with a request for permission to fence off the impact site from possible disturbance of the surface soil layer during excavation work, etc. and agreeing on the issue of its protection.
- fencing off the impact site with posts with wire and attaching durable signs with the inscriptions "DO NOT DIG!" It is also advisable to agree with local representatives of the initiative group on regular inspection of the integrity of the impact site.

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Section 3. The process of identification and the influence of the human factor

3.1. Processing data obtained from an eyewitness

When processing data provided by one eyewitness, determining the linear size and height of an object is actually reduced to a plane problem, where the parameters of determination are the angle between the conventional center of the object (determined visually and approximately corresponds to the geometric center of the object) and the horizontal plane in which the observer is located (angle to the horizon); the height of the object above the horizontal plane that passes through the observation point (height of the object); the distance from the observation point to the conventional center of the object (distance to the object); and the distance from the observation point to the point over which the object was "hovering" at the time of calculation, i.e. the projection of the distance to the object onto the horizontal plane. Moreover, any two of the above parameters are sufficient to fix the object in space.

As a rule, one of such parameters is the angle to the horizon, since its determination does not require additional data, and can be performed both directly during observation and during the preparation of a situational plan on site. With a variable angle to the horizon, its specific value must correspond to a separate moment of observation, at which the characteristics are determined.

The height of an object when processing data provided by one eyewitness can be determined both by direct measurements with special devices and based on the positioning of the object relative to bodies whose height is known or can be determined from information outside the observation data. Most often, positioning is carried out relative to clouds - whether cloud cover was observed or vice versa; less often - relative to other atmospheric objects - aircraft, birds (since in this case, a necessary condition is the intersection of trajectories or other interaction of the object under consideration and the object for comparison).

Table 3.1 Cloud height

Tier	Cloudiness character	Altitude level, m
Lower	stratus, stratocumulus, nimbostratus	<2000
Average	altostratus, altocumulus	2000-6000
Upper	cirrus, cirrostratus, cirrocumulus	>6000

The projection of the distance to an object can be determined most accurately if, at the time of registration, there was a remote interaction of the object with elements of the external environment, the distance to which is known (the influence of a terrain area, tree, animals, etc.)

In the case of direct interaction, or a distance close to it, like other characteristic parameters, it can be determined based on direct testimony of an eyewitness (taking into account the psychophysiological state at the time of interaction), or traces on the ground during reconnaissance.

Also, the projection of the distance to an object can be found by positioning the object relative to ground bodies, the distance to which is known, based on information about the visual location (coverage) of the object relative to ground bodies.

Table 3.2 Calculation formulas for calculating the linear diameter and height of an object

Input data:	Calculation formulas:	
	Diameter size, o_1o_1'	Height, OC
α; OC; d	$o_1o_1' = OC \times d / (0,6 \times \sin \alpha)$	-
α; OC; β	$o_1o_1' = 2 \times OC \times tg (\beta / 2) / \sin \alpha$	-
α; AO; d	$o_1o_1' = AO \times d / 0,6$	$OC = AO \times \sin \alpha$
α; AO; β	$o_1o_1' = 2\ AO \times tg (\beta / 2)$	$OC = AO \times \sin \alpha$
α; AC; d	$o_1o_1' = AC \times d / (0,6 \times \cos \alpha)$	$OC = AC \times tg\ \alpha$
α; AC; β	$o_1o_1' = 2 \times AC \times tg (\beta / 2) / \cos \alpha$	$OC = AC \times tg\ \alpha$

Also, the angular size can be calculated from the linear size $\beta = 2 \times arctg (d / (2 \times 0,6))$

3.2. Identification of an aerospace phenomenon

The expert approach is the formalization of arrays of primary messages (APM) reflecting qualitative parameters on classification scales and assigning weight coefficients of different importance to messages.
Before forming the APM, documents containing information about the observation of an event or recording on the appropriate equipment, which contain detailed information with technical details, are divided at the copying stage into separate fragments containing information about only one observation. The array of primary information should include all messages, regardless of their content. When entering the text of a message from a letter into a computer database, it is prohibited to distort the text, that is, to type it in a simpler and more convenient way. The text is entered in the way the eyewitness wrote it. Only correction of grammatical errors is allowed, but not stylistics, which in itself can be a subject of research for psychologists. In addition, stylistics studies can tell us whether we are dealing with a normal person or a mentally unstable one. Further work with the APM is connected with the compilation of a preliminary catalog (PC) and a working directory (WD), and requires a special procedure. Each of the listed arrays can serve as an independent subject of research.
The formation of the PC is a logical continuation of work with the APM and is carried out, accordingly, on its basis, including documents containing information about the observation of an event or recording on the appropriate equipment.

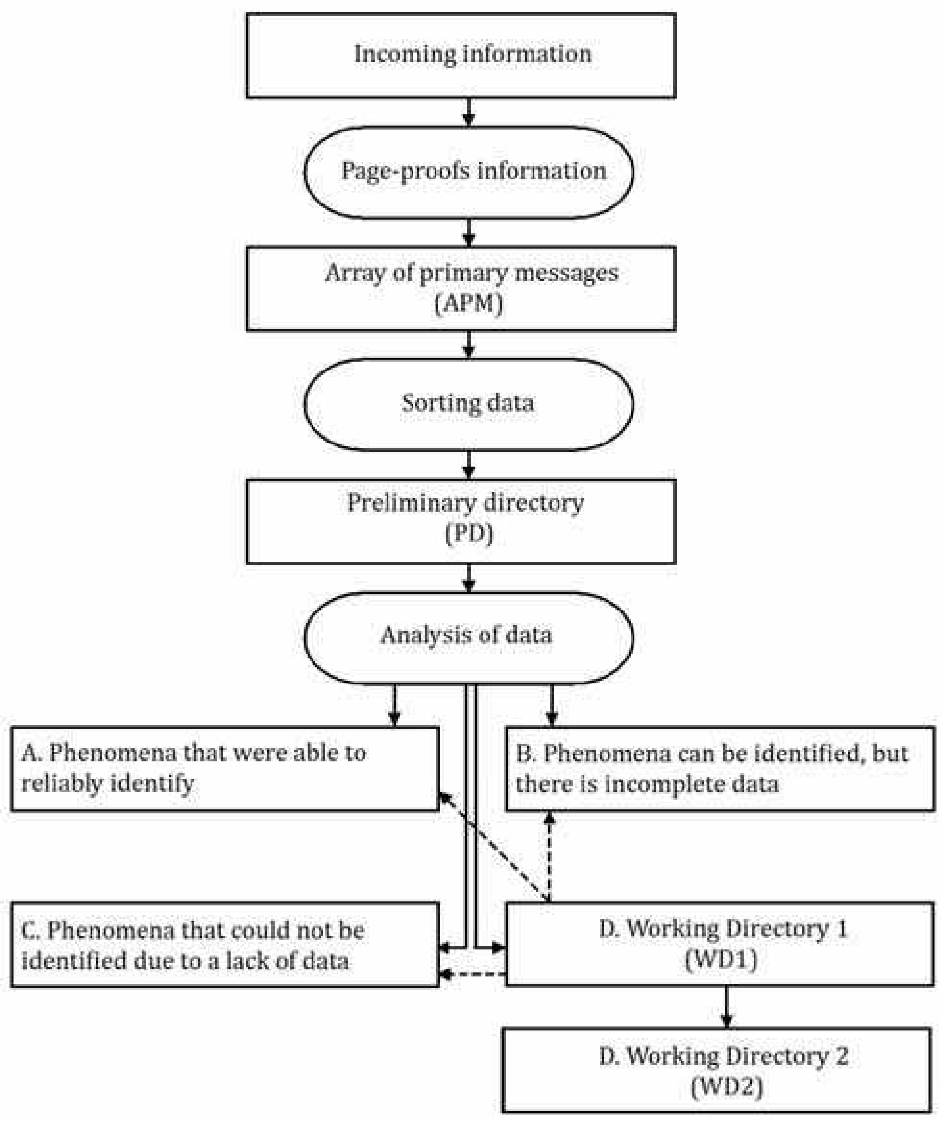


Fig.3.1 Expert approach to identification of aerospace phenomenon (A. Bilyk SRCAA "Zond")

Reports from a single eyewitness, without an exact or approximate date and time, are immediately rejected as unsuitable for examination. Reports from a single eyewitness without photos or videos, without additional witnesses or traces, have every chance of being rejected as well. It is possible that the same eyewitness can send additional details or clarifications on a previously conducted observation.

It is also possible that a group of independent and unrelated observers can send messages about the same specific phenomenon observed in the same place and time. Such primary documents at the stage of PC formation should be systematized and sorted by date, time and place of observation. More detailed sorting is not needed at this stage. The set of matches of primary documents by these parameters forms a case. In turn, the set of cases constitutes a PC. The next stage of work is the formation of a WD, which is associated with the analysis of cases and their identification with known natural and man-made phenomena. For this purpose, it is advisable to use the experience of classifying cases by their level of unusualness and information content with division into **four categories**:

Category A – cases that could be reliably identified with known natural and man-made phenomena and objects.

Category B – cases that could not be reliably identified with known natural and man-made phenomena and objects, but this could probably be done if more complete and accurate data on the phenomenon or object under study were available.

Category C – cases about which nothing definite can be said due to lack of information or unclear data.

Category D – cases for which there is complete, detailed and comprehensive information, but on its basis and within the framework of available knowledge it is impossible to identify the phenomenon or object under study with known natural or man-made phenomena or objects.

Additionally, subcategories can be added for category D, these are:

Subcategory D1 – unknown phenomenon or object, medium level of unusualness and information content (for example, one witness or no photo).

Subcategory D2 – an unknown phenomenon or object, with a high level of unusualness and information content (for example, there are photos from different observation sites from independent witnesses).

In the proposed identification model, phenomena of category C should be filtered first, and among the remaining three categories, the qualitative accumulation of knowledge regarding the phenomenon occurs mainly due to category D. In this case, conclusions about the nature of the observed phenomenon of one or another identification category are made mainly by an expert on the basis of generalization and careful study of the available information.

In the expert approach, to simplify the identification task, by means of scientific assistance in identification, it is necessary to achieve maximum cooperation with:

1) meteorological service (access to Weather Radar data, reception of cases in the APM)
2) aerospace agency (archive of satellite trajectories and space debris)
3) police or gendarmerie (reception of cases in the APM from the public)
4) Ministry of Civil Aviation and Air Traffic Control (access to Dispatch Radar and Surveillance Radar data, reception of cases in the APM)
5) Ministry of Defense (access to radar and passive radar data, flight logs). Thermal video from military drones. Data from military applications, where hundreds of eyewitness's report UFOs and other objects in the sky.

Or, in the opposite case, be content with freely available information:

1) communications and the media (reception of cases in the APM from the public)
2) tools for compiling observation maps
3) tools for photo and video reconstructions or an online parallax calculator
4) tools for quickly viewing photos and applying filters, analyzing EXIF data, searching for the original source
5) tools for viewing Media Info and editing videos
6) special tools for detailed analysis of images and videos, in particular for assessing angles, sizes and distances of objects, tools that remove video shake
7) maps of the area with the ability to travel as a virtual walk, web cameras broadcasting in real time, 3D world map with simulated weather conditions
8) maps of the position and movement of aircraft in the air (equipped with transponders) with the ability to select from a database
9) maps of winds, magnetosphere, seismic activity, with the ability to select from a database
10) archives of weather and meteorological data (weather data contains only wind speed at the ground)
11) virtual planetariums for astronomical reconstructions
12) flight simulators, ballistic editors, specialized calculators
13) data on the elements (TLE) of satellite and space debris orbits
14) programs for tracking the movement of satellites with the ability to select from a database
15) special auxiliary tools that will help in OSINT analytics, for example: archive of objects and features of different countries, determination of time by shadow, identification of plants and animals, including birds even by singing, etc.
16) everything else.

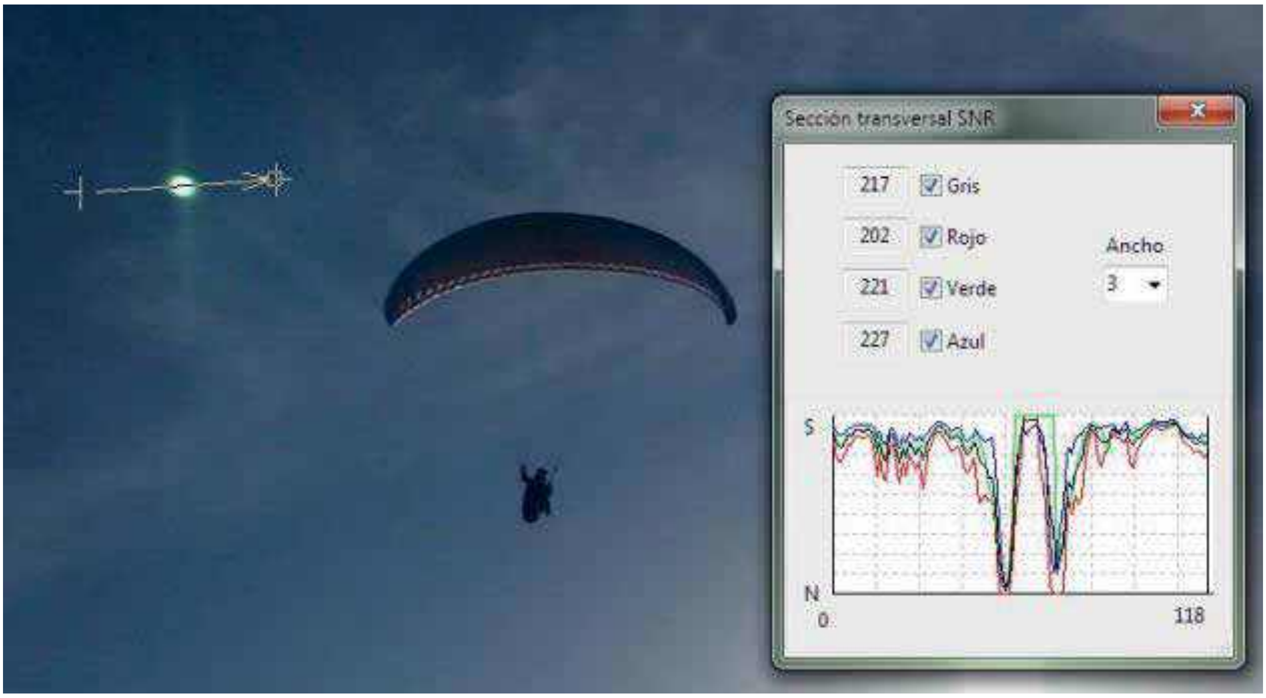


Fig.3.2 «Radiometry» of an object in a photo using IPACO (R. Lianza)

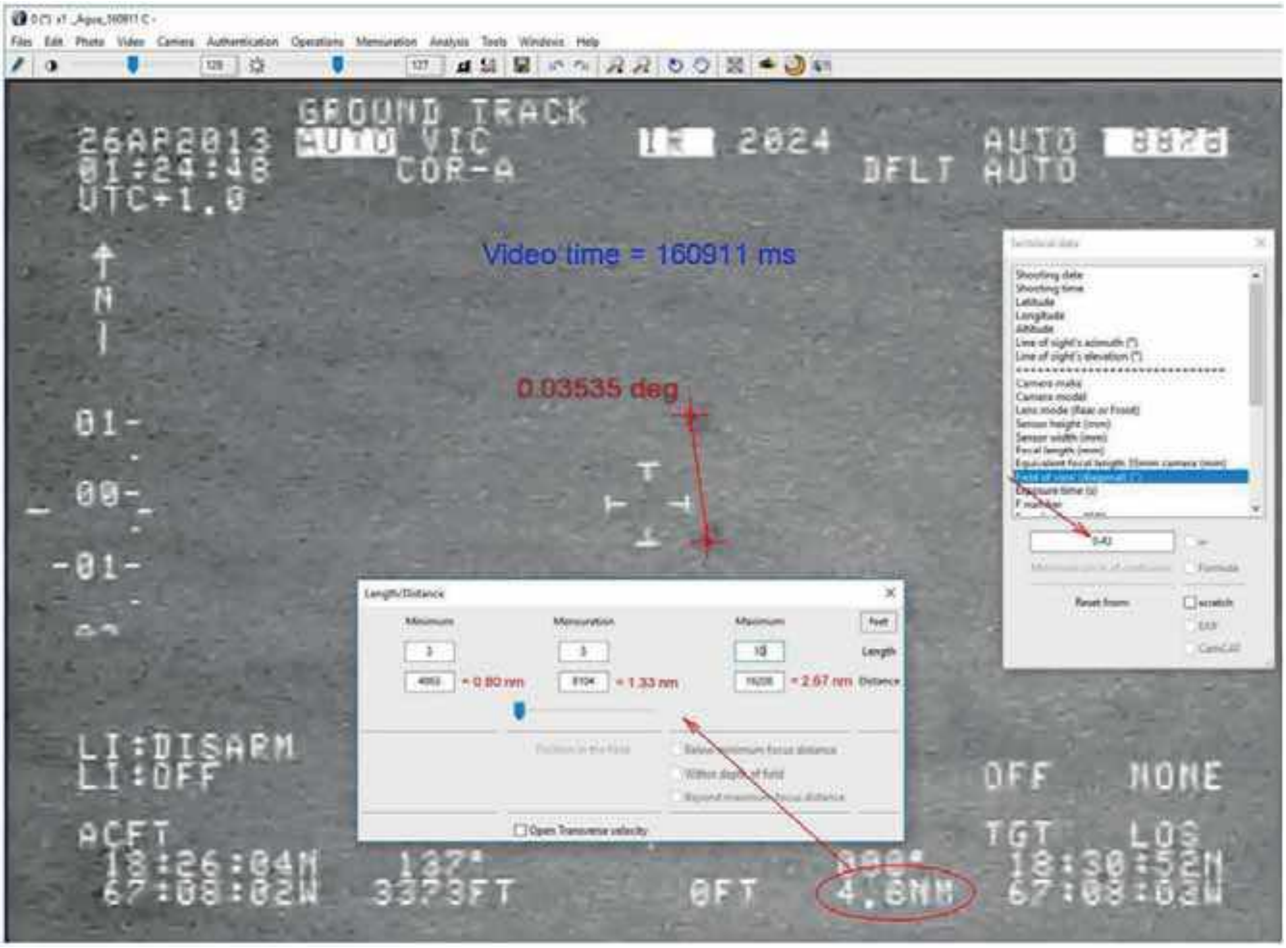


Fig.3.3 «Length-distance function» to obtain object-to-camera distance values for three specific values of the transverse distance between two hotspots using IPACO (F. Louange)

Only original materials (photos and videos in unaltered form) should be accepted for examination!

The sequence of compiling an expert analysis - an example for a digital photograph:

1) A general description of how and by whom the message was sent, and to whom it was forwarded for analysis, as well as a few words of gratitude to both the eyewitness and intermediaries, and the expert for their cooperation.

2) The text of the message is provided in electronic form (the date and location are mandatory, whether the object was observed with the naked eye or appeared only in the photo, and many other important data from the questionnaire, minor corrections to grammar and spelling are allowed), or a scan of the completed questionnaire is attached and sent to the expert along with the original photo.

3) Preliminary data: you need to indicate the time and exact date of shooting, a link to the original with EXIF, as well as separately processed drawings in the report itself indicating the position of the object / phenomenon of interest and their designations / numbering (if there is more than one object and / or they are poorly visible), lines and angular degrees.

4) Technical data: indicate the type and model of the device, matrix resolution (in megapixels), size (in millimeters, width × height) and digital format of the photograph, crop factor, focal length (in millimeters, if necessary, indicate the equivalent). Angular scale of photographs in degrees of arc per pixel (determined by the focal length and matrix size). Exposure time (in seconds), relative aperture.

5) Type of objects: screenshots with an enlargement of the object or phenomenon, indicating which frame each is from. Size in pixels, central / main part of the object in pixels (width × height). Color and compliance with the background and reflection of rays, transparency, color variations of parts, with a detailed description of their differences, if there are several objects.

6) A list of possible versions or causes of the occurrence of similar natural and / or man-made phenomena with visual examples and illustrations, must be described in great detail, assessing the probability of each. If necessary, indicate literature where you can get acquainted with scientific materials on this phenomenon.

7) Results of the analysis - the most likely causes of the occurrence of this object or phenomenon, or information on the impossibility of identification, describing the cause in detail. Indicate who performed the analysis, academic degrees (if any), date of examination.

8) Attach computer reconstructions in the appendices, for example, in virtual planetariums, ballistic editors, satellite trajectories, data from ADS-B transponders superimposed on the map, data from meteorological services, etc.

9) The submitting party completes the report in accordance with uniform standards and requirements for the design of scientific research papers. Classifies the category (ABCD). Before publication, be sure to familiarize the expert with it in order to take into account his comments. If there are disagreements regarding the assessment of the results, they should be noted separately. If necessary, you can also attach eyewitness reviews of the examination.

In the case of a photograph on film, a real scan is made using a slide module with a resolution of at least 1200 dpi, and in an uncompressed format (e.g. tiff). Technical data are taken from the passport for the film and lens.

Example 1:

For digital matrices, the angle of view (diagonally) is equal to *d=2*arctg(21.6/(f*K))*, where:
arctg – this is the trigonometric function arctangent,
f – focal length of the lens in mm,
K – crop factor.

Having determined the conditional number of pixels along the diagonal of the frame (Pythagoras theorem), we can find the angular scale in degrees per pixel.

If the distance to the object is unknown, we will estimate its linear size and speed at different distances using the relation *D=R*tg(a)*, where *R* and *D* – distance and size, *a* – angular size, *tg* – tangent function:

Table 3.3 Example of estimating linear size and speed at different distances

Distance	*Size*	*Speed*
1 km.	4 m.	2 km/s.
100 m.	40 cm.	720 km/h.
1 m.	0.4 cm.	7 km/h.
10 cm.	0.4 mm.	20 cm/c.

Example 2:

Key Parameters from the EXIF Data

- Exposure Time (T): 1/263.2 seconds ≈0.0038 s.
- Blur Length: 11.33 pixels.
- Equivalent Focal Length: 116 mm (in 35mm film).
- Image Width: 2048 pixels.
- Distance to the Object (R): This parameter is listed as 'Unknown' in the EXIF data, which means we'll have to assume a value to get a specific speed.

The Calculation Process:

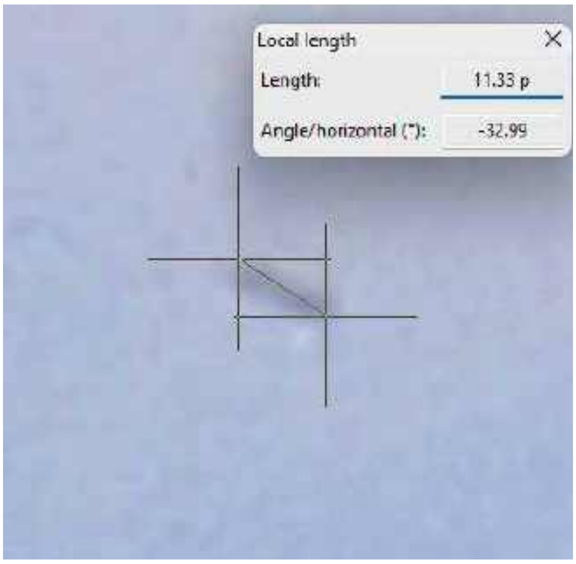


Fig.3.4 Local length using IPACO (I. Kalytyuk)

1.Calculate the Field of View (FOV)

The FOV can be determined from the equivalent focal length. The standard width of a 35mm film frame is 36 mm.

- $FOV = 2 \times \arctan\left(\frac{\text{35mm frame width}}{2\times\text{equivalent focal length}}\right)$
- $FOV = 2 \times \arctan\left(\frac{36\text{ mm}}{2\times 116\text{ mm}}\right) \approx 0.309$ radians, or $\approx 17.7^\circ$.

2.Calculate the Angular Displacement (θ)

The object's angular displacement is the fraction of the total FOV that the blur occupies.

- $\theta = FOV \times \frac{\text{blur length in pixels}}{\text{image width in pixels}}$
- $\theta = 0.309\text{ rad} \times \frac{11.33\text{ px}}{2048\text{ px}} \approx 0.00171$ radians.
  - This is approximately 0.098°.

3.Calculate the Linear Speed (V)

Since the distance to the object is unknown, we can express the speed as a function of that distance. For small angles, we can use the approximation V≈R×θ/T.

- $V = \frac{R\times 0.00171\text{ rad}}{0.0038\text{ s}} \approx R \times 0.45\frac{\text{m/s}}{\text{m}}$

This means the object's speed is 0.45 m/s for every meter of distance it was from the camera.

Conclusion

To get a specific speed, you need to plug in a reasonable estimate for the object's distance.

- For example, if the object was 10 meters away, its speed was approximately: V=10 m×0.45≈4.5 m/s, or about 16.2 km/h.
- If the distance was 50 meters, the speed would have been: V=50 m×0.45≈22.5 m/s, or about 81 km/h.

Description of an example of organizing the identification sequence:

At the beginning of the instructions there is an indication of who the moderators are and who the senior experts are.

1. Working with eyewitnesses who contact us with messages about UFOs:

1) The eyewitness sends a message to the moderators; the moderators immediately filter out "garbage" messages (Category C);
2) The moderator passes the message from the eyewitness to a group of experts for examination;
3) The expert who takes the message for analysis informs the moderators with the phrase: **Taken**, notifying other experts so that there is no duplication; It is necessary to consider all possible hypothesis, which is considered to exist in the case, as to what this observed UFO could be;
4) The expert is given 10 days for analysis, if the analysis is overdue, the message is returned to the group of experts, and another expert takes it for analysis;
5) If additional questions arise regarding the message that need to be clarified by the eyewitnesses, then they should be passed on to the moderator so that he can pass them on to the eyewitnesses. The moderator will send answers as soon as the eyewitnesses answer the questions;
6) If you have any questions regarding the consultation of the correct identification, then you should ask them to senior experts;
7) If the case is too complex or cannot be identified (presumably category D), it is worth passing the case to a senior expert for analysis, only senior experts make conclusions about the impossibility of identification (Category D);
8) If the identification was successful, and the case is fully identified (Category A), or presumably identified (Category B), the expert passes his analysis to one of the moderators;
9) If the moderator does not respond within **3 days**, pass the message to another moderator, if this one does not respond either, pass it to the senior expert;
10) Only moderators communicate with eyewitnesses, they also write responses to eyewitnesses; It is important that the observer feels that we are not trying to convince him/her of an explanation for what was observed.
11) Only moderators generate documentation in .doc/.docx format in .pdf, although moderators are professional document layout experts, it is worth having at least basic skills.
12) Moderators decide whether to publish the identification; If a report is to be published, the observer is always asked if he/she wishes to remain anonymous.
13) The moderator has the right to return the analysis to the expert for revision, indicating what else needs to be worked on.

2. Working with APM messages:

1) The expert independently chooses which message he will identify;
2) If questions arise regarding the consultation of the correctness of the identification, then they should be asked to senior experts;
3) If the case is too complex or cannot be identified (presumably category D), it is worth passing the case to a senior expert for analysis, only senior experts make conclusions about the impossibility of identification (Category D);
4) If the identification was successful, and the case is fully identified (Category A), or presumably identified (Category B), the expert, as soon as ready, passes his analysis to one of the moderators;
5) The moderators decide whether to publish the identification;
6) The moderator has the right to return the analysis to the expert for revision, indicating what else needs to be worked on.

At the end of the instructions there is a note: "Remember! We work only on a free public basis. Working with us gives you valuable experience that may be useful to you in the future."

It is very important to understand why you are doing this activity, what its purpose is!

Remember that during the examination process, all possible hypotheses should be considered, the material should be sufficient both quantitatively and qualitatively for conducting the examination and, if necessary, conduct a scientific experiment, sometimes it is worth going to the place or asking to take a photo or video from a certain angle of observation, at a certain time of day and taking into account the necessary weather conditions. You can also use flight simulators, virtual planetariums, etc. - if this helps with identification and does not distort the available data. You can always supplement the examination with something new, considering new hypotheses, if new ideas or comments appear. You should be careful with references to examinations that were not done by you, they may also contain non-obvious errors that you may not even suspect.

Anomalous factors – are manifestations of a phenomenon, the characteristics of which do not belong to the of manifestations of hypothetical phenomena of a known nature. They form a picture of the phenomenon by supplementing the knowledge base about it. **That is array only Subcategory D2 and no other way!** An anomalous aerospace phenomenon (AAP) is a phenomenon in which anomalous factors are present.

<u>List of factors of anomalous aerospace phenomena:</u>

1) unnatural shape and its change in time, as well as uncharacteristic group interactions of several objects changing unnatural shape

2) unusual change in speed and nature (variable angles) of the trajectory without inertial movement (sudden change in direction, at a speed exceeding the speed of flight and technical characteristics of known objects and phenomena, or even a sharp turn or stop, in gaseous environments with gravity, violating the laws of inertia and resistance of the environment)

3) unusual impact on equipment and the environment

4) in the presence of these signs, also a change in color and brightness, or visibility only in the thermal spectrum, and not visible in the visual

Here's an example of what's worth considering: The Sprint missile from the Nike-Zeus missile defense system demonstrated maneuvers with acceleration of 100 G in the 1960s. It accelerated to 6,000 km/h and made lateral deviations with a transverse speed of 3,200 km/h. That is, these are the same 100 G. What's the difference? Previously, this was done only on rocket engines, the fuel in which was enough for seconds - tens of seconds of operation. Now, it seems, ramjet engines that use oxygen from the air will be able to do this for a minute - two or something...

Making claims about AAP without reliable verified evidence or original data for independent analysis by anyone – is unacceptable for an AAP researcher!

<u>If we attribute the observation to the subcategory D2 (AAP), this means that the observed object may:</u>

- be of interest to the defense of the state (or potential planetary defense in the future) and is subject to more detailed study by authorized bodies and special services;
- if there are signs of a poorly understood natural phenomenon, then this requires a more in-depth and comprehensive study in cooperation with many scientists, with further funding;

If an observation is attributed to subcategory D2 (AAP), it indicates not only the absence of a conventional explanation but also the presence of data that may be valuable across multiple institutional and scientific domains. Such cases may contribute to the improvement of airspace safety by identifying previously unrecognized aerial behaviors that could pose risks to civil or military aviation. From a defense and security perspective, D2 observations support early detection of unconventional technologies, foreign test platforms, or novel electronic and electromagnetic effects, directly aligning with the missions of aerospace identification centers and air defense organizations. In the scientific domain, these events provide empirical datasets for advancing atmospheric physics, plasma studies, electromagnetic propagation, and sensor calibration under extreme or atypical conditions. Additionally, systematic AAP investigation strengthens national space agencies and research institutions by refining anomaly-handling methodologies, improving multi-sensor data fusion, and enhancing public transparency and institutional credibility, as demonstrated by long-standing programs such as GEIPAN and CIAE. Collectively, these benefits justify sustained institutional support and targeted funding, as D2 cases function as high-value testbeds for both technological resilience and scientific discovery.

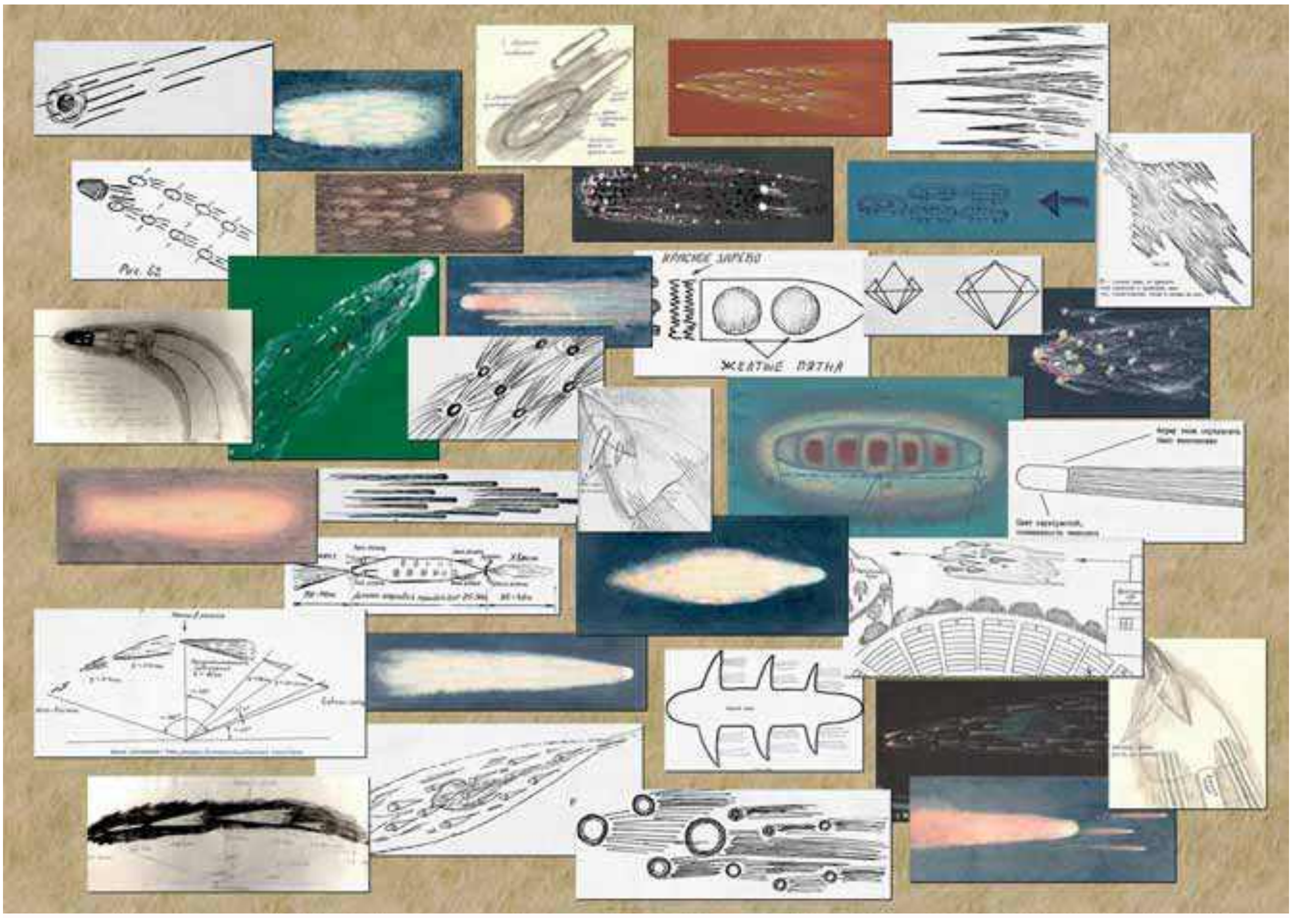
Effective AAP analysis requires a structured inter-institutional filtering process, in which observations are sequentially assessed by operational, technical, and scientific bodies to reduce noise, prevent misclassification, and ensure objective evaluation.

D2-classified AAP events often reveal limitations in existing detection, tracking, or attribution systems. As such, they serve as high-value diagnostic cases for improving sensor coverage, data fusion architectures, and anomaly-handling methodologies.

The classification of an event as anomalous reflects a temporary gap in available data or models, not an assumption regarding its origin. This approach aligns AAP research with standard scientific practices for handling unresolved observations.

Structured transparency in AAP investigations reduces public speculation and misinformation by demonstrating that anomalous reports are systematically analyzed within established scientific and institutional frameworks.

3.3. The influence of the "human factor"



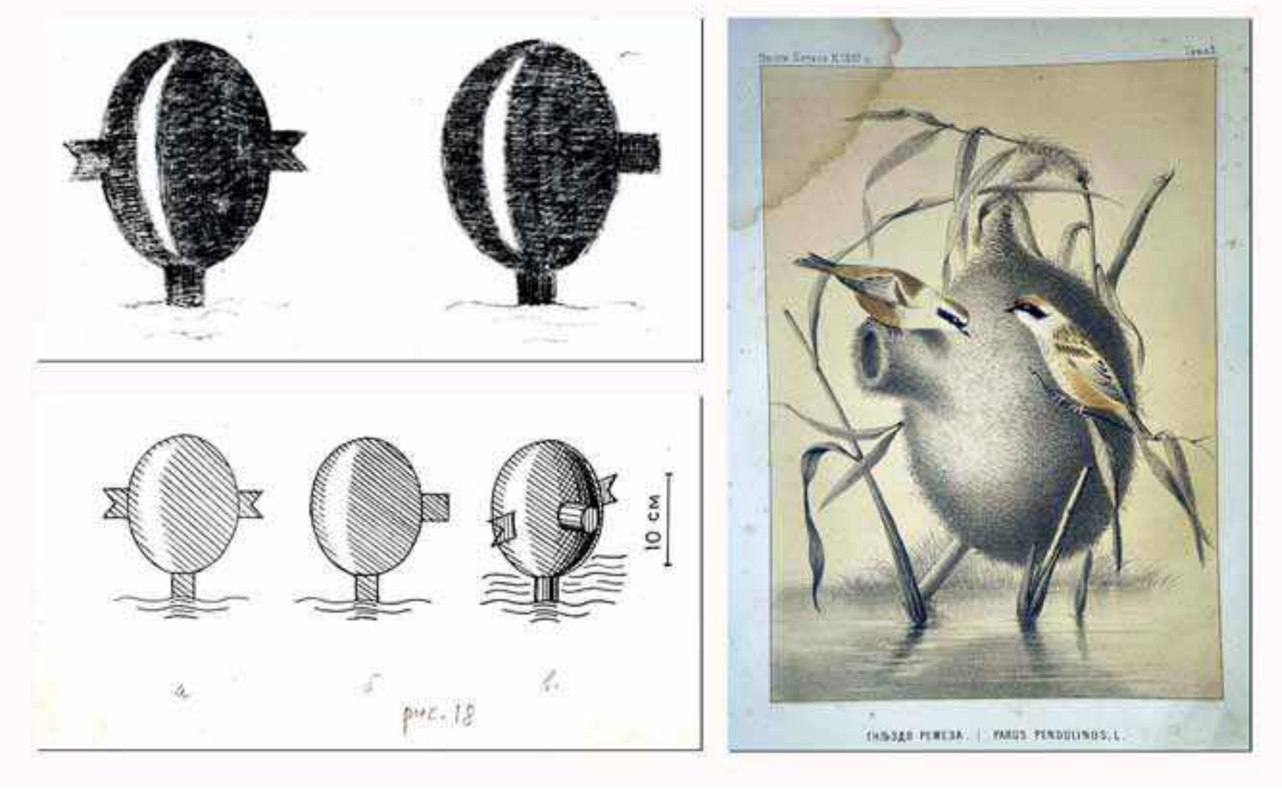


Fig.3.5 An example of how different eyewitnesses see the same reentry in 1963.10.30 different ways - collage from above. Below is a picture of the Remiz nest observed through optics with a 10x magnification 30 meters from the shore above the water surface, which was submitted to the array of primary messages as a "UFO landing." (Academy of Sciences of the Soviet Union)

The human ability to perceive and describe our surroundings is not an error-free process. There is recurring research that shows that human perception has quite large margins of error. Perception is the technical term for the sensory impressions that a person receives and interprets. When we perceive something in our surroundings, it is called that we have a perception of something and the process that takes place when our brains try to process and interpret the objects that we perceive visually (or via some other of the senses) is called the perception process. When our brains are to interpret something we see, or an external stimulus as it is usually called in technical terms, the interpretation depends on our memories and previous experiences – our preconceived notions. These are what affect how we perceive what we see and which allow us to perceive an object we see as completely different from how it actually looked.

The visual impressions we receive are therefore not an objective record of our surroundings, but all sensory impressions are processed and interpreted by our brains. When we perceive an external stimulus, our brains receive a signal about this through our eyes. The signal is then sent to the central nervous system in the brain for processing. There, the signal is converted into useful information and during this process, the brain looks for a suitable reference that it can use to interpret the signal before it is sent out to our consciousness. This reference can be anything from an element of an event that occurred the day before to something that was seen on TV ten years ago and has since been stored in the brain. Our brains' interpretation of what we see is thus colored by our memories and previous experiences. In most cases, the brain makes a completely correct interpretation of the signal and the personal perception of what we have seen then corresponds to external reality. However, in some cases, the information that the brain sends out is not as correct. For example, when an external stimulus of a flying object/phenomenon is to be interpreted, the brain finds an old reference from when the person saw a science fiction film ten years ago. There, a memory image of a flying saucer was stored and it simply has to be sufficient as an appropriate interpretation of what the person has seen. It is something that can happen to anyone and it does not require mental illness for it to happen.

It is important to point out that an individual's professional education has no influence whatsoever on their suitability as a witness. On the other hand, certain professionals such as astronomers have a broad knowledge of what can be seen in the sky and in such professions the risk of them reporting an object as something strange is reduced simply because they are not familiar with the phenomenon. However, these professionals are also just as prone to making so-called subjective misinterpretations as everyone else. The perception that certain professional groups are better at interpreting their surroundings than others is therefore incorrect as the human perception process is an innate function that cannot be trained away. The human brain and its shortcomings have nothing to do with a person's professional education. They are two completely different things and the interpretation process works the same for all people, regardless of whether you work as a pilot, police officer or mail sorter.

It is also not possible to distinguish between a correct and incorrect interpretation of external reality, and there is no immediate basis for being sure that the interpretation the brain has made of an object is completely correct. Thus, one cannot trust the statement “I know what I saw”. From a witness psychology perspective, the only correct statement would be “I know how I perceived what I saw”.

Another factor that can play a role when we interpret something we see is our expectation effect or the so-called suggestion. Human suggestion is largely about us seeing what we want or expect to see. If a person is in a place full of people around them on a hot summer day and sees a shadow behind a sun lounger that has been placed there temporarily, it is not very likely that the person in question will perceive this shadow as anything other than what it is. If, on the other hand, a person is in a partially lit house where the person is completely alone and the person is aware that people who have previously visited the place have experienced various haunting phenomena in the house, the suggestion factor is completely different. If a car then drives past outside and temporarily shines its light into the house and is reflected off a wall, it is not inconceivable that the person perceives the light from the car as a human-shaped light figure. Here, the environment and circumstances can play a decisive role, with the expectation effect reinforcing the whole thing.

Expectation can affect how the witness's brain interprets things that are seen, and a suggestion factor thus increases the risk that a witness will make a subjective misinterpretation of an external stimulus. An essential component here is one's own convictions, i.e., personal beliefs, as well as previous, similar experiences. This means that a witness who may have seen something similar before will compare the current sighting with that previous experience and, if necessary, incorporate details from the earlier experience, thereby distorting their memory. The same factors can of course come into play if, for example, you have a group of people sitting and looking for objects in the sky on a hill outside the city on a summer evening. Here, the risk is that the different people reinforce each other's expectations.

There is another relevant source of error that those working with testimonies must take into account and that is human memory. A number of studies on human memory show that it is not flawless either and that our ability to accurately remember an event declines very quickly after an observation has been made. This can be a matter of a few hours to up to a couple of days.

A statement that is common when we interview observers whose observation took place several years ago is “I still remember it as if it were yesterday”. This is nevertheless a difficult statement that the investigator must take with clear reservations. Research shows that human memory is affected by a number of factors.

How memory images are recreated: after an observation has taken place, the event is stored in our brains but there are no guarantees that the stored memory will remain intact. On the contrary, research shows that our memories are at great risk of being distorted and affected over time. Every time we repeat a previous event in our memory, it is reconstructed in our brains, and for each such occasion it risks being distorted a little from its original form. When a memory has been reconstructed a number of times, there has been a risk of distortion on repeated occasions, and the memory can then differ significantly from how it originally looked.

It is easy to consider a memory as a constant image in our brains that we can pick up again and admire in our consciousness. However, research has shown that our memory images are rather something that is reconstructed on each individual occasion when we remember them. This means that even if the core of the event we remember is likely to be correct every time we remember it, there is a great risk that the details will be incorrect. The memory image risks not only being filled out at a detailed level with correct memory details, but also being mixed in with fragments from other memories as well as pure imagination when our brains recreate a memory image. In other words, there is a significant risk that the complete memory image of an event has been distorted into a combination of different memory fragments, both correct and incorrect. In this respect, it makes a difference whether a witness reports a sighting immediately or after a month, a year, or even 10 years. Our memory and interpretation of something unknown always depends on our level of experience and knowledge at the time. However, since our level of knowledge is constantly changing, so too is our perspective and interpretation of past events. Additionally, every time we recall a memory, it changes. Therefore, when a witness reports a sighting from ten years ago, we must assume that what they tell us differs from what they would have said five years ago or immediately afterward.

A memory can thus be detailed but without being correct for that reason. In other words, the statement “I still remember it as if it were yesterday” is no guarantee whatsoever that the memory image is correct. The probability that a person several years later will have the same memory image that he/she had the day after the same event is consequently not very high. Therefore, it is always important to ask a witness for memory notes from the event in the form of diaries, calendar pages with notes, emails/text messages or the like.

Another problem when it comes to our memories is the influence of external factors. If two people have been involved in the same event and then discuss the event among themselves, the people also run the risk of influencing each other's memories. Research has shown that our memories are quite easily influenced and if, for example, a witness has a conviction about the color of what he/she saw and points this out to his/her co-witness ("the object was red"), this entails a risk that the co-witness will be influenced in his/her own memory and unconsciously adapt it to what the co-witness said. The famous Asch experiment demonstrated the influence of co-witnesses with consistent false assumptions on individual witnesses, who adopted the incorrectly communicated details.

We humans also have a tendency to think and remember similar things to people we associate with, and it can be easy for a witness to just agree with his/her husband or wife, for example. Studies show that statements made by particularly credible, intelligent or authoritative witnesses are more likely to be accepted than those made by others. The same applies to witnesses who are well known and trusted personally. Groups of witnesses with such a network of personal relationships among themselves show a high degree of similarity in their statements, indicating mutual influence. This mutual alignment of statements within witness groups is referred to as memory conformity. Even within witness groups, a longer time period before interviewing results in decreased detail accuracy following repeated internal discussions. Post-event information can also influence memory, mixing memories of the actual event with external information. These phenomena also occur in individual witnesses.

There are also several examples that show that leading questions from the person interviewing a witness can influence their memory to include details that were not in the witness's original story at all. A cautionary example is to ask a person who has watched a film or picture “what color was the barn in the picture and how big do you think the barn was”. Then the answer could easily be “the barn was red and I think it was 30 meters long”. This is despite the fact that there was no barn in the picture at all. For these reasons, two witnesses to the same event, who were in each other’s company or who were in different places at the time of the observation but who subsequently discussed their observation with each other, should not be considered genuinely independent. Only two witnesses who have no relationship to each other and who were geographically separated at the time of the observation, and subsequently gave separate accounts without having had contact with each other at any time in between, should be considered genuinely independent witnesses.

Another important factor is the age of the witnesses, particularly child witnesses (up to around 13 years of age) and older adults (over 60 years of age). Children are often viewed as unreliable witnesses, but they can actually make reliable statements and may even perform better in terms of memory, since they lack the experiential knowledge that adults have, which leads them to fill in gaps in their memory. However, it is essential that children are interviewed promptly to avoid suggestive influences from their environment, as they are more easily susceptible to influence. In older adults, cognitive ageing can lead to limitations in sensory perception and a decline in memory accuracy. However, these cognitive aspects vary from person to person and depend on many personal factors. Additionally, older adults are more likely to conflate their memories with information acquired later in life. They also display a high degree of subjective certainty that does not always correspond to objective accuracy. Even false memories are associated with a high degree of conviction that they are accurate.

What we have been talking about here, however, is about distortions of memories of existing events that individuals have nevertheless experienced. But there is also another variant called false memories. These memories are completely unfounded and are therefore about a person building up a memory of an event that never happened.

Experiments have been conducted where researchers have succeeded in planting false memories of past events in people and the results have varied. In some cases, only parts of the fabricated story have been perceived as a real memory, but in other cases, the fabricated story in its entirety has been transformed into a real memory image.

"The human factor" is the possibility of a person making erroneous or illogical decisions in specific situations. Erroneous and illogical decisions are made in conditions of lack of information and knowledge, this is influenced by the characteristics of the external environment, society, physical and psychological state and properties of a person. It is not very easy to understand what is really happening to a person, but it is possible. You must mentally analyze what you see and hear, and at the same time take into account the circumstances in which you are. And then you can make the right conclusions. Most people see only what they think they "really see", but reality is deceptive.

Therefore, there is a well-declared system for collecting, processing and studying this kind of information in the world. The priority of such systems is determined by their participants - experts and their expert groups. This allows you to quickly and instantly collect, evaluate and process any information in various force majeure situations, based on the assessment of the human factor. Therefore, it is worth familiarizing yourself with the typical structure of any expert assessment methods for use in all types of empirical research. An important component of the expert assessment method is the presence of a functional structure of the research process. This structure includes: an expert group, an expert arbitrator, an expert research methodologist, an operator and means for processing the information received. An expert group is a necessary tool for these studies, because the qualitative and quantitative experience of relationships between people has been accumulated for thousands of years. Only in some cases can it be inferior to automated methods, but only because of the need to level out all subjective errors even in the expert's assessment. But in most cases in a real society, the group method of expert assessments is the most common in all spheres and systems of human activity. It makes it possible to quickly or instantly evaluate the information that an expert encounter. As quickly as the intellectual capabilities of the expert group allow. Also, the expert group is a tool for collecting data for automated expert systems.

An expert arbitrator – is a functional position or position that can be occupied by the most experienced expert. Often this position is called arbitration, provided that such a position is occupied by several expert participants.

An expert research methodologist is a functional position of an expert group in which its participant - a methodologist, selects the most optimal research method. That is, makes a selection of the best methods necessary for collecting, processing information, further analysis, archiving and storage.

An expert research operator processes empirical data and various types of information (photos, video of communication with a respondent) and is subsequently responsible for storing and archiving all data.
Information processing tools are a set of tools, instruments and applications that are used by the expert group and all its participants at all stages of research. This is also technical support for research: photography, audio and sound recording equipment, copying equipment, computer equipment. A separate type of information processing and collection tools is software used by computer equipment and other devices.

To determine the human factor, an expert in situations of instant analysis, collection and processing of information has to deal with the following basic parameters and components of the assessment:
1) In case of indirect contact of the expert with the respondent or contact at a distance (the object of the study is the subject of the relationship, meeting, conversation, etc.): collection of only photo, video and audio information.

2) In case of direct contact of the expert with the respondent, information is collected about the person's behavior during the act of communication itself - the process of the expert's assessment of all behavioral parameters of communication and self-expression of the respondent: facial expressions, body gestures, general appearance of the respondent, behavior patterns, etc.

Emphasizing a certain connection between the internal psychological state of a person and external, morphological features of the facial structure, it is worth remembering that the face of each person is not something motionless, but represents a whole range of different movements, and is expressed in facial expressions, which, together with the gestures of the arms and legs, the position of the body, convey the internal mood of a person. Unlike polygraphs, the process of observing gestures and facial expressions of people really makes it possible to find out a specific emotion to the question of what we may be interested in. There are many books, hundreds of pages, where it is clearly described how to learn to read gestures and facial expressions of people, to identify all possible hidden and unhidden emotions, to see the moment of memory and lies. And if we are faced with the task of learning to expertly measure the human factor, then it is worth professionally mastering the methods outlined in these books.

Another important point that is not mentioned in the books is pretense in communication, if the individual does not feel completely adequate at the time of communication, or believes in his own fictitious story. Then the task is to catch the person substituting testimony. Initially, the person must be misled into trusting everything that is said, without giving the person a reason to think that he is being checked, and then ask questions with distorted information, or question in the opposite order, and if the person agrees with specially distorted erroneous testimony, then he is either not completely adequate or inattentive. You can also record the conversation on a hidden dictaphone. It is important to find out the motivation in order to try to understand what kind of person this is, you should ask yourself questions:

- Why did this person contact me?
- How does he know that I am working on this issue if I am seeing him for the first time?
- What does the person want from telling me?
- Should I trust a person if he uses verbal signs of lying?
- Should I trust a person if he gets confused in describing an event?
- Should I trust a person who changes his testimony after a month? (during this time, the testimony is forgotten and can be provoked to reveal a lie).
- What will misinformation lead to if I voice it in a circle of people who trust me?
- What is my attitude towards the interlocutor and his opinion after the conversation?
- How sober are his assessments on various issues?

If an expert has suspicions regarding a person's constant or very frequent inadequacy, then conclusions can only be made by a psychiatric commission, based on a psychiatric examination. The commission must consist of experts who have higher psychotherapeutic and medical education, and only on the basis of a comprehensive examination by the commission can a diagnosis be established according to ICD-10 and treatment prescribed.

A psychotherapist (who helps a person change) or a psychologist (who helps a person adapt) cannot make a diagnosis, since their task is to work only with healthy people. In other words, only a psychiatrist can make a diagnosis, otherwise the person to whom the unlawful insult was used, if, for example, a person is called "mentally ill" without evidence, has the full legal right to sue and seek moral damages.

A popular belief among the public is that hypnosis is a form of objective truth serum. This is a completely incorrect belief. The truth is that hypnosis is a very controversial tool, and the question of whether it is even possible to retrieve repressed memories in the way that occurs in these cases is also debated. Many in the behavioral science disciplines believe that hypnosis is associated with great risks of the individual producing fantasies and false memories. Not least, the risks have been pointed out that the person performing the hypnosis session risks leading and influencing the people who are put under hypnosis and thereby planting or reinforcing memories. Critics believe that people who are put under hypnosis are particularly suggestible and risk being led and influenced by those who are carrying out the hypnosis. Proponents of the method, for their part, claim that they have taken great care not to lead the individual and also point to coherent patterns in the stories that have emerged through hypnosis.

In order to exclude the influence of the "human factor", apophenia, pareidolia, distortion of the shape of an object due to poor eyesight or any other visual hallucinations, evidence recorded on technical means (photo, video or radar) should be accepted. Without this, verbal messages from eyewitnesses, as a rule, are of no value, since the presence of "abnormal factors" in their content is not obvious due to the significant influence of psychophysiological factors, uncertainty and unreliability of data. Such messages will have a low degree of information content. This applies primarily to reports that are not supported by data suitable for falsifiability analysis, as well as independent observations.

3.4. Measuring the "human factor" in a subject-oriented expert system

Subject-oriented expert system (SOES) is a program for researching the intellectual system of an eyewitness of a phenomenon, determining the coefficients of corrections for logical errors of respondents, the number of the "human factor". Further, a description of the problems and methods of thinking of an eyewitness is presented, in particular, such a type of logical errors as errors in judgment of the subject. We have made a brief summary of our study, showing how many times an eyewitness exaggerates or distorts information, making typical errors of judgment, known in the discipline of Logic of Judgments. Based on this, we determine our coefficient of correction for these distortions - the number of subjective or human factor. We have developed an appendix to our Eyewitness Questionnaire, which helps us identify a person for the purpose of further cooperation with him.

See also: Questionnaire for entering coefficients for eyewitness perception

The SOES program was implemented by decomposing the results of the tasks being solved: the psychological gave way to a more pragmatic approach in the study - assessing the human intellectual system, namely, determining logical errors in judgments applied to the associative series by the respondent. In the future, an attempt was made to solve two problems as one, having studied only the natural intellectual system of the subject.

The associative approach, which includes certain cognitive parameters, affects the data sample. That is, there is no point in delving into all the problems at once - it is enough to determine the indicators of the subject's intellectual system and decompose the problem into subtasks. To do this, let's move on to the laws of formal logic, because they are the connections of the internal structure of thoughts that have historically formed in the process of thinking practice based on the objective properties and relationships of the external world.
Having defined approaches to solving intellectual problems that already include criteria of the subject's established experience, without emphasis. Human logic is an intellectual model with a fuzzy structure, which is where it differs from strict logic.

At this stage of research, the methodology does not consider the theory of fuzzy sets, it is quite possible to return to it at the forecasting stage, because the given associative series, as a finite set of objects, is limited by logical frameworks, which, in fact, are syllogistic problems. In the new methodology "TO" at this stage, traditional mathematical methods are used, based on classical, Aristotelian logic, which is intolerant of inaccuracy and bias of truth, as well as uncertainty. Let us recall that the subject of fuzzy logic is considered to be the study of judgments under conditions of fuzziness - "TO" has formed clear frameworks, tasks and sets of data at the input and output in numerical form.

Classic algorithms of logical operators, which are also used in artificial intelligence systems (AI), can be applied to the subject's logic. Let's not forget that the basis of connections, for example, in neurocomputers is the principle of associations, but at the same time a logical model is used - a formal system with many basic elements and many syntactic rules, including the semantics of the processes under study.
Associative connections permeate all human thinking and it is certain that all mental phenomena are a very complex object of study, which is difficult to formalize and model. But at the same time, the natural intellectual model is the best for research.

In order to isolate the subjective ("human") factor, an objective approach from the whole variety of measurement techniques is conceptually needed. The "objective" approach is a measurement that is carried out on the basis of the effectiveness and features of the process (procedure) for solving a problem. This is mainly a measurement of intelligence (logically formalized tasks, tests of special abilities).
The "subjective" approach is a measurement that is carried out on the basis of data that the subject of the study (respondent, various questionnaires) reports about himself. *The "TO" measurement combines these two approaches.*

Terms and notions. Logical square is a well-known method of testing the logical quality of the respondent's judgments (classical logic); an associative row is a set of elements related to each other by a certain common feature; moreover, if element *A* is associated with element *B* by an associated attribute, and element *B* is associated with element *C*, then it is not necessary that *A* is associated with *C*; judgments are a form of thinking that reflects the connection between an object and its attribute; "TO associativity" is an internal concept of this study, reflecting the correlation between the respondent's choice of data subsets and the actual volume of a given set ($S = 30$); logical errors are errors in solving a logical task by the respondent, determined using the Logical square; "Complementarity of TO" is an internal concept of this study, reflects the results of solving logical tasks by the respondent in the form of volumes of subsets of empirical data (Euler circles); "Subject of TO" is a respondent, a participant in the questionnaire and further – the whole measurement of "TO"; subject(-s), predicate(-s) (*S, P*) are notions of formalized logic of judgments (subject-predicate approach); "point of support" is the concept of measuring "TO", the middle term of the syllogism-related task (*M*, is included in both premises (premise is a simple attributive judgment, part of a simple categorical syllogism-SCS), but is not included in the conclusion), that is, with which all S are compared (*S* is a smaller term in the lesser premise, called the subject of the conclusion) to obtain a conclusion-solution to the problem (in syllogism it is called a conclusion; i.e., a simple attributive judgment)). M in conclusion gives way to *S* and *P* (*P* is a predicate, and in SCS it is a larger term and predicate of conclusion). The syllogism-related task of "TO" consists of a simple categorical syllogism-SCS. And according to the rules of SCS, there must be a middle term, *M*, and, moreover, it must also be distributed in at least one of the two premises (larger or smaller). That is, the concept of "Supporting point" or an alternative to it – "equilibrium," which are intended for the classification and identification of the associative row of "TO"; in addition, is a mandatory component of the SCS rules. Terms rules: 1. Each syllogism must contain exactly three terms; 2. The middle term must be distributed in at least one of the premises; 3. A term not distributed in premise should not be distributed in the conclusion. Premises rules: 1. There must be at least one general premise (there is no output of two particulate); 2. If one of the premises is particulate, then the conclusion must also be particulate; 3. There must be at least one affirmative premises (no conclusion from two negative ones); 4. The number of negative premises should be equal to the number of negative conclusions.

As it was noted, not all respondents use the SCS rules, since when solving even one task of the TO program, someone does not make logical judgments at all, but simply chooses the answer options and that's it.

Concept (brief justification). The method focuses on the measurement process, not on testing as a method of measurement because an atypical method of "TO" is being developed. Along with the problems of the research concept itself, in the process of working with empirical data, key factors emerged that changed the vector from the analysis of psychology to the analysis of the intellectual system of the subject (the logic of judgments). Along with the linguistic phenomena that are often used today to manipulate social thought and the course of thinking (subjective-predicative neglect), the measurement of "TO" reveal the shortcomings of simple judgments due to the subject's rapid response to information; namely, neglect of conceptual apparatus (for example, the "average term" of the questionnaire "TO").

After all, the associative array is quite complex, and as a result, on the last questions, someone generally forgets what the tasks were and simply chooses answers that correspond to only one of the premises, which consists of either S or P, which gives rise to a probable logical-conceptual phenomenon. If we understand the global social problem of information perception, we can hypothesize that subjective-predicative neglect plus logical phenomena (absence P, M in judgment) are a possible sign of often distorted facts, unreliable information everywhere, and manipulation of society's thinking.

Problems of the respondent's thinking and solving the tasks of its measurement. Of a few disciplines that purposefully study this concept, the best model for measurement is the one that is best modeled (for example, thinking is studied by some sciences – philosophy, logic, physiology, genetics, cybernetics, psychology, etc.). An overview of different disciplines gives an understanding of the nature of thinking, its possibilities in the modern world of understanding various phenomena of a subjective nature. But again, it is for targeted measurement in practice, more effective methods have been tested. Cognitive studies are often perceived as superficial, subjective, unconfirmed if they do not meet standardization, normalization, and other proven techniques, without proper quantitative and qualitative analysis.

In essence, the methods of mathematical and statistical analysis include methods of descriptive statistics (description of the characteristics of the phenomenon under study; distribution, features of communication, etc.); methods of statistical inference (establishing the statistical significance of data obtained during experiments); data transformation methods (data transformation to optimize their presentation and analysis). Based on the theoretical model and systematization of the results of qualitative and quantitative analysis of research, material carries out the interpretation (interpretation, explanation) of the results as a systematic procedure for explaining the studied phenomena.

But very often pilot or experimental programs do not always fall under the typical criteria of mathematical-statistical methods. To investigate for further standardization or normalization, for example, a new measurement system does not always justify the goals. And often diverts the amount of cumbersome work of analysis that falls on the researcher. Of course, provided that sufficient material and sample data are collected, it is quite appropriate to make a quantitative and qualitative analysis, but not all at once. In addition, the authors of research projects have repeatedly argued that mathematical criteria are not considered in psychology as the most productive, but it is unacceptable to ignore them.

The accuracy of the conclusions depends on their, which, however, can be refuted using other research methods. Depending on the degree of their reliability and sureness, there are other types of empirical data "L" -, "Q" -, "T" -data. In this study, partially used "T" -data, due to the presence of an associative series, which affects the overall result of the respondent. These include data from objective measurement programs with a controlled experimental situation. Improving objectivity can be achieved through the following tactics applied to the tasks of the questionnaire in the measurement: 1. masking the true purpose of the study; 2. unexpected task statement, spontaneity; 3. uncertainty, the vagueness of measurement objectives (when checking the independence, persistence of the respondent); 4. distraction (offer distracting and basic tasks);

5. creating an emotional situation, including awkward (logical tasks and abstract associative series); 6. emotional content (atypical display of concepts, such as the concept of "point of support," or as in the second version of the measurement of "TO," an alternative condition of the tasks is proposed – "balance of objects"); 7. automated reactions (handwriting, manners, expressive movements, which were studied by the author's methods of measurement by IMK; 8) other types of indicators that were not used in this measurement of "TO." All these techniques are reflected when choosing the type of associative series or rows for measurement. In fact, this applies to the problems of thinking of the respondent or the natural intellectual system, which is characterized by greater "associativity" (associative connections permeate all human thinking) than any other system. That is, by improving the objectivity of the measurement, finding a semantic approach to the definition of subjective errors through the associative series (row), we can expect better indicators of formalized logic (logical tasks). IQ measurements are based on such principles. But most of them are standardized. Therefore, they are not suitable for other cases of experimental research (not situational), where, for example, it is necessary to determine the degree of influence of a subjective factor under certain conditions. They are designed to solve only a logical task, without showing what level of abstract thinking or "associativity" was applied to solve this problem. Instead, the measurement of "TO" is unique.

Another task is logical thinking, the transition from the initial states to their consequences according to the formalized laws of logic. The average person is rarely able to explain by what algorithms he makes logical constructions. But the techniques and algorithms by which logical thinking can be determined are, actually, well known. Implementation of formal requirements is important, otherwise, it is easy to make logical mistakes. The laws of achieving truth are the subject of the study of the discipline of logic, and the problem of achieving truth by reasoning is a matter of logic alone. The specificity of the laws of formal logic is that they are the links of the internal structure of thought, which has historically been formed in the process of thinking based on objective properties and relations of the external world.

The subject of study of the discipline of formal logic are schemes, forms, and constructions of reasoning of subjects (*Fig.3.6*). Formalized laws of logic are best for determining the results of solving a complex intelligence problem, including logical delivery. And then with the help of the subtraction, you can determine the additional impact in the form of errors in solving these problems and other indicators such as associativity of "TO" (errors of the logical problem, and the scope of "associativity").

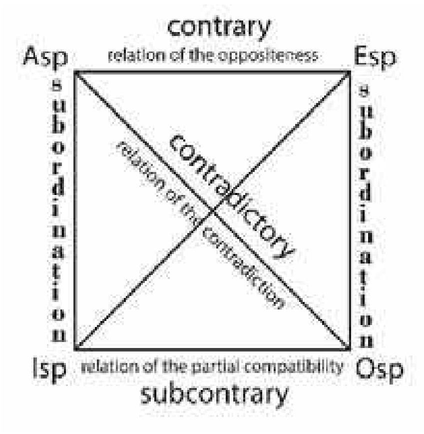


Fig.3.6 The Logical square (AspEspIspOsp, AEIO)), (Mykolyshyn A.I.)

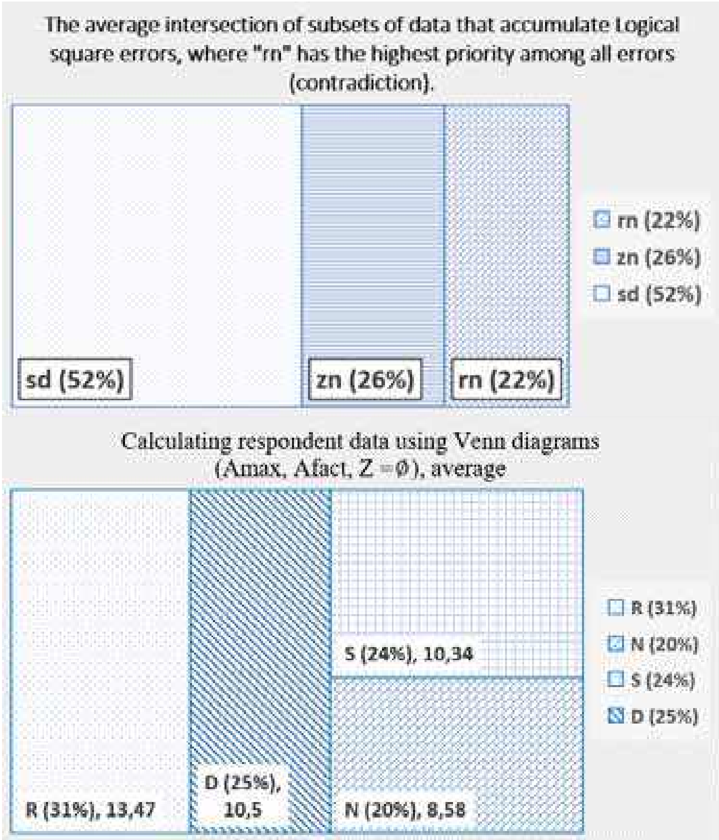


Fig.3.7 Calculus using Venn diagrams of volumes and sections of data subsets (AspEspIspOsp, AEIO)) (A. Mykolyshyn)

The problem of the influence of associative thinking was solved by setting an associative series (30 models of figures, the original set of data). The associative series affects a certain type of empirical data at the output. In combination with a logical problem (syllogism-related, categorical tasks), there is a determination of results, so ~~we~~ one gets several indicators of the intelligence system (type of judgments) of the respondent of "TO" and logic errors as a consequence of the associative series. Such a measurement may not be comfortable or clear to everyone. But as soon as the "TO's" respondent participates in it, almost immediately his intellect processes the problem and successfully solves the syllogism-related problem (simple categorical judgments) or is confused due to too high of a level of abstraction, which is influenced only by the associative series (SCS (simple categorical syllogism-SCS) within one task rarely built by the respondent). Thus, appears the internal term-concept in the system of measurement "TO" is as the concept of "scope of associativity."

During the research, it will be noticed that such a parameter is peculiar only to the natural intellectual system (subject-person-respondent), thanks to which it is possible to determine not only the influence of the associative series on logical errors but also to prevent the bot from measuring.

The purpose and objectives of the study. The aim is to study and determine the maximum number of criteria of the subjective factor. Not just typical concepts such as IQ (because AI is also characterized by such an indicator), or typical cognitive parameters of a person along with his EQ. The tasks of this study are solved at the expense of different disciplines at the intersection of sciences. To decompose the problem into sub-tasks of conceptual research, it is possible only by analyzing it from different methodologies and disciplines. It is important to single out the main task and set goals for the study. After separating the results, the parameters of the intelligent system are investigated. The next task is to display the model of the respondent's intelligence system (an abbreviation of semantic table of "TO," (*Fig.3.8-3.9*, *Fig.3.10*). Next is to compare the scheme of modes, if any, after solving a logical problem on typical models, and if there are none, then analyze the scheme of complementarity of "TO" subsets, the division of which was carried out by the respondent (Euler's circles). Since the excessive associativity of "TO" (the concept in "TO," is determined from empirical data) is a property only of the respondent, not a robot or other (AI), the actual subjective factor can be freely determined from the measurement of each respondent from data samples. The ultimate task is to create prognostic estimates of the dependence of the respondent's logical errors on the presence of an associative series and its type (images, photos, videos, and other information data), which will help to further investigate the subjective factor.

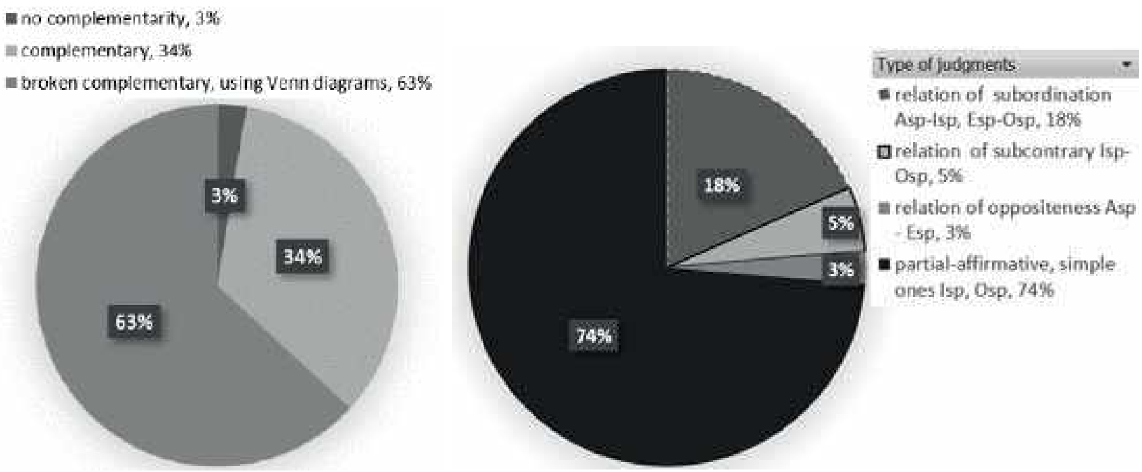


Fig.3.8-3.9 The models of the respondent's intellectual system generalized, "as a type of complementarity of TO" – an illogical division of circles "Impaired complementarity" (A. Mykolyshyn)

Thus, the study of the science of testing helped to determine the method of measuring the required indicators of subjectivity (research of intelligent tasks); from psychology, the type of empirical data on the complication of tasks is taken; from formal logic, the theory of syllogisms and categorical and simple judgments with the model of the decision of a problem in the form of a Logical square (*Fig.3.6*), Euler-Venn diagrams is taken; in the analytical part of the evaluation of empirical data in addition to classical mathematical and statistical methods taken as the basis for counting sets (Venn sets, discrete and other special sections of mathematics). This is what it is obtained through the analysis of measurement data: errors of the Logical Square by determining the types of judgments used by the respondents, there are errors of contradiction, oppositeness, subordination; syllogism solution errors by using five tasks to the associative series of "TO" which are syllogistic, there are type of judgments and their figures; errors in solving the logical model of data sets by using an associative series. The term "complementarity of TO" is chosen to describe subsets. The combinations used by the respondent for the questionnaire and the location of subsets are displayed using Euler-Venn diagrams to check the logic of judgments (section calculation, *Excel*). Circle diagrams are not broken, divided, or repeated according to their properties. Each subset, or each task of the questionnaire, corresponds own circle diagram: there are only intersections, consolidation, complement circles, not divisions, gaps, etc. This is further generalized, "as a type of complementarity of TO" as an illogical division of circles "Impaired complementarity" (*Fig.3.8-3.9*). Lack of "complementarity" is the absence of consolidation of circuit diagrams, subsets, which is evidence of the lack of analysis of tasks by the respondent (the subject of "TO's" measurement).

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The scope of "TO associativity" $29 \le Amax \le 83$ IAE control group with logical errors of respondents type L(AspEspIspOsp)=0,2 (avr); $0 \le L \le 4$								
Data origin/value	Respondents/ values	Amax	Acomb	Anot	Afact	AspEspIspOsp		
IAE	to1-am	68	65	3	30	rn	zn	sd
IAE	to1-am2	83	83	0	30	0	0	1
IAE	to1-rom	82	79	3	30	0	0	0
IAE	to1-kuz.s	78	77	2	30	0	0	0
IAE	to1-lud.yezg	29	18	11	18	0	0	0
IAE	to1-sta.nav	48	36	12	29	0	0	0
IAE	to1-bandr.andr	73	65	8	30	0	0	0
IAE	to1-lebet.uli	53	53	0	30	0	0	1
IAE	to1-pavlen.ir	39	22	17	27	0	0	0
IAE	to1-myha.a	76	75	1	30	4	0	0
Avr.values	Avr	62,9	57,3	5,7	28,4	0,4	0	0,2
Max.values	Max	83	83	17	30	4	0	1
Min.values	Min	29	18	0	18	0	0	0
Sampling volume	n	10	10	10	10	Avr(L)=0,2		
Standard deviation	Q(s)	19,3	24,07	5,93	3,78			
Mean square error	m	6,09	7,61	1,97	1,19			

Fig.3.10 After separating the results, the parameters of the intelligent system. Research conducted in the control group (A. Mykolyshyn)

First about the subjective-objective. To identify the subjective factor, an objective approach from a variety of measurement techniques is conceptually required. "Objective" approach – the measurement is based on the effectiveness and features of the process (procedure) of solving the problem. This is mainly a measurement of intelligence (logical-formalized tasks, tests of special abilities). "Subjective" approach is the measurement made on the basis of data reported by the subject (respondent, various questionnaires). Measuring "TO" combines these two approaches.

Methods and content of the study. In this study, the emphasis is on the measurement process, rather than on testing as a method of measurement, because an atypical method of "TO" is being developed. The program of measurements includes: the solution of the syllogism-related problem by the respondent (simple categorical judgments, the task of the "TO's" questionnaire); detection of logical errors (contradictions, oppositeness, subordination) using the method of Logical Square; determining the type of judgments and their figures (mode); determination of the "complementarity" of subsets of empirical data (only in "TO"), determination of the influence of the preset of the associative series of "TO" ("associativity," only in "TO").

Another important factor is the age of the witnesses, particularly child witnesses (up to around 13 years of age) and older adults (over 60 years of age). Children are often viewed as unreliable witnesses, but they can actually make reliable statements and may even perform better in terms of memory, since they lack the experiential knowledge that adults have, which leads them to fill in gaps in their memory. However, it is essential that children are interviewed promptly to avoid suggestive influences from their environment, as they are more easily susceptible to influence. In older adults, cognitive ageing can lead to limitations in sensory perception and a decline in memory accuracy. However, these cognitive aspects vary from person to person and depend on many personal factors. Additionally, older adults are more likely to conflate their memories with information acquired later in life. They also display a high degree of subjective certainty that does not always correspond to objective accuracy. Even false memories are associated with a high degree of conviction that they are accurate.

Formal and logical laws. The particularity of logical laws is that they use certain tools that allow one to calculate the correctness of any reasoning, regardless of its content. And where obviousness, psychological expediency, intuitive relevance are bad helpers, "naked" formalism comes to the rescue. However, to understand what kind of formalization is appropriate, one needs to understand what will give such an analytical approach. Given that in this method of measurement, there are typical logical problems, the methods of traditional logic (concepts, judgments, syllogisms, Logical square) may well be suitable for a simple analysis of a set of data. In addition to logical problems, the conceptual apparatus of the respondent is affected (the concept of "point of support" in "TO"); it is important to understand the role of the subject-conceptual analysis. It is part of a functional approach in the analysis of language statements, which makes it possible to more clearly determine the carriers of which logical forms are certain fragments of language, in fact, the concept.

But it is worth remembering that in traditional logic, the central categories are concepts, judgments, inference as a form of thinking, then in modern logic the central categories are argument and a propositional function. The concepts of logic statements and the logic of predicates appear. The following are the key categories without which it is not possible to analyze the attributive judgments (data) of the "TO" measurement. This is an abbreviation of statement of the theory that orients in which field the analytics was conducted.

Modern logic. Since traditional logic explores forms of thinking and considers them as a kind of familiarization, a reflection of reality, it is about concepts, judgments, inferences as forms of thinking. Modern logic, as the second stage of logic in the development of a single logical science, takes into consideration language, as the embodiment of thinking, or in other words, explores the semantic side of language. Therefore, in modern logic, one does not talk about concepts, judgments, inferences, but about terms, statements, their combinations, and relations. Modern logic uses the method of formalization in its purest form, excluding any means of natural language. This is the above written judgment in the language of formalism of modern logic: $\forall x(S(x) \supset P(x))$.

Subject-predicative formalism in traditional logic. According to the research conducted in the control group (*Fig.3.10*), the tasks set for the respondent in measuring "TO" are mostly solved by the logic of simple judgments, and traditional methods of calculating subsets are conveniently used even in the manual calculation of empirical data from which the study actually began. Next, it is worth mentioning the attributive categories (*S, P, M*), which solve the whole logical problem of "TO." In accordance with "subject" and predicate of judgments, we use *S* and *P* marking. The *S* is 30 figures; predicates (*P*) are categories into which the respondent distributes these figures ("real" belong to the concept of *M*, "unreal" do not belong to the concept of *M*, "regular" with the concept of M, and then "static" or "dynamic," including or excluding the concept of *M*). According to SCS rules, the concept of *M* is a classic "middle term" of a syllogism if the respondent-subject uses such a method of conclusion of judgments; if not, then we return to the logic of simple judgments. The concept of *M* is a term called by the actual measurement as the "point of support." What is most interesting, if the respondent does not use his conceptual apparatus for one reason or another to understand whether a given associative series corresponds to the concept, he will not be able to use the logic of judgments. Thus, it is possible to use the conceptual apparatus as a method, and it is possible only to use the method of judgments (simple, complex, inferences). Depending on their intelligence, respondents use these mechanisms of thinking in different ways. Tasks of "TO" are focused on judgments. But at the same time, simple trivial logic of concepts can also be used as an alternative. In traditional logic, *S* indicates what (or whom) is intended to characterize, describe in the judgment, and the predicate (*P*) represents the characteristic itself. (A predicate is that part of a judgment that reflects, captures, and attributes to the objects that represent *S* in the judgment). Judgment is a form of thinking (it is an idea in which the connection between objects and signs is affirmed or denied). Judgment is a form of thinking that reflects the connection between an object and its feature.

The logical structure of the judgment consists of the following parts: the object of thought, the sign of the object of thought, the relation of the object of thought, and its features. In the usual communicative process, concepts such as sentences, judgments, and statements are used as the same, identical. But when judgments are considered as one of the forms of thinking that explores traditional logic, then it is necessary to clearly distinguish between these concepts, to identify the specifics of each of the concepts. In the analysis of simple judgments by value, the whole set of simple judgments can be divided into two incompatible sets: true judgments and false judgments (special semantic tables we call the "truth-tables"). The procedure for identifying a value for a simple judgment is to establish conformity or no conformity between the judgment and what it is about. In the case of complex judgments, the emphasis is on the uniqueness of the procedure for establishing value for them. The value of a complex judgment depends on the values of simple judgments that make it up (not comparing the judgment with what is happening in reality, but the application of the "truth-table," where each simple judgment is compared with a set of values). The emphasis in the tasks of the questionnaire is on judgments, not on the concept of *M* ("point of support"), in order to determine as much as possible in the results of logical errors and not to understand the "conceptual apparatus" of the respondent.

Since judgment is one of the forms of abstract thinking, its material embodiment, material realization is language, more specifically – a sentence. The tasks of the questionnaire of "TO" mostly used sentences, not questions (direct instructions).

Rules of judgments. “Simple” is a judgment in which no logical part is a separate judgment and therefore has no independent parts. For example, "A book is a source of information." If you subtract any part of this judgment ("book" or "source of information"), then taken separately, it will not be a judgment, and the original judgment, as a whole object will collapse. A complex judgment is one that consists of two or more simple judgments that are connected by logical conjunctions, and each of its correct parts will be a separate judgment.

Let's focus on the analysis of simple judgments because everything complex consists of “simple.” By the nature of the sign, which is represented by the predicate (*P*) of the judgment, there are the following types: a) attributive; b) judgments with relations or judgments about relations; c) judgment of existence. *Categorical judgments* on the unified classification have acquired a standard statement: *Asp, Esp, Isp, Osp* (tops of the square). Mnemonic tool for the visual representation of logical relations between categorical judgments, which is called the Logical square (*Fig.3.6*). It is known that categorical judgments can be analyzed at the level of intentional and extensional (the concept of intentional and extensional was used by *R*. Carnap as explications, or clarifications, according to the concepts of content and volume).

At the level of the intentional, categorical judgments inform about the belonging or non-belonging features of the subject of thought: *Asp – P is inherent in all S*; *Esp – P is not inherent in all S*; *Isp – P is inherent in some S*; *Osp – P is not inherent in some S.* At the level of extensional or volume, the terms *S* and *P* can be represented as definite sets. This means that for two terms *(S, P)* there are five possible types of relations, which are represented by the corresponding schemes of judgments. Each type of the given relations has own names: *I* is coincidence or equivalence; *II* is left-sided inclusion; *III* is partial coincidence; *IV* is right-hand inclusion; *V* is incompatibility. Each categorical judgment can be compared with specific types of relations *S* and *P*. Conditions of truth (*i*) or falseness (*x*) of any categorical judgment: *1) Asp – i↔{I, II}* the judgment of *Asp* is true if and only if there are types of relations *I, II*; 2) *Asp – x↔{III, IV, V}* – the judgment of *Asp is false if and only if there are types of relations III, IV, V;* 3) *Esp – i↔{V}*; 4) *Esp – x ↔{I, II, III, IV}*; 5) *Isp – i↔{I, II, III, IV}*; 6) *Isp – x↔{V}*; 7) *Osp – i↔{III, IV, V}*; 8) *Osp – x↔{I, II}*. The relation between Euler circles (Euler diagrams) and Venn diagrams, and more precisely, the transition from one diagram to another – from Venn to Euler. Schemes are useful for understanding not only the evaluation criteria but also the main categories with which to conduct measurements of "TO": simple categorical judgments are attributive judgments. Since the tasks of the questionnaire give the opportunity to choose and to participate in this measurement or not, all respondents mainly use comparative categorical judgments (*Fig.3.8-3.9, Fig.3.10*). Studies have shown that the main vectors of movement of judgments (thinking) on the Logical square (*AspEspIspOsp, AEIO*) in respondents who participated in the measurement of "TO" on the example of solving the first and second measurement tasks – are such thinking operations that practically brought to automatism in the majority. However, they are part of the analysis of the thought process – trivial things that we do not notice in ourselves when we analyze. Typical transformations of partial judgments when solving tasks of "TO" (*Osp – Isp*) look like this: *"Some S are not real" (Osp) = "Some S are non-real" (Isp)* is category of data subsets *N*; *"Some S are not non-real" (Osp) = "Some S are real" (Isp)* is category of subsets of data *R*, etc. with subsets of *Z, St, D.* Transformation of general judgments (rarely in "TO," *Esp – Asp*): *"No S is real" (Esp) = "All S is unreal" (Asp)* is category of data set *N*; or *"No S is non-real" (Esp) = "All S is real" (Asp)* is the category of the data set *R*: the third is not given, and the category of subsets *Z, St, D* is not formed, only all *N*, or all *R*, which excludes the entire volume *S = 30.* The vectors of the final compatible conclusions of the respondents' judgments are the conclusions in which there are only *S* (smaller premise, subject SCS) and *P* (larger premise, predicate), and the middle term *M* (the concept of "point of support") is absent (in the case of syllogism). Even if the syllogism is not used, the respondent solves a complex problem of five tasks with the help of simple judgments (categorical). Output schema for *S, P* (partially affirmative, *Isp*): *"Some R is Z," "Some R is St," "Some R is D"*; *"Some N is St," "Some N is D."* And also, with the formation of relations of subordination in a subset (*Asp – Isp*): *"All Z is R (Isp)" – Z=R* (algebraic), etc.

The most typical relation is the probability of forming a mode figure (syllogism) under the condition of the existence of such a figure are examples of how many different combinations can be. Therefore, in the main table, the analysis of logical errors is made, according to the rules of traditional logic of incompatible comparable judgments (*Fig.3.10*). *Fig.3.11* displays the results of analytical processing of respondents' data, divided into groups – samples. The concept of associativity is an internal concept of research (see above). The black bars in the charts are all potential volume which is the actual volume of subsets of the respondents' data. Gray areas reflect the number of the respondents' abstract thinking, interpretation of the associative series, which might not have been necessary, because there is a strict logic (black and white columns), which, without exception, as we see in the diagram, was used by each respondent.

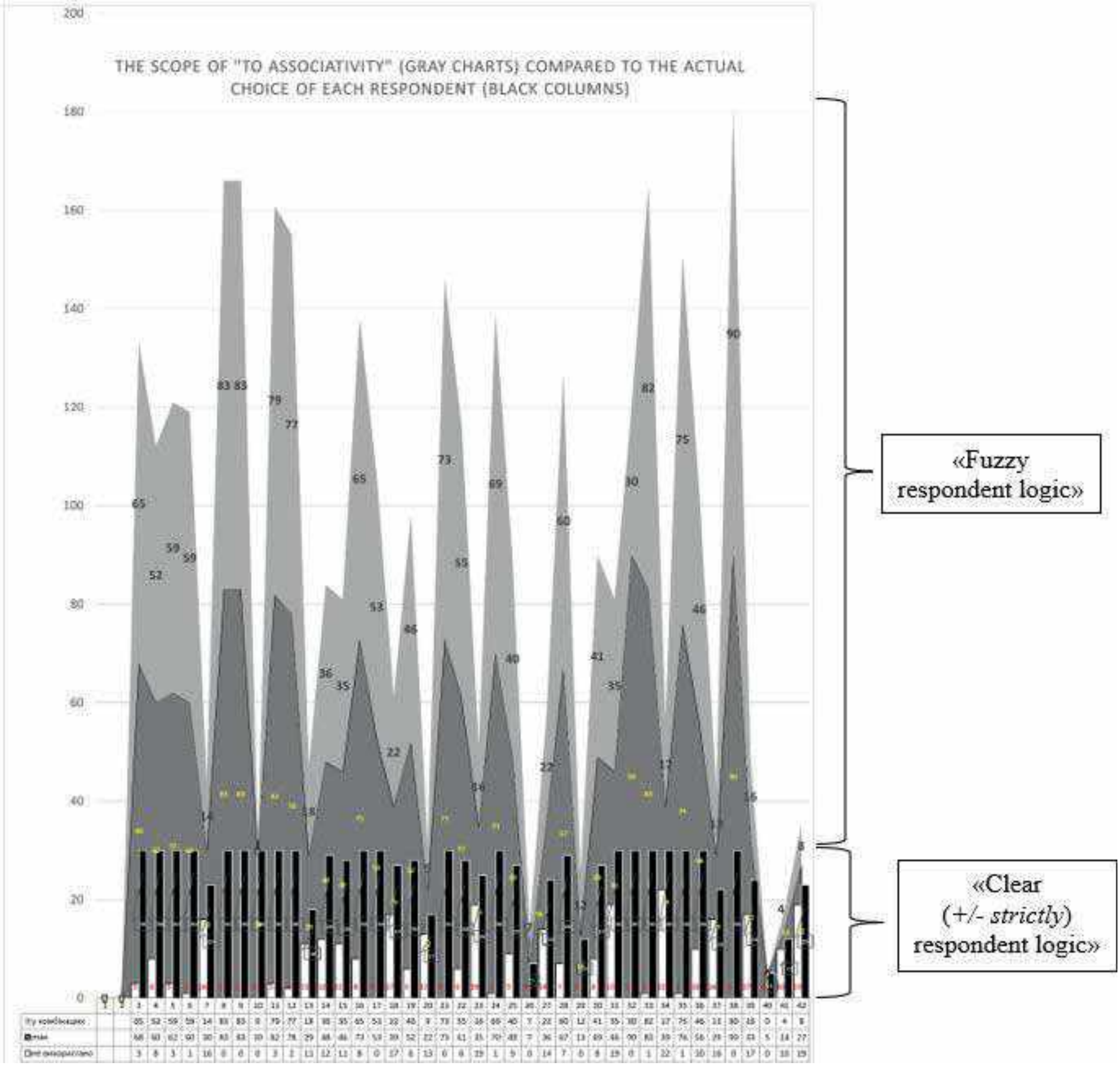

Fig.3.11 Displaying the results of analytical processing of respondents' data, divided into groups – samples. The concept of associativity is an internal concept of research (see above). The black bars in the charts are all potential volume – the actual volume of subsets of the respondents' data. Gray areas – reflect the work of the respondents' abstract thinking – interpretation of the associative series – which might not have been necessary, because there is a strict logic (black and white columns), which, without exception, as we see in the diagram, was used by each respondent (A. Mykolyshyn)

Our diagrams show quantitative and qualitative indicators of subsets of data. These diagrams show the quantitative indicators of the subjects of the study (respondents); namely, the distribution of the results of each respondent on one line. The diagram shows the distribution made by Euler-Venn diagrams (circles), essentially the same subsets, but with a plus or minus sign, respectively, which are included in the circles, and which are not included. It shows the volumes of all subsets for each respondent: here are those indicators that did not participate in the Euler-Venn diagrams (for example, $Z=ø$). Also, we have the diagram which shows the results of the found logical errors in the respondents due to the analysis by the method of the Logical square of incompatibility of judgments. In *Fig.3.11*, the black columns of the diagrams show the full potential volume is the actual volume of a subset of data respondents; gray areas are a clear view of the results of abstract thinking of the respondent, his interpretation of the associative series, which may not be necessary, because there is a strict logic (black and white columns), which without exception, as shown in the diagram, used each respondent. Since the concept of the respondent's interpretation of the visual object and abstract thinking have their meanings in everyday life, the very concept of "associativity in TO" is relatively free to assign new meanings in this study. In the syllogistic theory, in one way or another, the conditions for the truth of attributive statements are set.

This is usually done using the so-called Euler circles (or Venn diagrams), which act as model schemes for the truth of attributive statements. As for inferences, they are determined from inferences by the Logical Square to direct and indirect inferences. The number of direct inferences in positive judgment includes the operation of *conversion*, or *obversion* (transformation) in negative judgment, and various types of contrapositions. Euler-Venn diagrams are used for a visual representation of logical operations, as a visual tool for working with sets. In these diagrams, all possible options for intersecting plurals are displayed. The number of intersections (areas), *N,* is determined by the formula:

$$N = 2^n, \tag{3.1}$$

where *n* is the number of sets. Venn diagrams are a graphical way of setting and analyzing logical and mathematical theories and their formulas. It is used in the analytics of combinations of different operations on sets (respectively, union, intersection, difference, symmetric difference, absolute complement as a kind of complementarity):

$$A \cup B = \{x | x \in A \text{ or } x \in B\};\ A \cap B = \{x | x \in A \text{ and } x \in B\};$$
$$A \cap B = \{x | x \in A \text{ and } x \in B\};\ A + B = \{x | or \in A, \text{ or } x \in B\}; \tag{3.2}$$

The search for errors by the Logical square is carried out by investigating certain pairs of sets, the combinations of which may have an intersection match. The inclusion-exclusion formula (or the principle of inclusion-exclusion) is a combinatorial formula that allows you to determine the cardinality of the union of a finite number of finite sets, which in the general case can intersect with each other. In the case of two sets *A, B,* the inclusion-exclusion formula: $|A \cup B| = |A| + |B| - |A \cap B|$. The sum $|A| + |B|$ the intersection $A \cap B$ elements are counted twice, and to compensate for this, we subtract $|A \cap B|$ from the right side of the formula. In the same way, with $n>2$ sets, finding the number of elements of the union $A_1UA_2U\ldots UA_n$ consists in including everything, then eliminating the unnecessary required parameters. We also have the diagram which displays the relationship between original data samples, where a series of charts is set from the largest average of logical errors *L* (Logical square *AspEspIspOsp*) to the smallest ($L=3.5$; $L=0.2$; $L=0.1$). The previous conclusion of the influence of the respondent's "associativity" A_{to} on logical errors L_{AEIO}, directly shows that A_{max} is a harbinger of $L>0$. That is, the associative series of "TO" affects the number of logical errors. And, in fact, its very presence affects the indicators of A_{max}, A_{komb}. However, the A_{fact}, A_{not} indicators, respectively, the black and white columns of the diagrams, are actual figures of the associative series and not used in logical analysis, keep their trend, and are depicted as columns, not areas. Two other diagrams are also shown: with the least number of logical errors. For comparison, a diagram of the entire data set of a large sample of research subjects is presented. It is noticeable that the gray areas of the diagram (horizontal) with a minimum amount of logical errors are narrow, they are also minimal. This means that interpretations, illogical judgments, and abstract constructions of the respondents under the influence of the associative series are also minimal.

The white trend line in the diagrams separates the level of actual choice, which is almost the same for most respondents and does not differ much, because the actual volume of the associative range is always equal to $A_{fact}=30$ under ideal conditions, or is approaching this value (≤), according to statistics, "TO." Three graphs clearly show how much the associativity of Amax depends on the logical errors L_{min} and L_{max}. Without charts or graphs, it would be almost impossible to notice this in data tables at once. Thus, the high associativity and a large number of subset figures used by the respondent in combinations (A_{komb}) to solve the "TO" problem is likely to lead to many errors (*L*) resulting from the diagrams and the study. In the future, one can even predict, according to the average statistical indicators, for any respondent, the occurrence of logical errors, having only the initial data, the first results of solving the syllogism-related problem of "TO." Across the entire research dataset, the Amin values are on average close to A_{fact}: $A_{fact} \leq A_{min}$. The actual volume of the set of the whole associative series does not decrease or increase by itself: $S=A_{fact}=30$.

Statistical results of respondents and introducing coefficients as corrections for logical and semantic errors of the subject. Models for compensation of errors of clear logic of the subject (respondent "TO") are in order to make sure that the coefficients are effective. The coefficient that compensates for the errors on the diagrams is always at the top (on the line graph, the upper broken line), and the maximum coefficient does not exceed the limit $y=1$: $Kmax=1$, and the minimum coefficient is not equal to zero (greater than zero) – $Kmin \neq 0$, $Kmin>0$. The value for respondents $Kresp=0$ shows that such a coefficient is not relevant and, is not introduced, because the errors are equal to zero. Corrections for errors of judgment (according to the Logical square) are tiny, and in the general array of others they are shown lower by columns on our diagrams. Because of this difference, the idea arose of introducing separate correction factors. The table with the results of respondents (in points) after passing the questionnaire (total marks), where there is a clear division into points of clear and non-clear logic of the respondent (upper broken line and lower, respectively). Statistical results of respondents in points, respectively, after passing the questionnaire (total marks) and after introducing coefficients of corrections for logical and semantic errors of the subject of measurement (real marks) can be seen on *Fig.3.12*

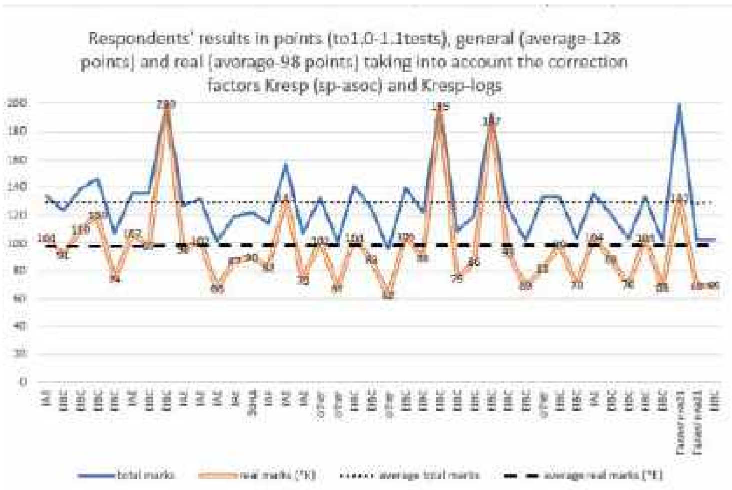

Fig.3.12 Statistical results of respondents in points, respectively, after passing the questionnaire (total marks) and after introducing coefficients of corrections for logical and semantic errors of the subject of measurement (real marks), (A.Mykolyshyn)

The maximum number of *points* is *200*, the minimum is *0 points*. The average value of the score after passing the questionnaire is *128 points*. After introducing the correction coefficients for errors in passing the measurement, the average value is *98 points*.

On average, the coefficients affect *1.4 times* toward reducing the number of points. However, there are three types of coefficients; therefore, for different cases, one or another coefficient can be selectively considered. The average values of each type of coefficient was found by the analytical method. For example, the average coefficient $AK_{resp\text{-}logs}$ already considers the relative errors, which are found from the Logical square (logic of judgments) in recalculation on the volume of data subsets that it covered. The errors of judgments by the Logical square are distributed:

$$P_{logs}=P_{rn}+P_{zn}+P_{sd}\ , \qquad (3.3)$$

$$P_{rn}=1-((A_{fact}*2)/2S)\geq 0, \text{ where } A_{fact}=S. \qquad (3.4)$$

The same formulas, respectively, for P_{rn}, P_{zn} and P_{sd}, where the maximum volumes of subsets are *2S*. The coefficients $AK_{resp\text{-}sp}$ and $AK_{resp\text{-}assoc}$ are relative values from empirical data from the TO subsets. Moreover, $AK_{resp\text{-}assoc}$ is a deterministic indicator of the respondent's intelligence model (*Fig.3.11*), which is responsible for the areas of the subject's unclear logic, and in fact, is the characteristic of these areas. $AK_{resp\text{-}sp}$ is the average value of the coefficient found from the ratio between the volumes of subsets A_{fact} (data from areas of clear logic (*Fig.3.11*)) and A_{not} (unallocated *S*). Thus, the indicators of clear (0.71) and unclear logic (0.57) of the respondent are like average correcting coefficients. They can be considered in the received (total) scores of the respondent to find the real (real marks) of his scores and not to compare the respondents with each other, but with analytical indicators. The indicator of the logic of judgments (0.96) is not defined as a separate coefficient, because it is a relative value between sample subsets of data, the ratio of which is individually responsible for one or another type of judgment; namely: the ratio of oppositeness, contradiction, partial compatibility. Coefficients *AK*, which are equal to zero or one, show an impeccably-completed measurement questionnaire of "TO," or because of "self-correction" of the respondent's data (unsatisfactory answers were compensated by the best, for example). Parametric methods for estimating and analyzing statistical hypotheses are an important step for the study of empirical data. When the first data samples are formed, one can further predict certain results, the actual absolute and relative values, as well as their averages. For data analysis, it often carried research out on sample sets, which determine the average error of a relative or average value, which allows to determine the essence of the derived value, its confidence limits (intervals). Determining the possible limits of fluctuations in repeated studies allows one to set the limits of the norm of indicators in the study. If the study of the same phenomenon in different samples leads to different results, each of them to some extent characterizes the phenomenon, but depending on random fluctuations, it differs from the result of the general population. In this case, it is necessary to assess the probability (significance) of the difference between these results using a parametric reliability factor (Student's criterion).

Evaluating the reliability of research results helps to make the right conclusions with a guarantee against errors in interpreting the results. In the future, we can summarize the following algorithm and problems:-(areas of application) transfer of the results of the sample survey to the general population, determination of the materiality of the derived values, determination of the difference between the derived values;-(conditions that affect the reliability) the variety of features in the sample, the number of observations (n), the degree of probability of error prediction (%);-(methods of reliability assessment) determination of possible confidence limits of fluctuations of the obtained indicators, the ratio of the indicator to its average error in determining the reliability of the difference between the values. Determination of probable confidence limits of fluctuations of the received indicators (for average values and for relative values):

$$\bar{X}_{gen} = \bar{X}_{sam} \pm tm_x, \qquad P_{gen} = P_{sam} \pm tm_p, \qquad (3.5, 3.6)$$

where $\bar{X}_{gen}$, $\bar{X}_{sam}$ – are confidence intervals (limits) of the average value for the general totality and the sample, respectively; P_{sam}, P_{gen} – are confidence intervals (limits) of relative value for sample totality and general totality, respectively; m_x, m_p – are errors of average and relative values, respectively; t – Student's reliability criterion, which is used to assess the reliability of differences between indicators. The ratio of the indicator to its average error (for average and relative values, respectively):

$$m_x = \frac{\delta}{\sqrt{n}}, \quad t = \frac{\bar{X}}{m_x}; \quad m_p = \sqrt{\frac{P_q}{n}}, \quad t = \frac{P}{m_p}, \qquad (3.7, 3.8)$$

where σ – standard deviation; n – number of observation results; $q=1–P$ $(q=100–P, q=1000–P, q=10000–P, q=1000000–P)$. Standard (standard deviation) is the degree of deviation of all values of the feature from its mean, one of the most important methods to help determine how much a certain value changes: the larger the standard deviation, the wider the range of changes in the values of this value. Also, this method is one of the three known methods that allow one to decide based on the uncertainty factor (standard deviations, confidence intervals, and multiple regression analysis).

$$\sigma_s = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}, \quad \sigma = \sqrt{\frac{\sum(x_i-\mu)^2}{N}}, \qquad (3.9)$$

where $\sum(x_i - \bar{x})^2$ – is a sum of the squares of all deviations of individual values (x_i) from their average size ($\bar{x}$); n – is a number of observation results. $(n-1)$ used in small samples, where a limited number of objects are randomly selected from the entire population for further study, N we use in the case of a continuous survey, when the data for each object of the population are considered. Determining the significance of differences between values (for average and relative values, respectively):

$$t = \frac{\overline{X_1}-\overline{X_2}}{\sqrt{m_1^2+m_2^2}}, \quad t = \frac{P_1 - P_2}{\sqrt{m_1^2+m_2^2}} \qquad (3.10, 3.11)$$

where $\overline{X_1} > \overline{X_2}$, $P_1 > P_2$. With numerous observations $(n>30)$ the difference between the indicators is significant (essential, significant, non-random), if: $t \geq 2$ $(p<0,05)$, it corresponds to a probability of error-free prediction of 95.5% *if* $t>3$ $(p<0.01)$, it corresponds to a probability of error of 99.7%. If it is planned to transfer the conclusions got in the data sample to a similar population or the entire population, then the indicators (relative and average) require an assessment of probability (except for continuous studies). In addition, the analysis of the obtained data will show whether it will be possible to make prediction in the future or not. Evaluation of results we have in the following statement. The results are significant at $t>3$. Differences between indicators at $n>30$: unreliable at $t<2$ $(p>0,05)$, probable at $t>2$ $(p<0,05)$, probable at $t>3$ $(p<0,01)$. With a small sample $(n<30)$ t is estimated from the Student's table $(n`=n_1+n_2–2, n´=(n_1–1)+(n_2–1))$. If $t_{fact} \geq t_{tab}$ – the difference between the indicators is probable. Probability of an unmistakable forecast and risk of error in the Table 1.

Table 3.4. Assessment of reliability and probability of error prediction.

t	Probability of an unmistakable forecast (in fractions of a unit and in %, respectively)		Risk of error, (p) (in fractions of a unit and in %, respectively)		Reliability assessment
1	0,66	66	0,34	34	unreliable
2	0,95	**95**	**0,05**	5	reliably
3	0,99	**99**	**0,01**	1	reliably

Furthermore, about the confidence intervals of 95% and 99% in the degree of probability for the results (to1.0-1.1tests) in points (respondents) at $n>30$, where $t = 2$, $t = 3$. Initial data (tabular): $\sigma = \pm 4$ points at $\bar{X}_{total} = 128p.$ (average score of clear logic of the respondent before introducing correction factors) and $\sigma = \pm 5$ points at $\bar{X}_{real} = 98p.$ (average score of clear logic of the respondent after introducing correction factors), $t = 4.7$ $(t>3$ $(p<0.01)$, which corresponds to a probability of error-free prediction of 99.7% with numerous observations $(n>30))$. $\bar{X}_{gen} = \bar{X}_{total} \pm tm_x = 128 \pm 2*4$ points, with a probability of 95%, the average scores are in the range of

120–136p., $\bar{X}_{gen} = \bar{X}_{total} \pm tm_x = 128\pm3*5$ points, with a probability of 99%, the average scores are in the range of 116–140p. After adding the correction factors: $\bar{X}_{gen} = \bar{X}_{real} \pm tm_x = 98\pm2*4$ points, with a probability of 95%, the average scores are in the range of 88–108p., $\bar{X}_{gen} = \bar{X}_{real} \pm tm_x = 98\pm3*5$ points, with a probability of 99%, the average scores are in the range of 83–113p., show the degree of probability by which it can be argued that the scores are indeed within these limits. *We made the same calculations for all relative values to find the correction factors:*

$$A_{fact}/A_{max} = Ak_{resp\text{-}assoc} \text{ and } 1-A_n/A_{fact} = Ak_{sp};\ Ak'_{resp\text{-}logs} = \sum\left(\frac{A^{logs}_{komb}}{2S}\right) = \frac{A^{rn}_{komb}}{2S}+\frac{A^{zn}_{komb}}{2S}+\frac{A^{sd}_{komb}}{2S} \quad (3.12)$$

For errors in the judgments of the Logic square: $P_{logs}=P_{rn}+P_{zn}+P_{sd}=0$. Standard deviation for absolute values of errors of a Logical square of all data set (A^{logs}_{komb}): $\sigma_{rn}=\pm1,48$, $\sigma_{zn}=\pm1,72$, $\sigma_{sd}=\pm5,02$. Average value error: $m_{rn}=0,24$, $m_{zn}=0,28$, $m_{sd}=0,81$. And for relative ones ($Ak'_{resp\text{-}logs}$): $\sigma^{log}_{komb}=\pm0,09$; $m^{log}_{komb}=0,02$. Hence, the methods used to make decisions considering the uncertainty factor, as well as the influence of random value (researched standard deviations of averages and relative values, as well as confidence intervals of the results of respondents in points). In order to avoid inaccuracies, an already generalized indicator of all coefficients and a diagram of average indicators is proposed; *Kmin=0* was not considered in further analytical processing (*Kmin≠0, Kmin>0*). We can see this on *Fig.3.13*.

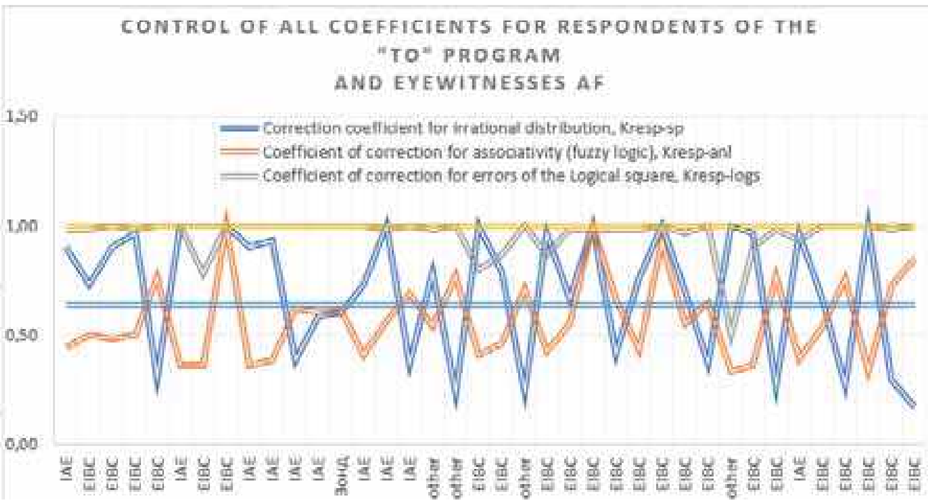

Fig.3.13 In order to avoid inaccuracies, an already generalized indicator of all coefficients and a diagram of average indicators is proposed; $K_{min}=0$ was not considered in further analytical processing ($K_{min}\neq0$, $K_{min}>0$) (A. Mykolyshyn)

The number of subjective factors. The higher the coefficient in value, the less the human factor took place in the measurement "TO" ("to1.0-1.1 tests"). Although the average total coefficient is *0.75*. That is, the average score obtained by the average respondent, the subject of measurement TO, may decrease *1.4 times*. Thus, the subjective or human factor on average in the program "TO" affects *1.4 times*. But according to the above, this indicator depends on at least several factors: it is an associative series, and the complexity of syllogism-related questions, and the conceptual apparatus of the respondent, as well as a set of other intelligence parameters. In the respondent's case-subject-person there is an element of the human factor – that's when A_{max}, A_{komb} are not just judgments, but complex inferences, interpretations, with a violation of the logic of simple judgments and, accordingly, logical errors of judgments. Thus, the model of the intelligence system of the subject with the help of the logic of judgments becomes clear through diagrams and formal logic formulas.[1]

Conclusions. The algorithm of any analysis involves the division into components of what is analyzed. In the case of the respondent-human subject, the human factor appears. It causes the appearance of A_{max}, A_{komb} which are not just judgments, but complex inferences, interpretations, with a violation of the logic of simple judgments and, accordingly, the logical errors of judgments. Thus, the model of the intelligence system of the subject with the help of the logic of judgments becomes clear through diagrams and formal-logical formulas.

The main goal of the problem is experimentally investigated the determination of the rational logic and the ability to see what is "associativity TO" presented on our special resulting diagram – here rational logic is symmetrical to a new characteristic associativity. This diagram shows how obvious the issue of the influence of associativity is (individual interpretation, perception, experience, or the human factor).

Single cases of convergence were received by those respondents in whom the number of logical errors is zero or minimal, and $A_{max} \approx A_{fact}$. Then the two curves on this diagram are combined. However, such a phenomenon is unfortunately not observed due to the presence of additional factors, namely, the human factor, which is studied and determined under the experimental name "TO associativity." Convergence is no exception: it is a case of minimal human influence. Eyewitnesses, AP witnesses, who are among the respondents, are no exception. Such people are a clear example of the hidden associativity of memory and experience. The associative series is the only tool that guides the eyewitness through similar experiences and forces them to interpret, but only through the prism of logical constructions and judgments of the "to-1.0-1.1 tests" program or "TO." The program-method "TO" after analytical processing of the information carries out construction of the corresponding diagrams and an output of data on the respondent.

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Appendix 1. Forms and blanks that are not included in office work manuals and in standards for the design of research papers

A1.1. Application for participation in the expedition

*Reg. No.*_______ *Form E-1*

(the number is assigned by the expedition leader)

This application is mandatory to ensure participation in expeditions. ____.

The application is filled in by a potential expedition participant or, on his behalf, by a trusted person. The information contained in the application is necessary for the correct planning of expeditions and the prevention of accidents of their participants. These applications are considered by the Coordination Council ____________________________ based on the submission of the Head of the Expedition. Based on the results of the application review, a decision is made to enroll the applicant in the expedition, of which he will be notified. The application must be received by the Head of the Expedition no less than 1.5 months before the start of the expedition. The application can be sent to the Head of the Expedition in either paper or electronic form.

To the Coordinating Council ____

From____

Application for participation in the expedition

Please enroll ____

Full name.

as part of the expedition ____

name of the expedition

scheduled for ____

dates of the expedition

in____

expedition area

Personal data:

Research area of interest ____

Level of cooperation ____

Coordinator, participant, interested

The department in which the cooperation is carried out _______________________

Date, month, year of birth __________________ Main occupation ____________________

Position and place of work ____

Full home address, with postcode ____

Postal address (if different from home address)____________________________

Mobile phone number ______________________ E-mail ___________________________

The presence of chronic diseases, injuries, psychological characteristics that may affect the performance of work on the expedition ____

Nervous system type in terms of biological clock ____________________________

(lark, dove, owl)

Expedition experience:

No.	*Name and location of the expedition*	*Date of the expedition*	*Works carried out during the expedition*	*Notes*

Research planned to be carried out during the expedition:

No.	*Research Title*	*Planned research results*	*Notes*

Research equipment and property for collective expedition use that are planned to be taken with you:

No.	*Name of equipment and property*	*Characteristics*	*Weight, kg*

Specialists with whom it is planned to carry out work on the expedition and with whom this issue has been agreed upon:

No.	*Full name*	*Type of research*

Equipment, property and other needs that are not available and for which there is a request for assistance from other members of the expedition:

No.	*Equipment*	*Technical requirements*

Signature Application submission date ____________________

A1.2. Program for a participant in conducting search and research activities as part of an expedition

Form E-2

Participant program for conducting search and research activities as part of an expedition

Name of the expedition ____
Structural unit (group, department or individual)____
Personnel: 1.__________________________ 5.__________________________
2.__________________________ 6.__________________________
3.__________________________ 7.__________________________
4.__________________________ 8.__________________________

No.	*Types of research and development work that can be carried out by the participant*	*Equipment and gear*	*Consumables, energy needs*	*Costs, man-hour*
1				
2				
3				
4				

Other works that can be carried out using additional equipment _________________________________
____
____
Other work that can be carried out by involving third parties ___________________________________
____
____
Provision of equipment:

Name	*Characteristic*	*In stock*	*Notes*

Experience in conducting expeditions, readiness to work in difficult conditions ________________________
____
____
The program has been compiled ____ Date ________________
Full name

A1.3. Application for an expedition

Form E-3

Application for an expedition

Applicant ____

Name of the expedition «______________________» The purpose of the expedition: ___________________

____

Reasons for the expedition: ____

____

____

Location of the expedition: ____

in km. from ____

Date of the expedition: ______________________________ Preliminary expedition schedule:

1.____
2.____
3.____
4.____
5.____
6.____
7.____
8.____
9.____

Preliminary personnel of the expedition:

1.__________________________	5.__________________________
2.__________________________	6.__________________________
3.__________________________	7.__________________________
4.__________________________	8.__________________________

Preliminary list of technical equipment:

1.____
2.____
3.____
4.____
5.____
6.____
7.____
8.____
9.____
10.____
11.____
12.____
13.____
14.____

A1.4. Expedition program

Form E-4

Expedition program

Name of the expedition «______________________» The purpose of the expedition___________________
____
Reasons for the expedition: ____
____
____
Location of the expedition: ____
in km. from ____
Dates of the expedition ____ Deadline __________________
Expedition schedule:

Time	*Actions*

Head of the expedition: ____
Manager's contact details:
Mobile phone number ______________________ E-mail ____
Planned composition of the expedition:

No.	*Full name*	*Position or research area*
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Technical equipment:

No.	*Expeditionary property*	*Who takes?*
Equipment for observation and recording of images		
1.		
2.		
3.		
4.		
5.		
Devices		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
Life support equipment		
23.		
24.		
25.		
26.		
27.		
28.		
29.		
30.		

Research program:

No.	*Research*	*Responsible*
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

A1.5. Expedition report

Form E-5

WORK LOG

Name of the expedition	*- 20__*
Expedition No.	
Dates of the event	*__.__.20__* *__.__.20__* *__.__.20__* *__.__.20__* *__.__.20__*
Supervisor	

________________-____________________20__
Country *Locality*

Content:

Notes:
Section 1. Applications for conducting an expedition - see Form E-3
Section 2. Program for conducting search and research work as part of individual participants or structural divisions - see Form E-2
Section 3. Reference materials – text
Section 4. General schedule of completed works
__:__ -
__:__ -
__:__ -
Section 5. Standards of safety regulations and conduct, log of their compliance – text
Section 6. Maps, diagrams with attached expedition routes – in compliance with all cartographic requirements and standards
Section 7. Characteristic photographic materials and recorded videos
Filmed __ digital photographs and __ video duration _:__:__. Individual photographs and their optional graphic materials are provided in Appendix No. 1.
Section 8. Protocols of eyewitness interviews

Phonogram
interrogation of witnesses __

Survey date __.__.____ The survey was attended by (full name)__________________________________
____
Full name:
Full name:
…
Section 9. Information on the results of the study of samples and analyses – text
Section 10. Reports of individual participants or structural divisions – text
Section 11. General conclusion – text

A1.6. Descriptive catalog

Form K-1

Descriptive Catalogue No.____

Format:

A	artifacts
L	letters from eyewitnesses
M	array primary message
B	books, materials, individually bound
D	disks
S	selection of materials, articles
t	typewritten
p	printed on a printer or in a printing house
h	manuscripts
c	photocopies
n/n	no number

Br-and	No.	Tom	Contents/Title	Author or editor	Source/place of publication	Number/year of publication	Instance No.	Pages (from*to)	Format	In electronic form
			…							
			…							
			…							
			…							
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			…							

Note: *1 volume ~ 150-200 pages, the number in brackets shows the number of volumes and volume*

A1.7. Questionnaire for entering coefficients for eyewitness perception

Form A-1

No._________

Questionnaire for entering coefficients on eyewitness perception

This questionnaire is filled in to measure the "human factor", an eyewitness to an object or phenomenon that cannot be identified as a natural or man-made phenomenon. To do this, you need to answer five questions.

1.Determine the images of figures in which the phenomenon is observed (there may be several).

____

2.Select from thirty figures those in which the phenomenon is not observed (there may be several).

____

3.Specify the image of figures that contain patterns (similarity, relevance, correspondence to the phenomenon or physical law of the phenomenon (there may be several)).

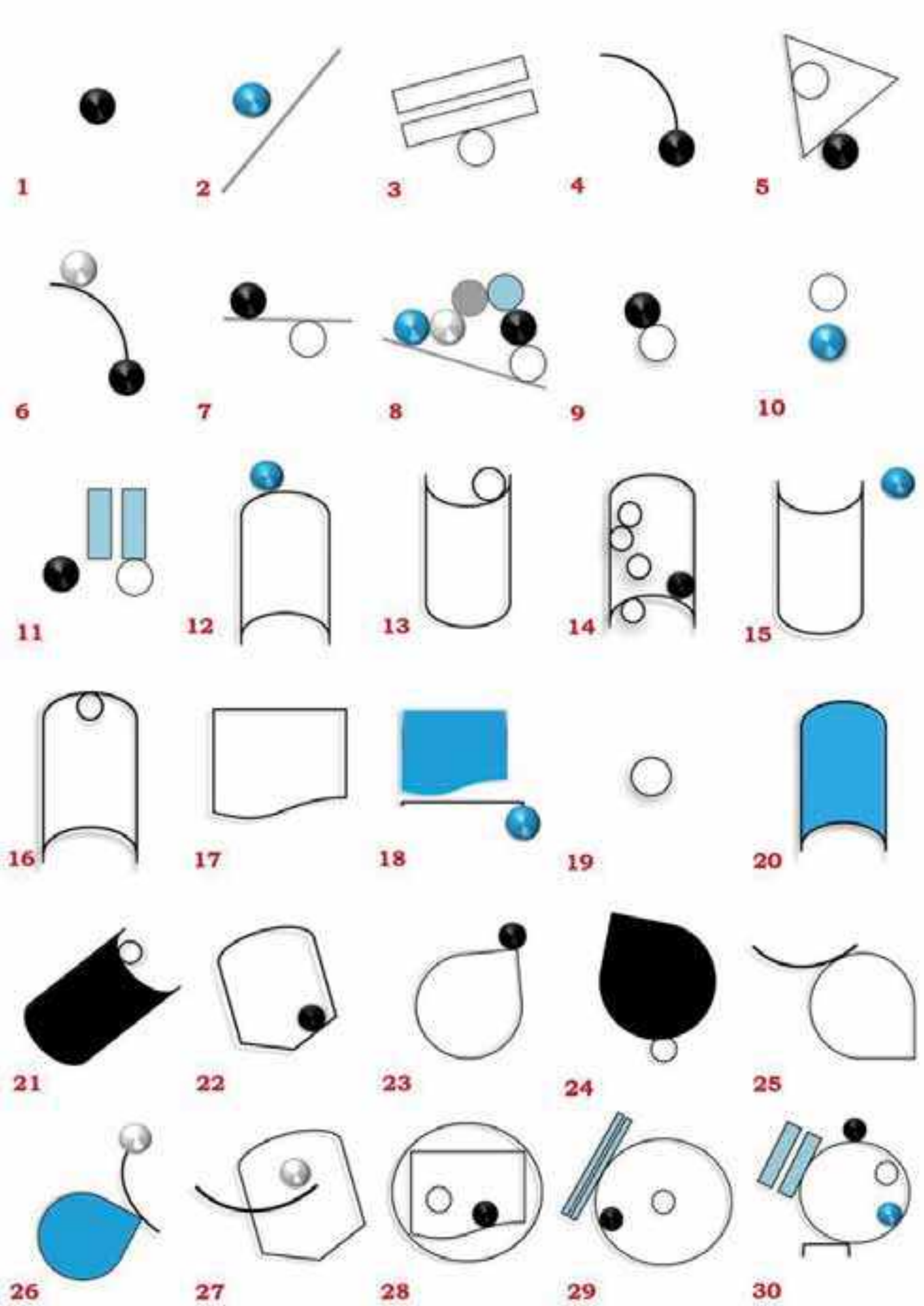
____

4.Specify "static" figures, but corresponding to the phenomenon (there may be several).

____

5.Specify "dynamic" figures, but corresponding to the phenomenon (there may be several).

____



A1.8. Questionnaire of data on the discovery of a mysterious object found on the surface of the Earth

Form A-2

No._________

Questionnaire of data on the discovery of a mysterious object found on the surface of the earth

This questionnaire is filled in to document the discovery of an object that has fallen to the ground (or into the water) and that cannot be identified as an object common for the given time/place or natural in terms of the possibility of falling. Both objects that were observed to fall by the person who found them and objects the conditions of which fell to the ground are unknown to those who found them are subject to description. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire. The additional sheets must have the number of the item that is being supplemented.

1.Information about the person who discovered the object (if there are several persons, then several questionnaires are filled out)

Surname ______________________________________ Name ______________________________________

Date, month, year of birth ________________________ Occupation ___________________________________

Position and place of work ____

Postal address ____

____

Mobile phone___________________________________ Email _______________________________________

2.Information about the discovery of the object

Date of observation __.__.20__y Detection area ____

____

Description of how the item was discovered ____

____

____

____

____

____

Description of how the object was lying (e.g. half buried in the soil, on the surface, etc.)________________

____

____

Description of the location of the find relative to the terrain from a distance (approximately or in steps) from local landmarks ____

____

____

____

Scheme of the location of the object's discovery with reference to local landmarks

If the discovered object has been lying there for a long time, estimate the possible period of time it has been there since it fell, substantiating the estimate with observations (for example, this can be done based on the plants growing on it, the oxide layer, the flight trace in the atmosphere seen earlier, etc.)___________________

____

3.Data on the fall of the object

Did the discovered object fall in front of eyewitnesses? (Yes/No)_____

If yes, please specify:

a)its flight (glow, noise)____

b) his fall (impact, explosion, crater, traces around)____

c) the characteristics of the object immediately after falling (temperature, changes on the surface)_________

____

Weather conditions at the time of the fall:

a) cloudiness ____

b) precipitation ____

c) direction and strength of the wind ____

Were there any aircraft in the sky at the time of the fall? (Yes/No)_____

If yes, then which ones?:____

Observer's opinion on whether this object could have fallen from an aircraft?__________________________

____

Were there any phenomena observed that could be associated with the falling of the object? (Yes/No)_____

If yes, please provide as detailed a description as possible. ____

____

____

____

4.Preliminary research of the subject

Item Description:

a)shape (if difficult to describe, compare with standard objects, eg a car part, a piece of clothing, etc.)

____

b)size (if difficult to measure, compare with standard measuring items) _______________________________

____

c)weight (if difficult to measure, compare with standard objects, e.g. AA battery, car battery)

____

____

d)material (if it is difficult to give an exact definition, compare with standard materials, eg steel, cast iron, granite, earthenware, cotton wool, etc.) ____

f)texture (monolith, porous, etc.)____

g) color and shade both on the surface and on the fractures (if any) _________________________________

____

Provide a drawing or photograph of the object. The drawing or photograph should include a ruler or a standard object, such as a matchbox, which will allow the size of the object to be assessed. Were any strange features of the object observed (maintaining a temperature different from the ambient temperature, glowing, making sounds, etc.)? ____

____

____

Was the object observed to have any effect on people, animals, plants? (Yes/No)_____

If yes, you need to give the most complete description of the results of the observed impact. ______________

____

____

____

Were any measurements of the object's objective characteristics (temperature, radioactivity, density, etc.) taken? (Yes/No)_____

If yes, the results of these measurements____

____

____

____

If there are documents confirming the research conducted, provide a copy of these documents as an appendix to the questionnaire! ………………………………………………………………………………………..

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion ____

A1.9. Questionnaire for an astronomer about observing an unidentified object or phenomenon

Form A-3

*No.*_________

Questionnaire for an astronomer about observing an unidentified object or phenomenon

This questionnaire is filled in for the purpose of documenting the observation of an object or phenomenon that cannot be identified as a natural or man-made phenomenon. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire, or on the back of the questionnaire. Be sure to indicate the number of the item that is being supplemented.

1.Data on the person who observed the unidentified object or phenomenon (if there are several persons, then several questionnaires are filled out)

Last name_________________________ Name _________________________

Date, month, year of birth _________________ Occupation _________________________

Postal address ____

____

Mobile phone_________________________ Email _________________________

How long have you been doing astronomy? ___ years. Are you a member of any astronomy clubs? (Yes/No)_____

Have there been other astronomers who have observed this object or phenomenon? (Yes/No)_____

Please provide information on how to contact them_________________________

2.Observation details

Observation date __.__.20__y Detection area (indicate with reference to the area)_________________

____

Where were you at the time of observation (GPS coordinates if possible) _________________

____

Weather conditions:

a) Ambient temperature _______________ b) Atmospheric pressure _________________

c) Wind speed (calm, weak, medium, strong) _________________________

d) Clarity of the sky (clear or not) ____________ e) The smallest apparent stellar magnitude _______

3.Technical characteristics of surveillance

Quantity _______ changes in azimuth ____________ height of the angle ______________

If it is difficult, please indicate in which constellation the phenomenon was observed and the trajectory of its movement:_________________________

Form _________________________ Was there a change in shape? (Yes/No)_____

Color _________________________ Was there a color change? (Yes/No)_____

Apparent stellar magnitude _______________ Was there a change in brightness? (Yes/No)_____

Noise _________________________ Scent _________________________

Observation start time __:__ Did you see the appearance of an object or phenomenon? (Yes/No)_____

End time of observation __:__ Did you see the end of the manifestation? (Yes/No)_____

If you are physically unable to determine the exact time, then indicate the name of a bright star located near the horizon _________________________

Were any aircraft observed in the sky during the manifestation? (Yes/No)_____

If yes, then describe in which constellation was observed and the trajectory of its motion. ___________

____

Were reflections of sunlight on the satellite observed during the manifestation? (Yes/No)_____

If yes, then describe in which constellation the satellite was observed and its trajectory ____________

____

If you want to make a sketch or describe the observation in more detail, do it on a separate sheet, and if you have a photo or video, you need to provide a copy of the original with EXIF!

Specify the camera type _________________________

Focal length ___________________ Was a diaphragm used? (Yes/No)______

What filters were used? ___________ Was shutter speed used? (Yes/No)______

The camera was on a tripod (Yes/No) __________

What type of astronomical instrument was used? _________________________

Was magnification used and by how much? _________________________

4.Eyewitness opinion

What do you think about the observed object or phenomenon? What could it be? _______________

____

…………………………………………………………………………………………………...

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion _________________________

A1.10. Questionnaire for a meteorologist about observing an unidentified object or phenomenon

Form A-4

*No.*_________

Questionnaire for a meteorologist about observing an unidentified object or phenomenon

This questionnaire is filled in for the purpose of documenting the observation of an object or phenomenon that cannot be identified as a natural or man-made phenomenon. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire, or on the back of the questionnaire. Be sure to indicate the number of the item that is being supplemented.

1. Data about the person who observed the unidentified object or phenomenon (if there are several persons, then several questionnaires are filled out)

Last name______________________________________ Name _____________________________________

Station ____ Job title ___________________________________

2. Observation details

Date of observation __.__.20__y Name of the phenomenon _____________________________________

Observation start time __:__ Did you see the appearance of an object or phenomenon? (Yes/No)_____

End time of observation __:__ Did you see the end of the manifestation? (Yes/No)_____

Weather conditions:

a) Ambient temperature _________________________ b) Atmospheric pressure _________________________

c) Wind speed (calm, weak, medium, strong) ____

d) Cloudiness ________________________________ f) Visibility ___________________________________

e) Presence of solar or lunar radiance ____

g) Observed atmospheric phenomena (thunderstorm, fog, etc..)_______________________________________

____

3.Technical characteristics of observation

Quantity ______ the phenomenon or object was observed in what part of the sky? ______________________

At what angular height above the horizon ______° by azimuth ______°

The angular size of a phenomenon or object ______° or indicate in comparison with the Moon or other objects

____

Form __________________________________ Was there a change in shape? (Yes/No)_____

Color ____________________________________ Was there a color change? (Yes/No)_____

Noise ____________________________________ Scent ____

Describe the trajectory of an object or phenomenon ____

____

____

Unusual impact on the environment, people, animals, etc.____

____

____

If observation instruments were used, please indicate which ones______________________________________

____

____

A copy of the instrument readings must be provided!

Unusual malfunctions of devices ____

____

If you want to make a sketch or describe the observation in more detail, do it on a separate sheet, and if you have a photo or video, you need to provide a copy of the original with EXIF!

Specify the camera type ____

Focal length ___________________________ Was a diaphragm used? (Yes/No)______

What filters were used? ________________ Was shutter speed used? (Yes/No)______

The camera was on a tripod (Yes/No) _____________

4.Eyewitness opinion

Eyewitness OpinionWhat do you think about the observed object or phenomenon? What could it be? ______

____

____

………...

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion ____

A1.11. Questionnaire for the flying club about observing an unidentified object or phenomenon

Form A-5

*No.*_________

Questionnaire for the flying club about observation of an unidentified object or phenomenon

This questionnaire is filled in for the purpose of documenting the observation of an object or phenomenon that cannot be identified as a natural or man-made phenomenon. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire, or on the back of the questionnaire. Be sure to indicate the number of the item that is being supplemented.

Last name______________________________________ Name _____________________________________

Aeroculube______________________________________ Addres_____________________________________

____

Model of an aircraft ____

Registered ____

Departure airport ____

Arrival airport ____

Were ADS-B transponders used (Yes/No)_________

At the beginning of the observation of an unidentified object or phenomenon:	At the end of observation of an unidentified object or phenomenon:
Latitude ______________	Latitude ______________
Longitude ______________	Longitude ______________
Date and time __.__.20__ - __:__	Date and time __.__.20__ - __:__
Altitude ______________	Altitude ______________
Position to the horizon ______________	Position to the horizon ______________
Rise ______________	Rise ______________
Descent ______________	Descent ______________

Meteorological conditions at the time of observation (fog, clouds, etc.)_______________________________

____

____

____

An observed unidentified object or phenomenon: quantity _________

Specify if the phenomenon was observed above, below or inside the clouds?________________________

Form _____________________________________ Was there a change in shape? (Yes/No)_____

Color _____________________________________ Was there a color change? (Yes/No)_____

Speed _____________________________________ Was there a change in speed? (Yes/No)_____

Height _____________________________________Was there a change in altitude? (Yes/No)_____

Direction ___________________________________ Was there a change in direction? (Yes/No)_____

Were there any malfunctions in the operation of devices and equipment? (Yes/No)_____

If yes, please specify which ones: ____

And how did it manifest itself? ____

____

If there is electronic data from onboard radars at the time of observation, please provide it!

Radar type ____

If you want to make a sketch or describe the observation in more detail, do it on a separate sheet, and if you have a photo or video, you need to provide a copy of the original with EXIF!

Specify the camera type ____

Focal length ____________________________ Was a diaphragm used? (Yes/No)______

What filters were used? ________________ Was shutter speed used? (Yes/No)______

Have you reported your observation to the appropriate authorities? (Yes/No)______

If yes, then where exactly? ____

Please specify the date and time of the message __.__.20__ - __:__

Do you know of any other observers of this phenomenon? (Yes/No) ______

If yes, please indicate how to contact them: ____

____

What do you think about the observed object or phenomenon? What could it be? ______________________

____

____

………...

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion ____

A1.12. Questionnaire for an air traffic controller or pilot about observing an unidentified object or phenomenon

Form A-6

*No.*_________

Questionnaire for an air traffic controller or pilot about observing an unidentified object or phenomenon

This questionnaire is filled in for the purpose of documenting the observation of an object or phenomenon that cannot be identified as a natural or man-made phenomenon. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire, or on the back of the questionnaire. Be sure to indicate the number of the item that is being supplemented.

Last name_________________________________ Name ______________________________

Pilot ☐ Air traffic controller ☐ Place of work ____________________________________

Address ____

Model of an aircraft ____

Flight number ____________________________ Call sign __________________________

Departure airport ____

Arrival airport ____

Were ADS-B transponders used (Yes/No)_________

At the beginning of the observation of an unidentified object or phenomenon:	At the end of observation of an unidentified object or phenomenon:
Latitude ______________	Latitude ______________
Longitude ______________	Longitude ______________
Date and time __.__.20__ - __:__	Date and time __.__.20__ - __:__
Altitude ______________	Altitude ______________
Position to the horizon ______________	Position to the horizon ______________
Rise ______________	Rise ______________
Descent ______________	Descent ______________
Echelon ______________	Echelon ______________

Meteorological conditions at the time of observation (fog, clouds, etc.)_____________________

____

____

An observed unidentified object or phenomenon: quantity _________

Specify if the phenomenon was observed above, below or inside the clouds?________________

Form ________________________________ Was there a change in shape? (Yes/No)_____

Color ________________________________ Was there a color change? (Yes/No)_____

Speed ________________________________ Was there a change in speed? (Yes/No)_____

Height ________________________________Was there a change in altitude? (Yes/No)_____

Direction _____________________________ Was there a change in direction? (Yes/No)_____

Were there any malfunctions in the operation of devices and equipment? (Yes/No)_____

If yes, please specify which ones: ____

And how did it manifest itself?____

____

If there is electronic data from onboard radars at the time of observation, please provide it!

Radar type ____

If you want to make a sketch or describe the observation in more detail, do it on a separate sheet, and if you have a photo or video, you need to provide a copy of the original with EXIF!

Specify the camera type ____

Focal length _________________________ Was a diaphragm used? (Yes/No)______

What filters were used? ________________ Was shutter speed used? (Yes/No)______

Have you reported your observation to the appropriate authorities? (Yes/No)______

If yes, then where exactly? ____

Please specify the date and time of the message __.__.20__ - __:__

Do you know of any other observers of this phenomenon? (Yes/No) ______

If yes, please indicate how to contact them: _____________________________________

What do you think about the observed object or phenomenon? What could it be? ______________

____

____

…………………………………………………………………………………………………...

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion ______________________________________

A1.13. Questionnaire on observation of an unidentified object or phenomenon

Form A-7

*No.*_________

Questionnaire on observation of an unidentified object or phenomenon

This questionnaire is filled in for the purpose of documenting the observation of an object or phenomenon that cannot be identified as a natural or man-made phenomenon. The questionnaire is filled in as completely as possible in block letters. If there is no information on any question, a dash is put in the corresponding cell. If the cell of the questionnaire is too small for a full answer, additional information can be given on separate sheets attached to the questionnaire, or on the back of the questionnaire. Be sure to indicate the number of the item that is being supplemented.

1.Data on the person who observed the unidentified object or phenomenon (if there are several persons, then several questionnaires are filled out))

Last name_________________________ Name _________________________

Date, month, year of birth _________________ Occupation _________________

Postal address ____

____

Mobile phone_________________________ Email _________________________

Were there other eyewitnesses who observed this object or phenomenon? (Yes/No)________

If it is not too much trouble, please indicate how to contact them _______________________

____

____

2.Observation details

If necessary, the entire story, as fully as possible, as well as the drawings for it, can be presented on a separate blank sheet!

Date of observation *accurate*:____.____._y., *approximate*_____*season*_.______y.

Where exactly were you at the time of the observation (specify location)?____________________

____

Area of manifestation according to eyewitness_______________________________

____

If you were moving at the time of observation, please indicate the approximate speed of movement, direction, and whether there were any stops__________________________________

____

____

Weather conditions:

Cloudiness	Clear sky		Light clouds		Cloudy		Sky is overcast	
Temperature	Cold		Freshly		Warm		Hot	
Wind	No wind		Light breeze		Moderate		Strong	
Precipitation	Dry		Fog		Rain		Snow	
In the sky	Stars		Moon		Planets		Sun	

3.Technical characteristics of surveillance

An observed unidentified object or phenomenon: Number of phenomena or objects ______________

Form ____________________________ Was there a change in shape? (Yes/No)_____

Color ____________________________ Was there a color change? (Yes/No)_____

Noise ____________________________Scent ____________________________

Lighting effects and their color______________________________________

Observation start time __:__ Did you see the appearance of an object or phenomenon? (Yes/No)_____

End time of observation __:__ Did you see the end of the manifestation? (Yes/No)_____

Describe whether visibility was good in the observation area (indicate what limited the view, or for example, you were indoors) ______________________________________

____

____

____

Did the object or phenomenon visually intersect atmospheric or terrestrial objects, if so, how ____________

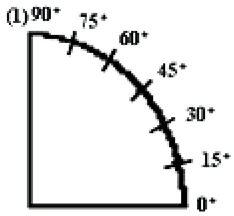
____

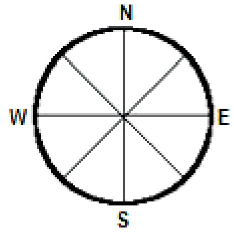
____

The nature of the movement of phenomena or objects:

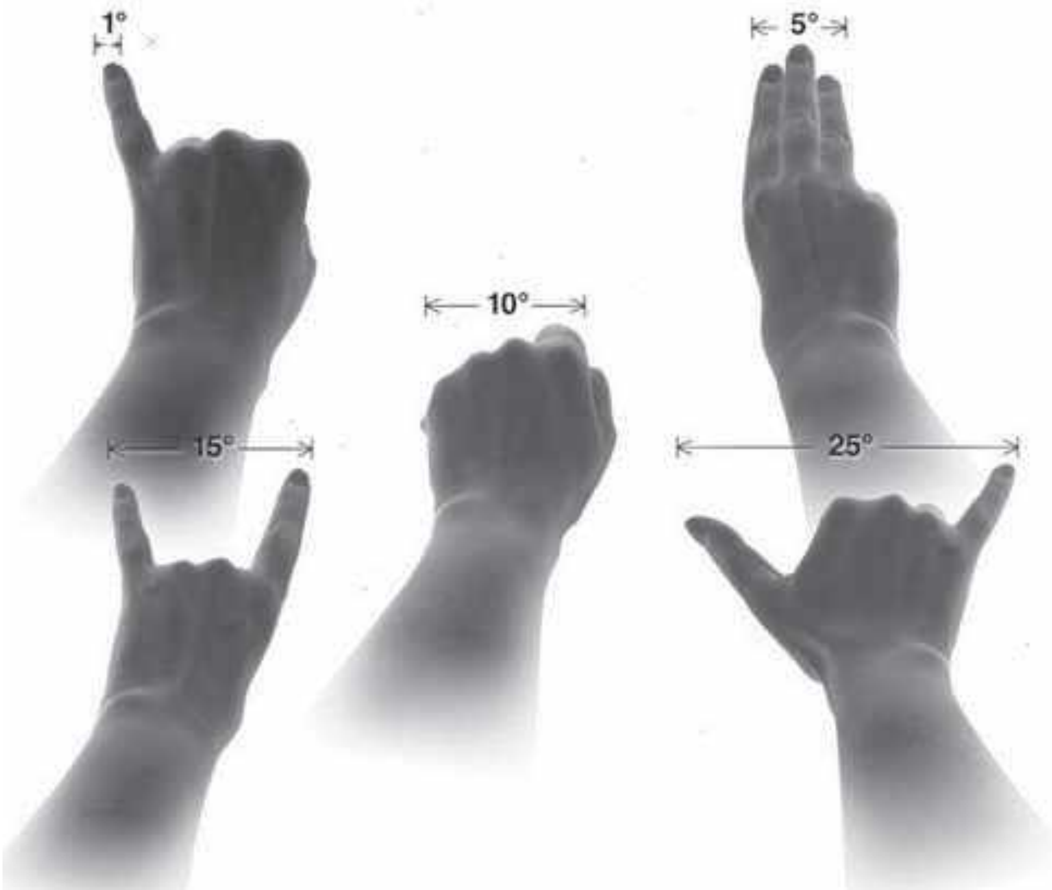
Trajectory		***Speed***	
Horizontal		Permanent	
Vertical		Slowdown	
Diagonal		Acceleration	
Arc-shaped		Hung	
Chaotic		Variable	

Trajectory:
Put the letter "A" on the diagram (1), indicating the height of the object(s) or phenomenon above the horizon at the beginning of the observation and "B" - at the end of the observation. Similarly, mark with the letter "A" on the outer circle of the compass (2) the direction in which you saw the objects at the beginning, and "B" - at the end of the observation.





If this seems difficult, please indicate the location relative to objects known to you, the approximate height, or indicate the direction with arrows.
Size:
If objects were held in an outstretched hand, which of them would have the same apparent size?



The angular size of a phenomenon or object ______° or indicate in comparison with the Moon or other objects
____
If it is possible to specify the linear (diametrical) size, please specify it ____________________________
If you want to make a sketch or describe the observation in more detail, do it on a separate sheet, and if you have a photo or video, you need to provide a copy of the original with EXIF!
Specify the camera type ____
Focal length __________________________ Was a diaphragm used? (Yes/No)______
What filters were used? ________________ Was shutter speed used? (Yes/No)______
Time of day: morning__, afternoon__, evening__, night__. The camera was on a tripod (Yes/No)_______
4. Material impact: (if you don't want to, you can skip it)
If you saw an object or phenomenon low above the ground, indicate the approximate height of the hovering above the ground from __m to __m. If you noticed any material traces after the disappearance of the phenomenon at the place of its appearance low above the surface, describe this __________________________
____
____
____
____

If you notice unusual effects in the behavior of people, animals, electrical appliances, or other surrounding objects, describe it____
____
____

Did the object or phenomenon have an impact on you or other eyewitnesses, and if so, what was it? ________
____
____

Are there any traces of the impact of an object or phenomenon on your body? _________________________
____

What was your psychological state at the time of observation? _____________________________________

5. Eyewitness opinion (if you don't want to, you can skip this)

How did you become aware of the presence of an object or phenomenon? ____________________________
____

What were you doing when you started your observation? ____
____

What made you stop watching? ____
____

Had you had any interest in similar phenomena prior to your observation? If so, what kind? How strong?
____

Has your opinion changed after observing? If so, how would you formulate it today? ____________________
____

Who were the first people you told about what you saw? What was the reaction of the listeners to your story?____
____

What do you think about the observed object or phenomenon? What could it be? _______________________
____

6. Supplement

Describe the observation in more detail. ____
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……...

By filling out this form, do you want the data from the form to be confidential or public?

Confidential __ Public __ Date of completion ____

A1.14. Request for information on observation of an unidentified object or phenomenon

Form R-1

______________________________   *Name*   ____   *Postal address*

Dear ____

We have learned that you have observed an unidentified object or phenomenon. In order to determine its nature and characteristics, please fill out a questionnaire about your observation.

Send the completed form to the address ________________________________

____

Thank you in advance for the material you have submitted. We assure you that your message is of scientific interest and will be carefully studied in a proper manner. We hope to cooperate with you in the future.

Sincerely ____

____
(Full name)

A1.15. Response to receiving information about observation of an unidentified object or phenomenon

Form R-2

______________________________   *Name*   ____   *Postal address*

Dear ____

Your observation report __.__.20__y we received.

We thank you for the material provided and forward your message to the experts. Wait for a response. We hope to cooperate with you in the future.

Sincerely ____

____
(Full name)

A1.16. Response after analyzing information about the observation of an unidentified object or phenomenon

Form R-3

______________________________   *Name*   ____   *Postal address*

Dear ____

We have identified the unidentified object or phenomenon you observed, the results of which are as follows:

____

____

____

____

We look forward to working with you in the future.

Attached files with case analysis ____

Sincerely ____

____
(Full name)

A1.17. Approval of the topics of scientific research

Form T-1

____

Name

____

Postal address

Topic name:	
Code, type	
Submitter:	
Rank, status:	
Target department:	
Theme task:	
Supervisor:	
Relevance of the topic, justification for publication:	
Connection of the topic with other scientific topics:	
Research tasks to be solved:	
Object of research:	
Subject of research:	
Research methods:	
Expected scientific novelty of the research:	
Expected practical usefulness of the results:	
Time frame and work plan:	
Required resources and their sources:	
Involved departments, employees:	

Coordination: The decision was made at meeting No.____ dated "__"__________________20__

Supervisor ________________________ ____________

Deputy ____ ____________

P.S.

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Appendix 2. Natural phenomena that may serve as a source of misinterpretation, as well as environmental impacts observed or recorded in connection with reports of UFO-related events.

A-2.I. Optical phenomena:

A-2.I.1. "Light pillars" and anti-crepuscular rays

Fig.A-2.1 "Light pillars" can be of any color scheme (CC/GFDL)

"Light pillars" are a visual atmospheric phenomenon that looks like a vertical strip of light extending from a source. This is a fairly common type of optical phenomenon, the cause of which are hexagonal flat or ice needle-shaped crystals, with almost horizontal flat parallel surfaces from which the light is reflected. And in lower layers of the atmosphere, such crystals are formed due to low temperatures of -10º and below. Sometimes these ice needles fall from different types of cirrus clouds, which allows us to observe a similar phenomenon at higher temperatures.

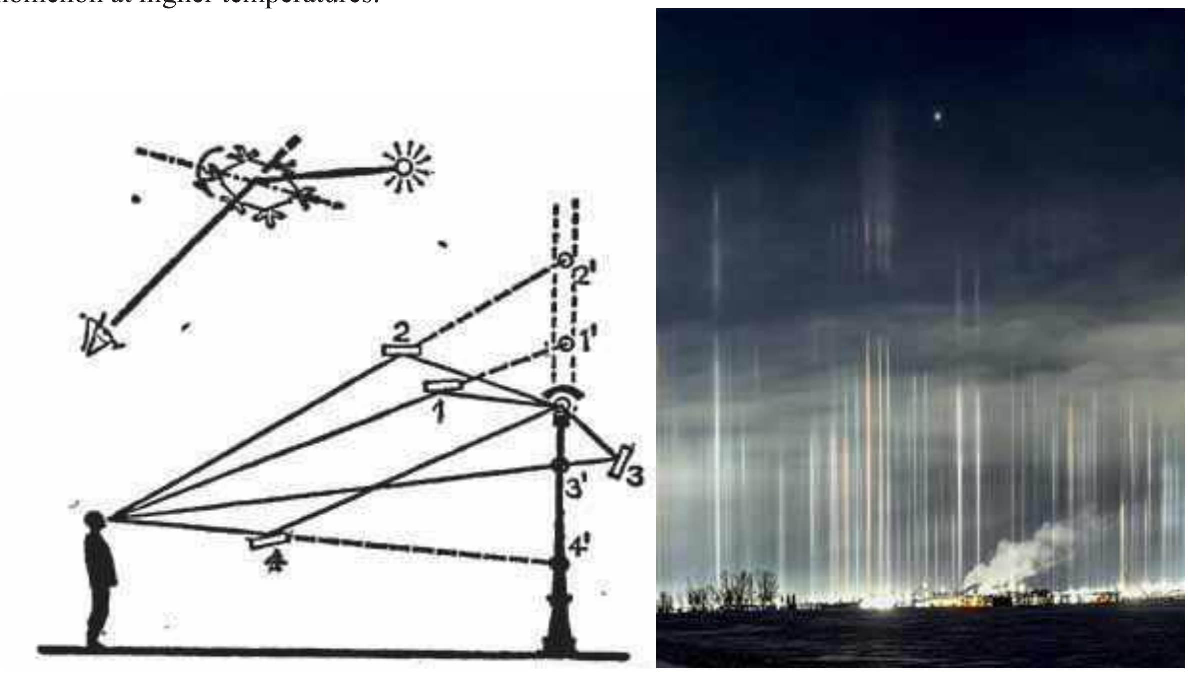

Fig.A-2.2 Formation of "light pillars" (CC/GFDL)

During the dark hours of the day, reflections from artificial light sources such as street lamps and other stationary lighting can occur during the winter months. These reflections occur as a result of the light being scattered in the atmosphere and reflected off ice crystals. These reflections then resemble an extended pillar of light. The requirement for them to occur is that there are horizontally oriented ice crystals in the atmosphere, and that the wind is still. The pillar of light occurs in the same shade as the light source that causes the reflection and it is not uncommon for several pillars of light to be seen over the same area, creating a dramatic sight. Sometimes the pillar of light can be expanded like a funnel at the top, but they can also be extended in a completely straight line.

Fig.A-2.3 More examples of "light pillars" (D. Calio, CC/GFDL)

If a low-lying sun illuminates the horizontal ice crystals, the sunlight can be reflected and a vertically extended pillar of light of the same shade as the low-lying sun can then be seen in the direction of the sun. The phenomenon is then called a vertical pillar.

Fig.A-2.4 Crepuscular rays are not "light pillars" (CC/GFDL, L. Cowley)

Fig.A-2.5 Anti-crepuscular rays are also not "light pillars" (CC/GFDL)

Fig.A-2.6 Tyndall effect (CC/GFDL)

Tyndall effect - light scattering when a light beam passes through an optically inhomogeneous medium.

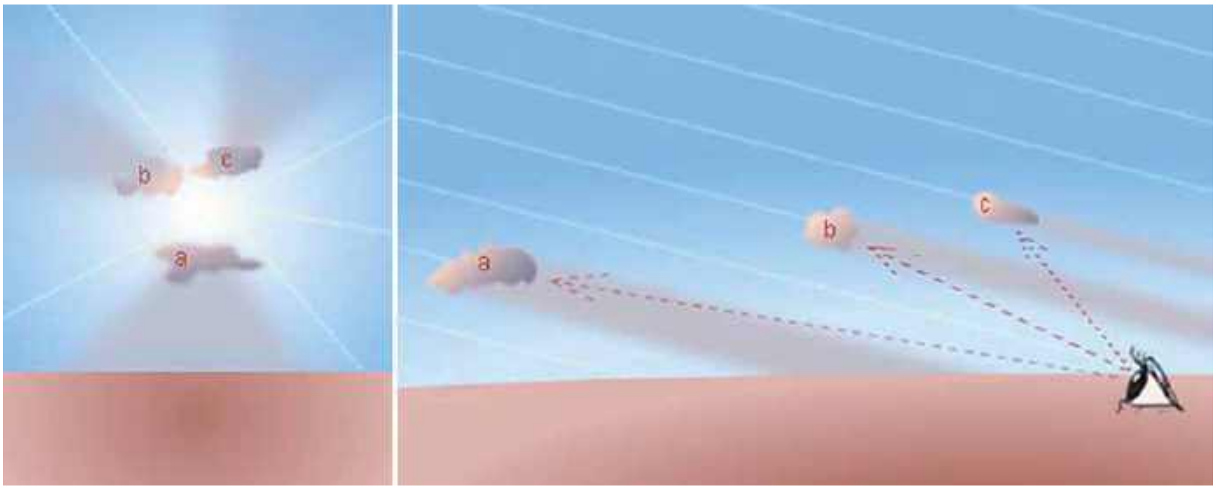

Fig.A-2.7 Formation of crepuscular rays (L. Cowley)

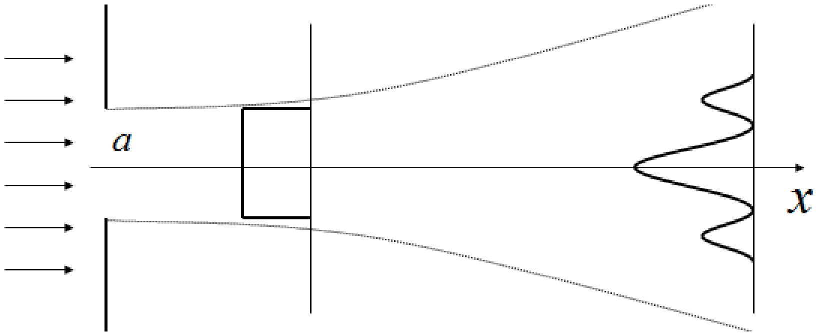

Fig.A-2.8 Fresnel parameter (Kurin V.V. IPM RAS)

Fresnel parameter $F = \frac{x\lambda}{a^2}$ (A-2.1)

Where: F<<1 – geometric optics region, F>>1 – Fraunhofer diffraction region, F≥1 – Fresnel diffraction region.

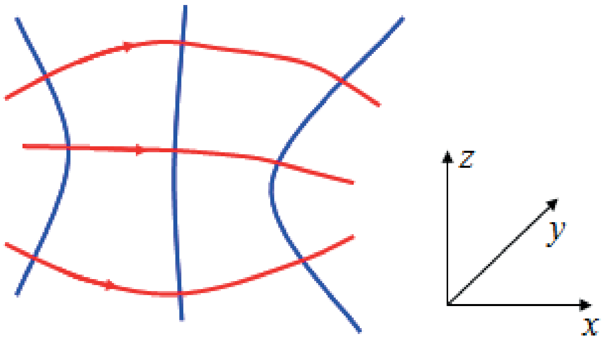

Fig.A-2.9 Rays – normals to Fresnel wave fronts (Kurin V.V. IPM RAS)

The relationship between the wave and geometric picture

- wave $\cos[\omega t - \varphi(x, y, z)]$ (A-2.2)
- phase $\omega t - \varphi(x, y, z)$ (A-2.3)
- wave front-surface $\varphi(x, y, z) = const$ (A-2.4)

Fig.A-2.10 Mountain shadow and cloud shadow (Dale Ireland)

Fig.A-2.11 Earth's Shadow (M. Riikonen, L. Cowley)

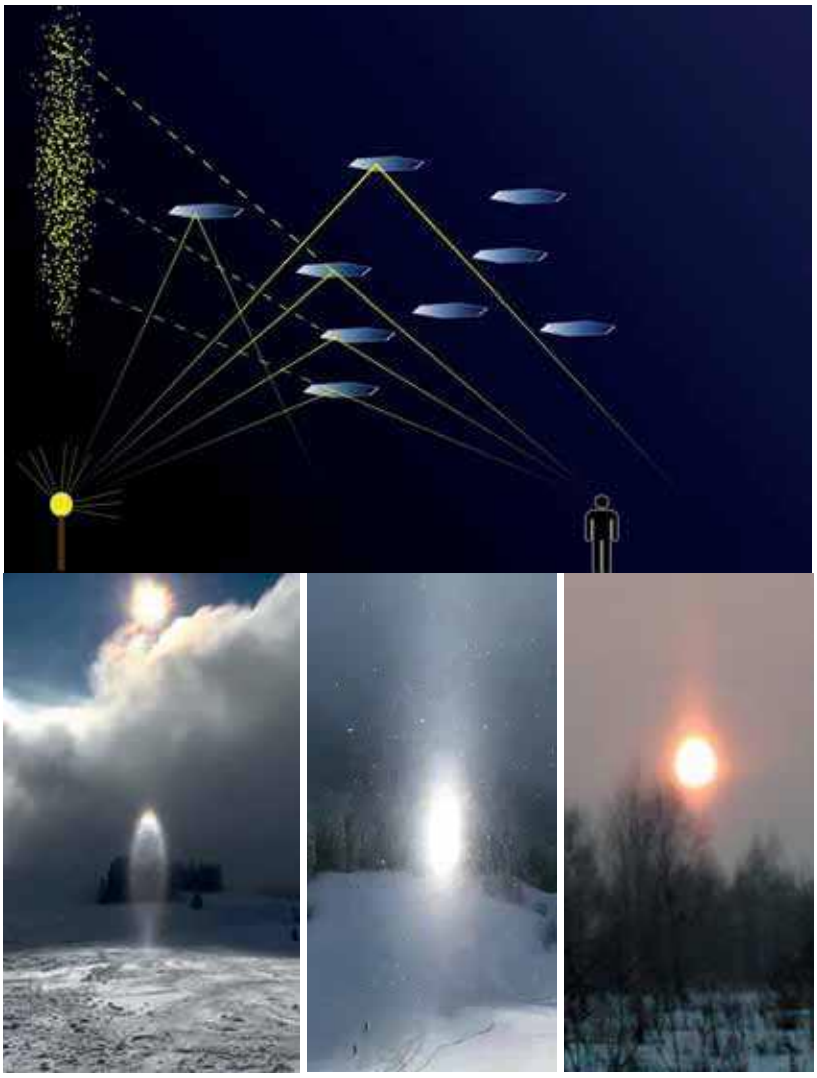

Fig.A-2.12 "Light Oval" (CC/GFDL)

A-2.I.2. Parhelium, Antihelium, Diffraction

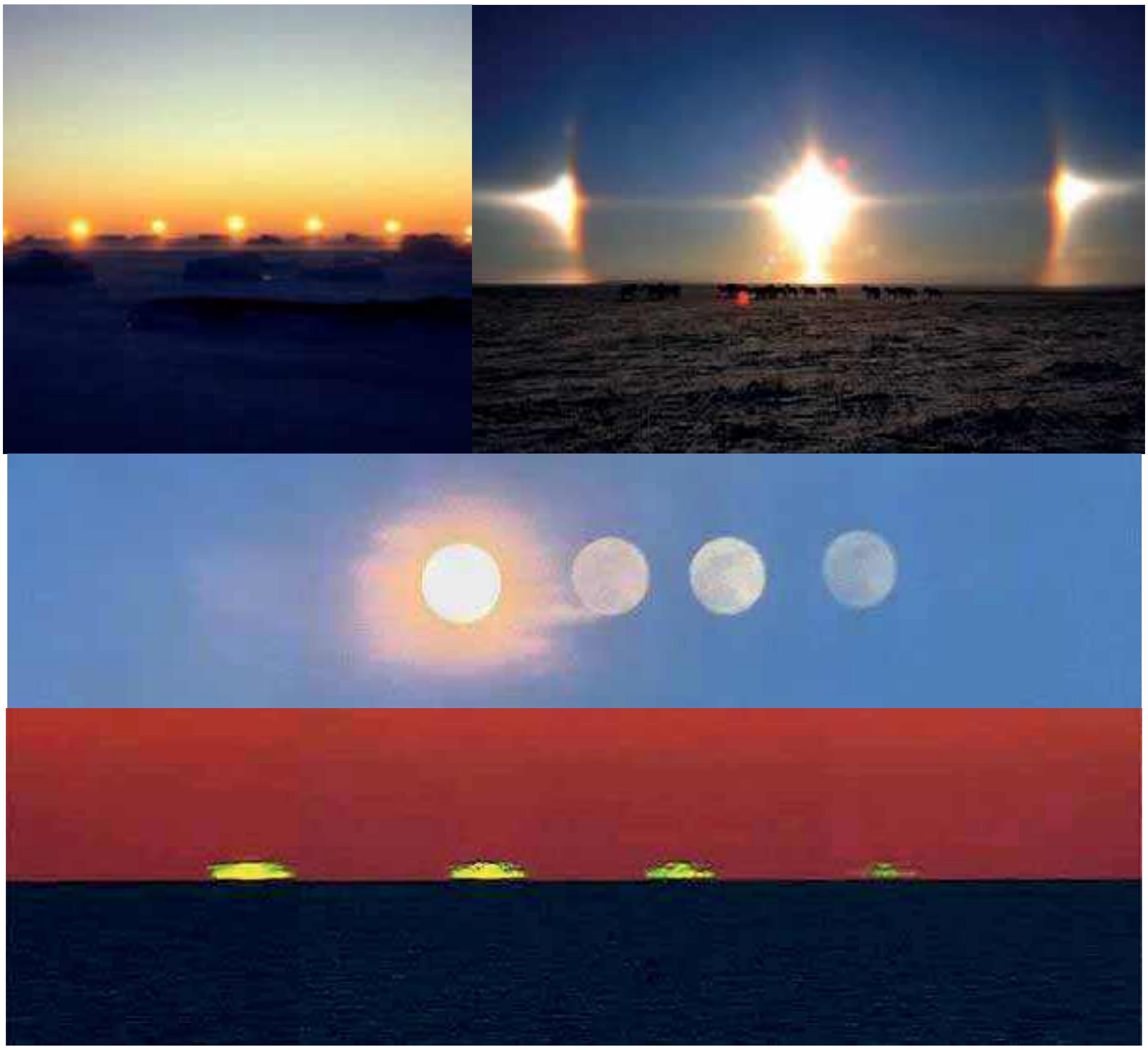

Fig.A-2.13 Antihelium (photo 1 and 4) and Parhelium (only in photo 2), Antiselene (photo 3) (CC/GFDL)

Parhelium (false sun) or Parselena (false moon) is also one of the types of optical phenomena (halo), which arises due to the refraction of light from a source in anisotropically oriented ice crystals (with unequal properties) floating in the atmosphere.

In the case of Antihelium, the "second Sun" appears at the same height above the horizon as the real one, but in the opposite region of the sky. The appearance of Antihelium is caused by internal reflection and refraction of light in a suspension of tiny ice crystals in the atmosphere.

Parhelium (also called sun dogs) are a phenomenon observed in certain weather situations as a colored intense spot of light on either side of the sun and at the same height above the horizon as the sun. These intense luminous figures in the sky give the impression of being suns and are located 22 degrees apart on either side of the real sun. When this phenomenon occurs and the moon is the main object, it is called a double moon (weather moon). A double moon appears in the same way as a Parhelium and the only difference between these two phenomena is that the moon has taken the place of the sun.

Often Parhelium are colored like a rainbow while double moons are whiter. Parhelium appear when a large number of ice crystals fall in such a special way that the base surface of the crystals becomes horizontal and the side surfaces become vertical. Under these special circumstances, the ice crystals do not form a complete halo ring, but the light is only reflected from the part of the halo that is located to the side of the sun at the same height and then, for reasons of symmetry, a Parhelium arises on each side of the sun.

Fig.A-2.14 Parselene is the same effect (CC/GFDL)

The more horizontally located crystals there are, the sharper the light spots become and these can become very bright and sometimes almost "as big as the sun", these parhelia are reddish towards the sun. Sometimes no distinct bisol occurs but only a certain increase in intensity at the location of the bisol and when these light intensities are above or below the sun, the term vertical parhelia is usually used. When sunlight hits ice crystals in clouds or fog, many types of light phenomena occur, these phenomena are collectively called halo phenomena. These halo phenomena are an optical phenomenon in the atmosphere that can be observed as colored or white rings, arcs, surfaces and spots of light in the sky in certain weather situations (the light source is usually the sun or the moon). A light beam passing through an ice crystal is deflected from the original beam direction.

This deflection (deviation) is determined by how the beam strikes the crystal. The moon gives rise to the same halo phenomenon as the sun, but the moon's halos are usually so faint that they are not visible during a full moon.

An effect similar to a parhelion, only here instead of ice crystals there is fog. One of the types of halo.

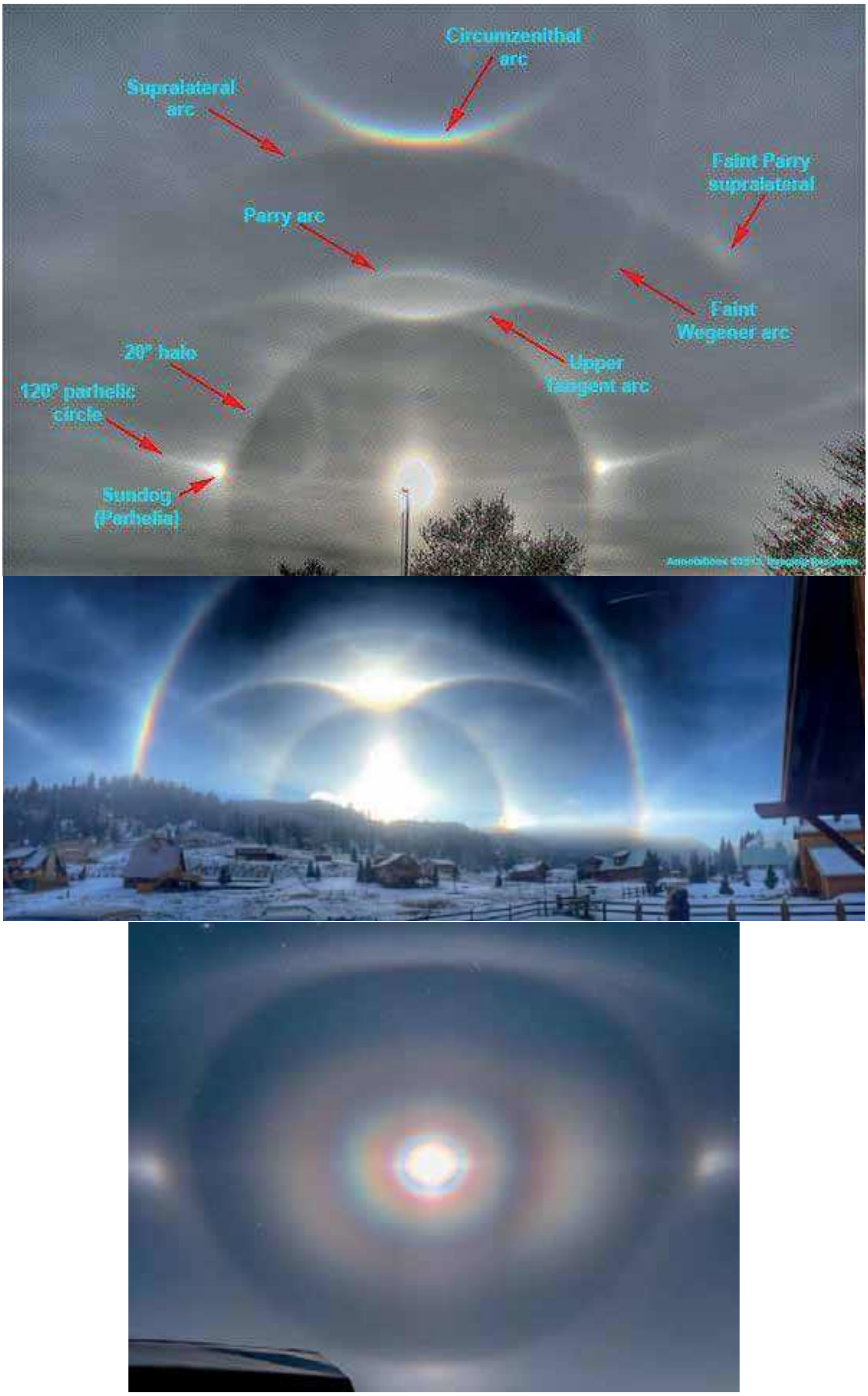

Fig.A-2.15 Types of parhelia (CC/GFDL, B. McKean)

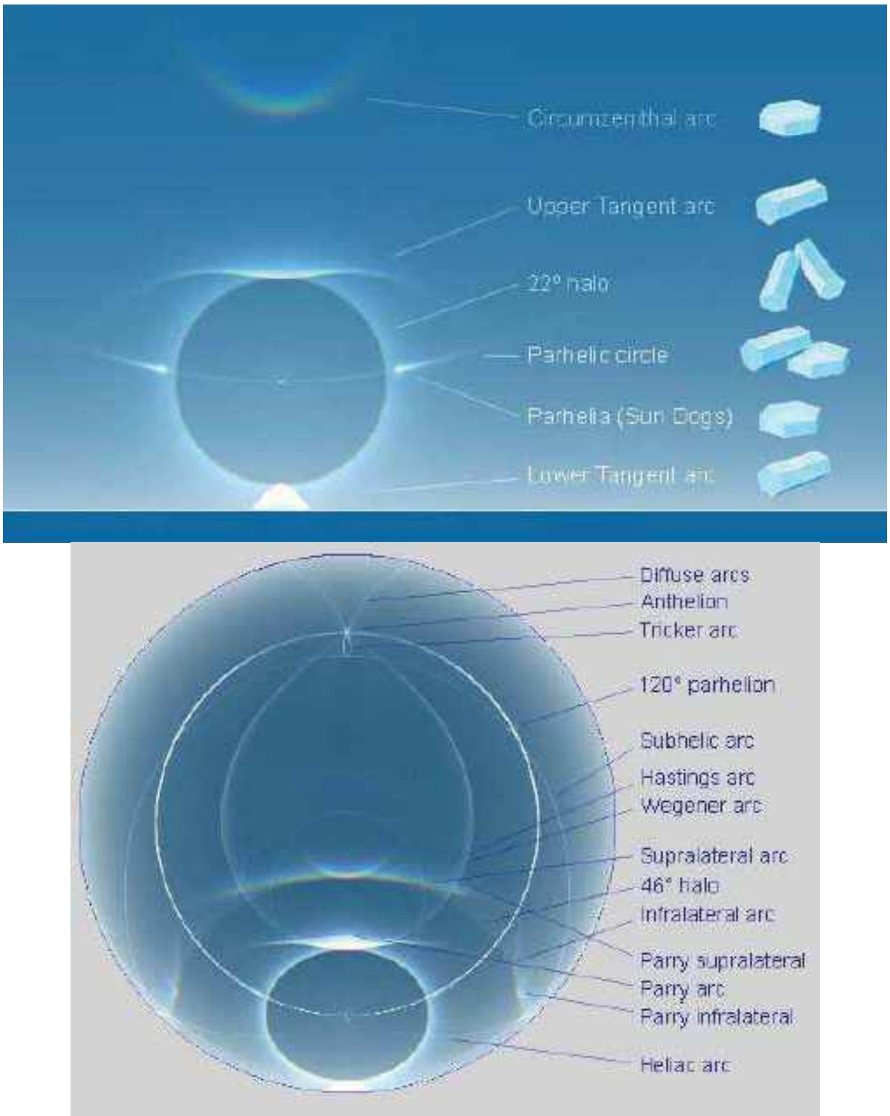

Fig.A-2.16 Dependence on the shape of crystals (L. Cowley)

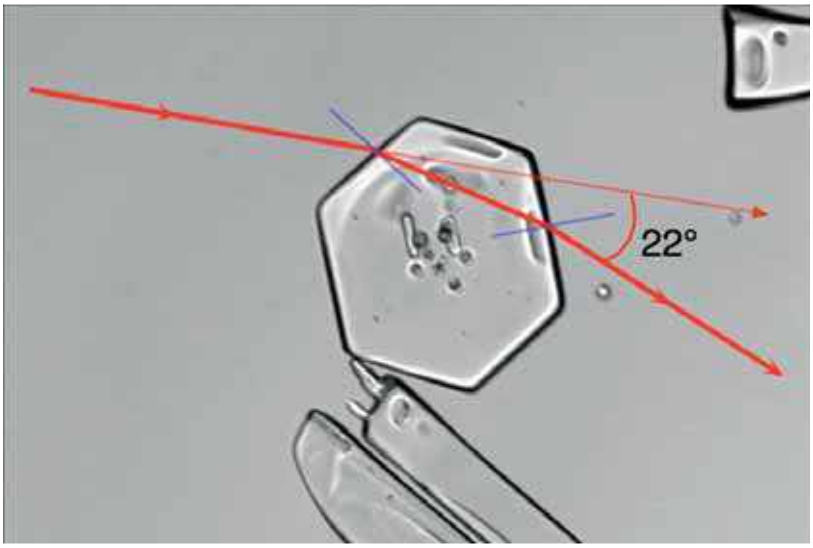

Fig.A-2.17 Refraction of light on ice crystals (CC/GFDL)

A-2.I.3. Round-horizontal arc

Fig.A-2.18 Circular horizontal arc (CC/GFDL)

A fire rainbow or a circular horizontal arc is a rare optical effect in the atmosphere, it looks like a horizontal rainbow appears on high-lying cirrus clouds. For the effect to occur, the Sun must be higher than 58º above the horizon, cirrus clouds must be present, and flat hexagonal ice crystals must be horizontal. The rays of the sun pass through the flat side walls of the hexagonal crystals and exit from the lower horizontal side, which ensures spectral separation of colors. In polar zones, they are observed only from the mountains, in other zones, they can be observed from the valley.

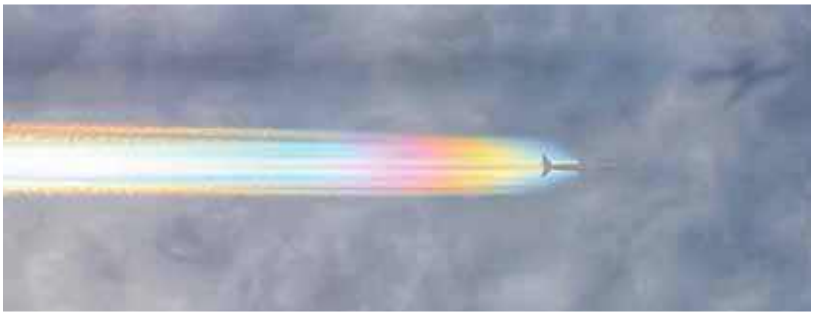

Fig.A-2.19 Bright Iridescence (CC/GFDL)

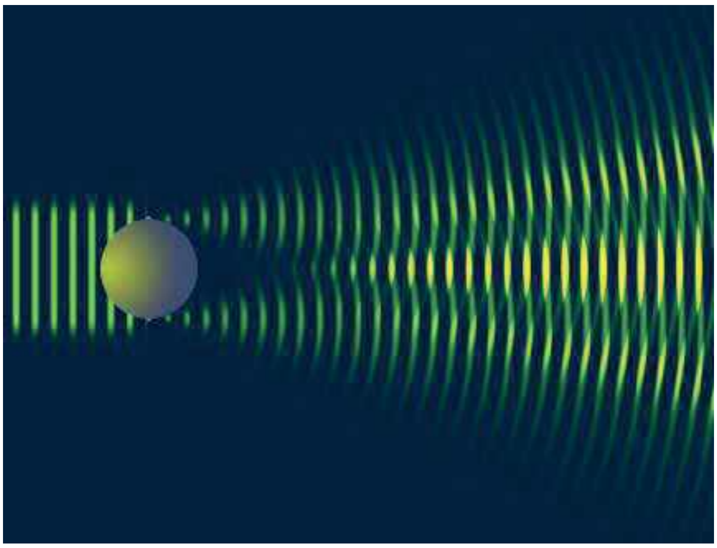

Fig.A-2.20 Formation of the wave front corona (L. Cowley)

Fig.A-2.21 Dependence on droplet size (L. Cowley)

A-2.I.4. Gloria and the Misty Rainbow

Fig.A-2.22 Foggy Crown (CC/GFDL, C. Cogan)

Examples of the corona phenomenon an optical effect caused by the diffraction of sunlight or moonlight.

Fig.A-2.23 Brocken Harz Ghost (Atmospheric Optics)

The phenomenon of refraction of light (diffraction), which has already been reflected, and returns in the same direction to the observer, often observed on clouds or fog of varying density, located directly opposite the light source. The nature of the phenomenon is very similar to a rainbow, when many water droplets are illuminated. Gloria is also called the "Brocken-Harz ghost" which can fluctuate depending on the density in the cloud

Fig.A-2.24 Foggy rainbow (CC/GFDL)

It occurs as a result of scattering and refraction of light in water mist (droplets less than 25 microns in radius). And the inner side of the rainbow can sometimes be purple, and the outer side - orange.

$$\Delta\varphi \approx \lambda / D \qquad \text{(A-2.5)}$$

Diffraction divergence is close to the division of the light wave by the beam diameter (measured in radians). Thus, due to the refraction and dispersion of light in the fog, the division of light into components of different colors occurs, then due to diffraction, the reverse process occurs - the combination of light beams of different colors into white.

Fig.A-2.25 Rainbow Sun (CC/GFDL)

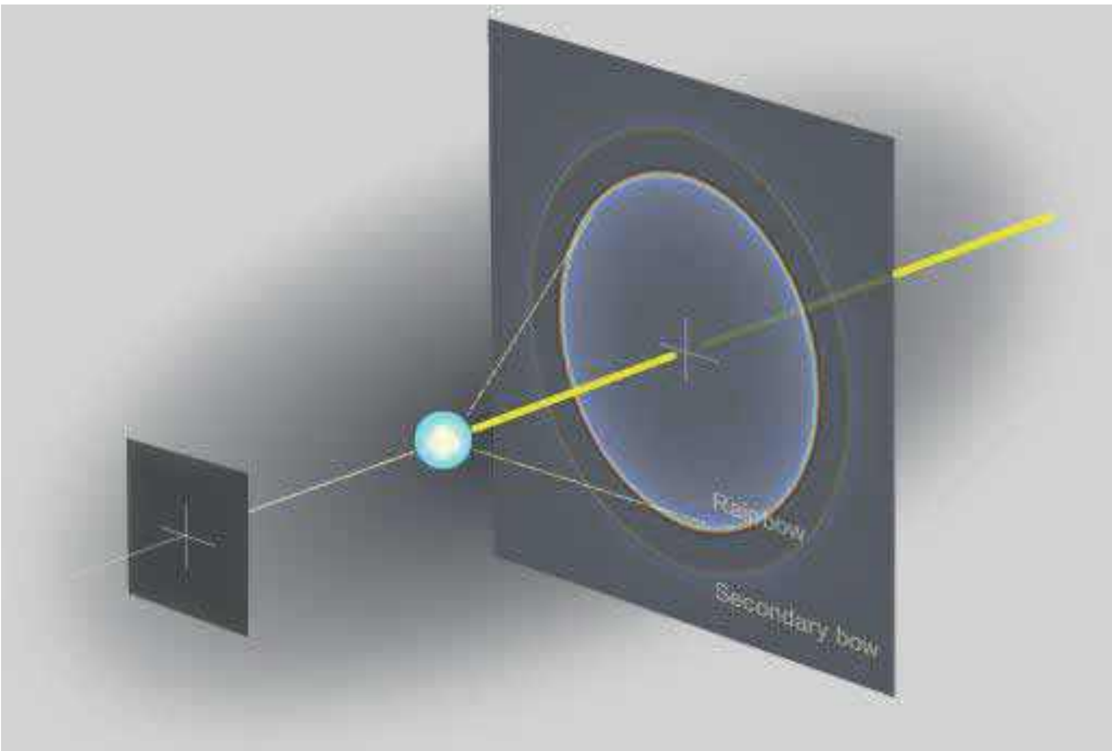

Fig.A-2.26 Diffraction of light on large drops a=1mm (L. Cowley)

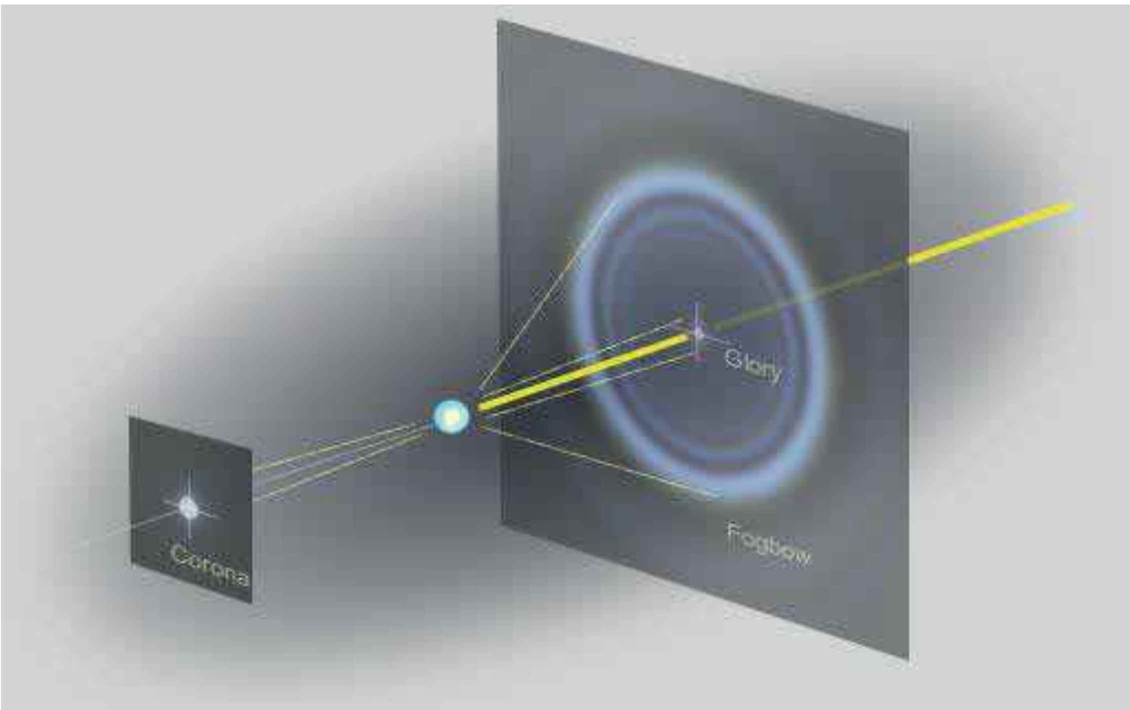

Fig.A-2.27 Diffraction of light on small drops a=20μm (L. Cowley)

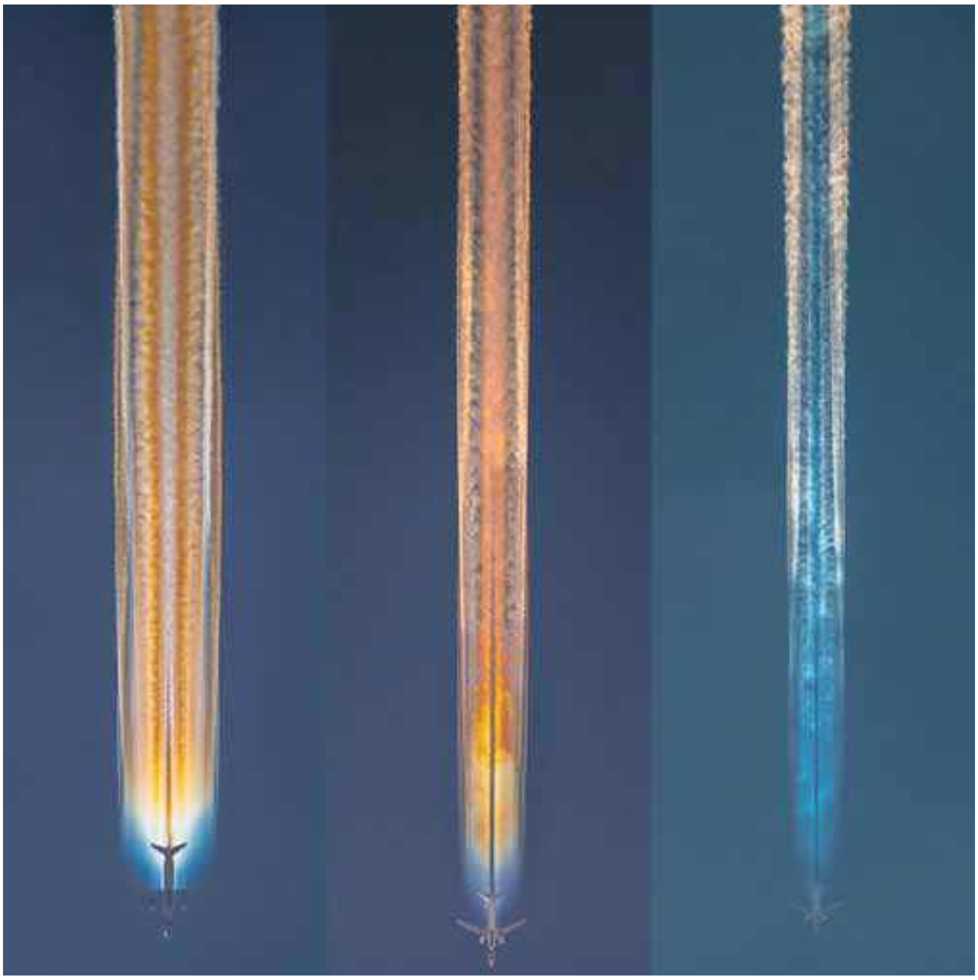

Fig.A-2.28 Rainbow inversion train (S. Mukherjee)

Condensation contrails are the trails left by aircraft at high altitudes. There are no dust particles in the upper atmosphere, and even when the temperature is below the dew point, atmospheric moisture remains in a gaseous state. The flight of an aircraft causes the appearance of a large number of condensation centers, and the existing moisture condenses on them instantly. Supporters of conspiracy theories, on the other hand, believe that these trails are evidence that civil aviation is being used by the authorities to secretly distribute harmful chemicals.

Fig.A-2.29 Rainbow and volcano (CC/GFDL)

A-2.I.5. Nacreous and Noctilucent Clouds

Fig.A-2.30 Water nacreous clouds (CC/GFDL)

Thin nacreous clouds often form at high altitudes of 20-30 km and consist of ice or supercooled water droplets. These phenomena are observed mainly before sunrise or after sunset; they are invisible during the day. Jet streams in the upper and middle troposphere encounter a mountain range as an obstacle, where waves are formed on the leeward side of the obstacle, which acquire a vertical component in their speed.

Gravity counteracts the forced rise of particles, and on the leeward side of the obstacle, on the contrary, it leads to the air descending down to the initial level of their state. Since vertical oscillations of particles occur under conditions of horizontal transfer, these oscillations acquire a wave character.

Conditions of occurrence: increase in wind speed when gaining altitude, wind direction no more than 30º to the mountain ridge line, strong winds at relatively low altitudes in a stable atmosphere, wind speed of at least 10 m/s. Conditions for occurrence are especially favorable in polar zones, where the height of the troposphere does not exceed 7-8 km. The top of the wave, therefore, ends up in the stratosphere, which creates favorable conditions for the formation of nacreous clouds in the stratosphere.

The clouds consist partly of water or ice particles but also of sulfuric acid and nitric acid. The clouds are usually seen when a cold front has passed and the air is clean in the lower layers of the air. These clouds iridescent in magnificent pearlescent colors and shine for several hours after sunset. Since the clouds consist of many small particles that are of approximately the same size, the light is scattered in a similar way for each wavelength (color shade). This results in a color separation, so-called iridescence, which makes the clouds shimmer beautifully like mother of pearl. If the clouds instead form under other conditions when the droplets are not the same size, the color separation does not occur and the clouds then take on the more typical white shade.

Fig.A-2.31 Night luminous clouds (CC/GFDL, C. Andersson)

Noctilucent clouds are very rarefied clouds and appear in the mesosphere below the mesopause, at an altitude of 76-85 km and become visible in deep twilight. These phenomena are observed mainly in summer. There is no general theory of their origin, there are dozens of hypotheses. The noctilucent clouds are mainly visible from mid-May to mid-August in the Northern Hemisphere and most often at latitudes between 50 degrees and 65 degrees between midnight and 02. The clouds are only visible when the sun has sunk a bit below the horizon and the sky has become dark enough. The reason the clouds are luminous is because they are at such a high altitude and thus reflect sunlight.

A-2.I.6. Mirages

Fig.A-2.32 Upper and lower mirage, as well as their alternation (CC/GFDL, A. Young A. & E. Frappa.)

Mirages arise as a result of reflection (refraction) of light by the boundary between sharply distinguishable layers of air in density. For an eyewitness, such a reflection consists in the fact that together with the distant object, its virtual image is also visible, shifted relatively.

Mirages are:

1. with two images: lower (inverted image under the direct image), and upper image (inverted above the direct).
2. with three images (inverted image between two direct).
3. fata morgana (alternation of distorted direct and inverted images)

Inferior mirages are observed with a very sharp difference in temperature at altitude and above a smooth, overheated surface, which in the distance seems damp. And the upper mirage is observed above a cold surface, with a decrease in temperature in the atmosphere. Upper mirages are rare, but also more stable, since cold air does not tend to move up, and warm air down. A superior mirage can be either upright or inverted, depending on the distance to the true object and the temperature gradient. Often the image appears as a fragmentary mosaic of upright and inverted parts. Superior mirages can have a striking effect due to the curvature of the Earth. If the curvature of the rays is approximately the same as the curvature of the Earth, the rays of light can travel great distances, causing the observer to see objects far beyond the horizon. A lateral mirage is a reflection from a heated vertical wall.

Fata Morgana – is a combination of several forms of mirages, when some objects are visible multiple times and with various distortions. Fata Morgana occurs when, due to temperature differences, several layers of air of different densities are formed in the lower layers of the atmosphere, which alternate and are capable of giving mirror reflections. As a result of reflection, as well as refraction of rays, real objects are displayed on the horizon or above it as several distorted images, partially overlapping each other and quickly changing over time, which creates this bizarre picture of a fata Morgana.

Fig.A-2.33 Increasing the size of the mirage. (CC/GFDL)

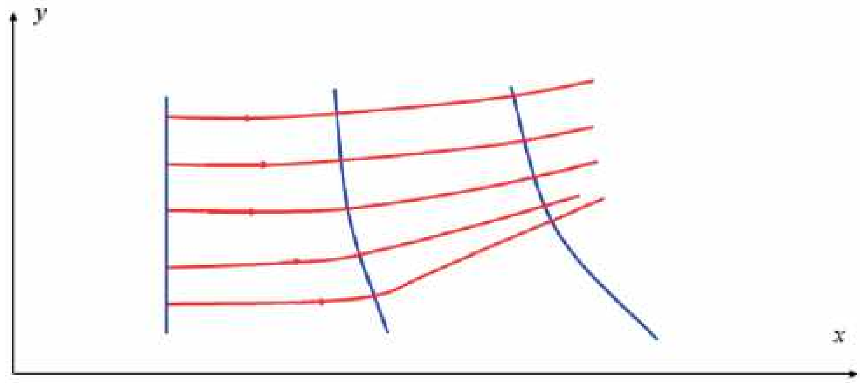

Fig.A-2.34 Phenomenon caused by refraction of light by a non-uniformly heated atmosphere (V. Kurin IPM RAS)

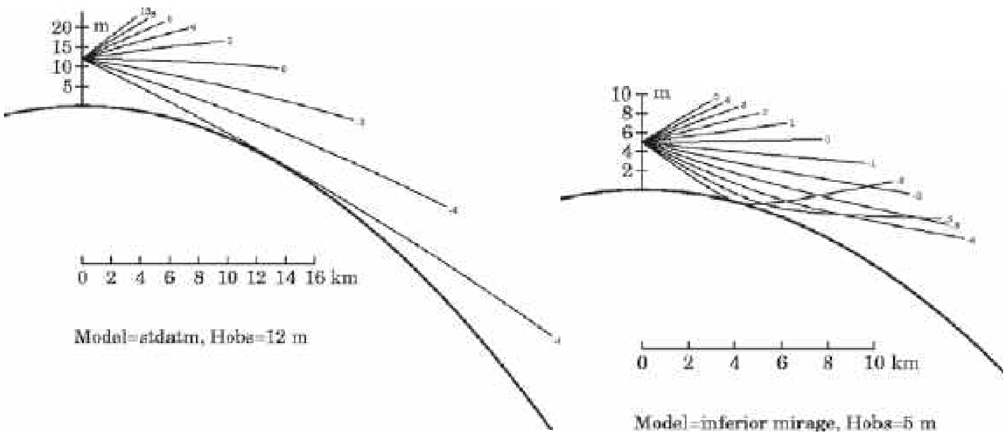

Fig.A-2.35 The course of the best with mirages (V. Kurin IPM RAS)

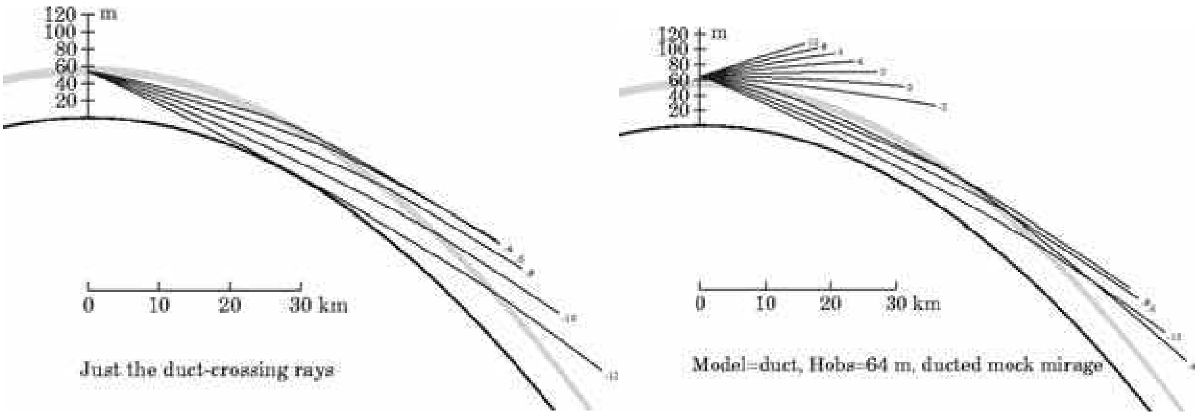

Fig.A-2.36 Ray path in the presence of an inversion layer (V. Kurin IPM RAS)

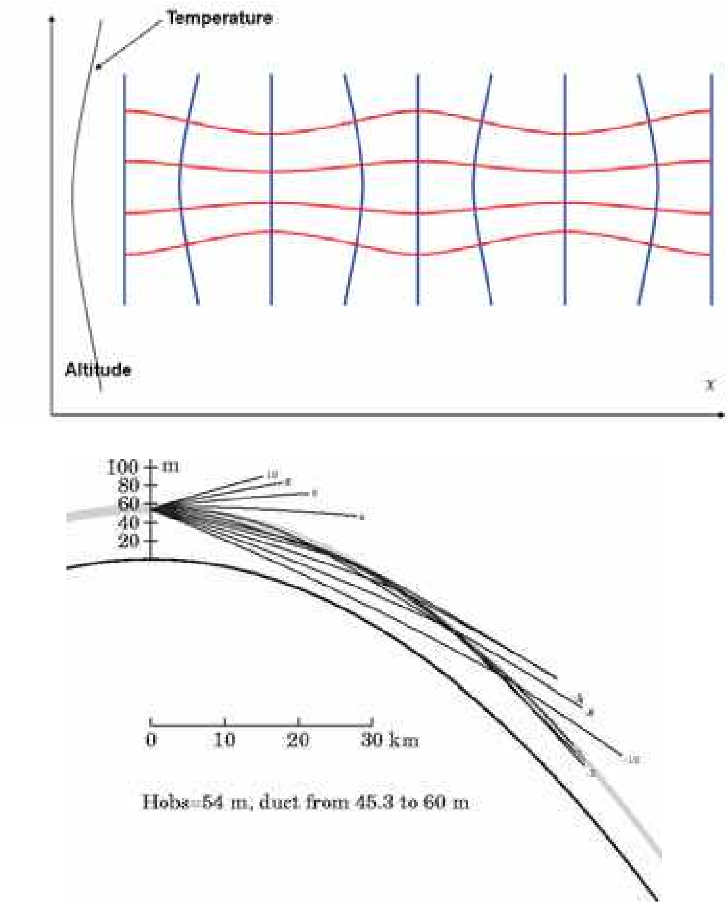

Fig.A-2.37 Optical atmospheric waveguide (V. Kurin IPM RAS)

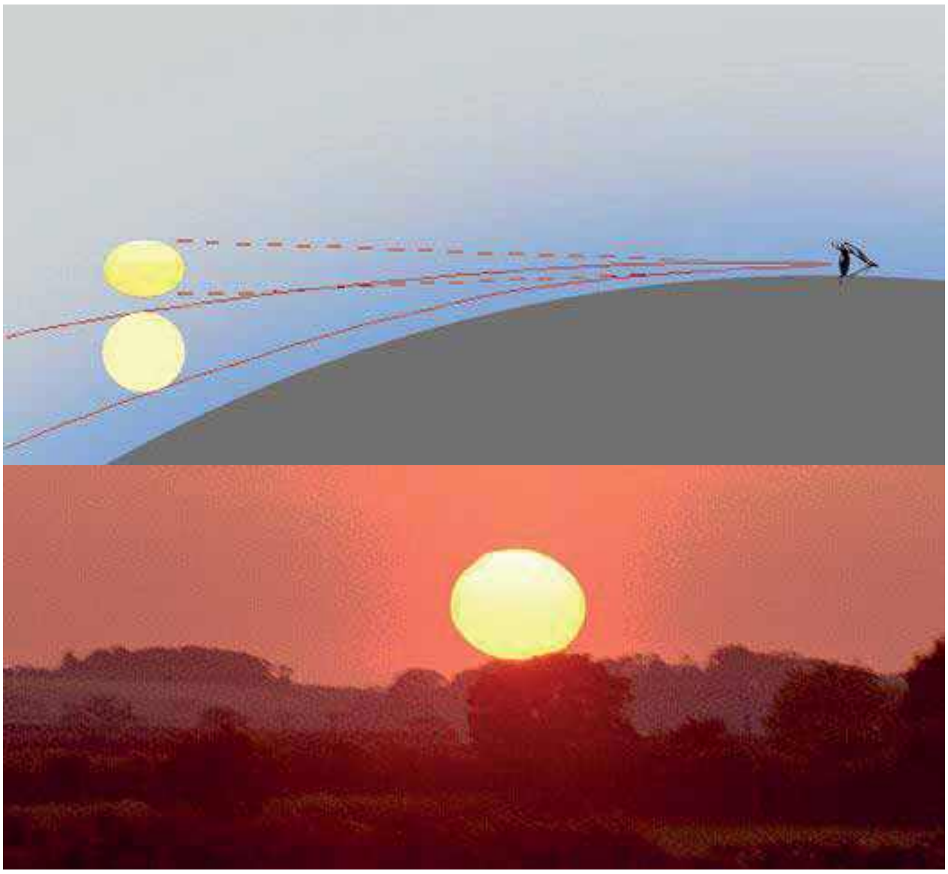

Fig.A-2.38 Flattened sun - superior mirage (L. Cowley, CC/GFDL)

Fig.A-2.39 Colors of the Moon and mirage (M.G. Pace, P. Horálek, CC/GFDL)

Fig.A-2.40 Mirage during a solar eclipse (CC/CFDL, Matuutex)

Fig.A-2.41 Double sunset (CC/GFDL)

Fig.A-2.42 Red Sun in a cloud of smoke – not to be confused with mirages (CC/GFDL)

Glow – is a reflections in the sky, orange, red or yellow at sunset.

Red sky at morning – the glow of the sky before sunrise (morning dawn) and after sunset (evening dawn), caused by the reflection of the sun's rays from the upper layers of the atmosphere.

The refraction of solar rays is accompanied by a spectrum decomposition (dispersion), and the strength of the refraction itself depends on the length of the beam. This phenomenon can be observed at the moment of the disappearance or appearance of the solar disk due to a cloudless clear horizon. With exceptionally high air transparency, it can also be green-blue or even light blue. Red beam - is observed when the lower edge of the solar disk appears under a clearly formed edge of a cloud, which covers the rest of the disk.

Fig.A-2.43 Superior mirage of different shapes (CC/GFDL)

Fig.A-2.44 Green beam (CC/GFDL, M. Okiyama)

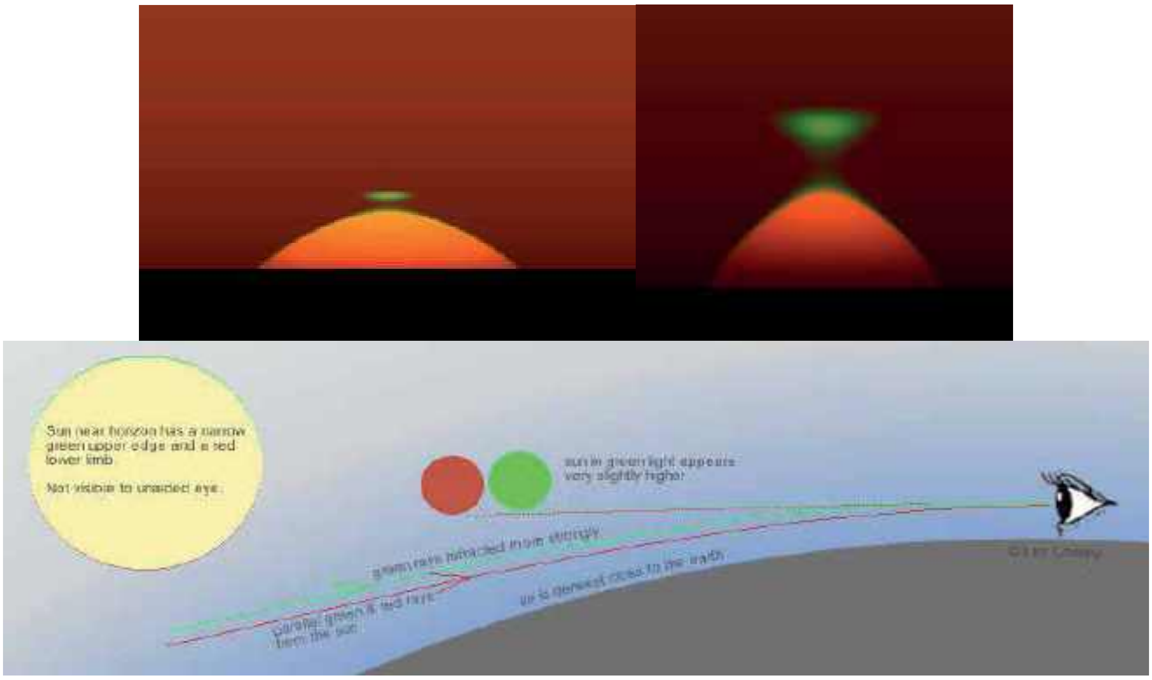

Fig.A-2.45 Sequence of formation of the "Green Ray" (L. Cowley)

Fig.A-2.46 Reflection of glow and dawn on a cloud (CC/GFDL)

Fig.A-2.47 Example of other optical phenomena (CC/GFDL, J. Grant)

There are a number of other, amazing and very rare little-studied natural phenomena that are not described in this reference book, due to the lack of photo or video recording of these phenomena, but only descriptions of what was seen by eyewitnesses. Some of them are recorded in the book "Handbook of Unusual Natural Phenomena" (Corliss, William R, 1986).

A-2.II. Convective phenomena

A-2.II.1. Lenticular clouds

When air flows over mountain ranges or around single mountains, so-called lenticular clouds can form. Lenticular clouds sometimes have a slightly saucer-shaped appearance and are probably the type of cloud that has been most associated with and mistaken for UFO phenomena. This type of cloud can form when the wind moves over a mountain or mountain range. On the leeward side of the mountains, the air moves in vertically spread waves. On the wave crests, the air can be cooled enough that the moisture condenses and clouds form. The shape of the cloud, which can therefore be somewhat lenticular, depends on the shape of the waves, which in turn depends on how the wind is affected by the mountains and on the distribution of moisture in the atmosphere.

Lenticular clouds (Cirrocumulus lenticularis) are formed between two layers of air or on the crests of air waves. A characteristic feature of these clouds is that they do not move, no matter how strong the wind is. The air flow rushing over the Earth's surface flows around obstacles, and in doing so forms air waves. Clouds usually hang on the leeward side of mountain ranges, behind ridges and individual peaks at an altitude of two to fifteen kilometers. In wave flows, there is a continuous process of condensation of water vapor when the dew point is reached and evaporation during the downward movement of air. Therefore, lenticular clouds do not change their position in space, but stand as if glued. The appearance of such clouds indicates that there are strong horizontal air flows in the atmosphere, forming waves over mountain obstacles, and that the air has a fairly high moisture content. This is due to the approach of an atmospheric front or the energetic transfer of air from remote areas.

Fig.A-2.48 Lenticular clouds (CC/GFDL)

Fig.A-2.49 Lenticular clouds (CC/GFDL)

A-2.II.2.Tubular clouds

Fig.A-2.50 Tubular clouds (CC/GFDL)

Mammatus clouds are a rare type of cloud found primarily in tropical latitudes. The clouds are a manifestation of the Rayleigh-Taylor instability

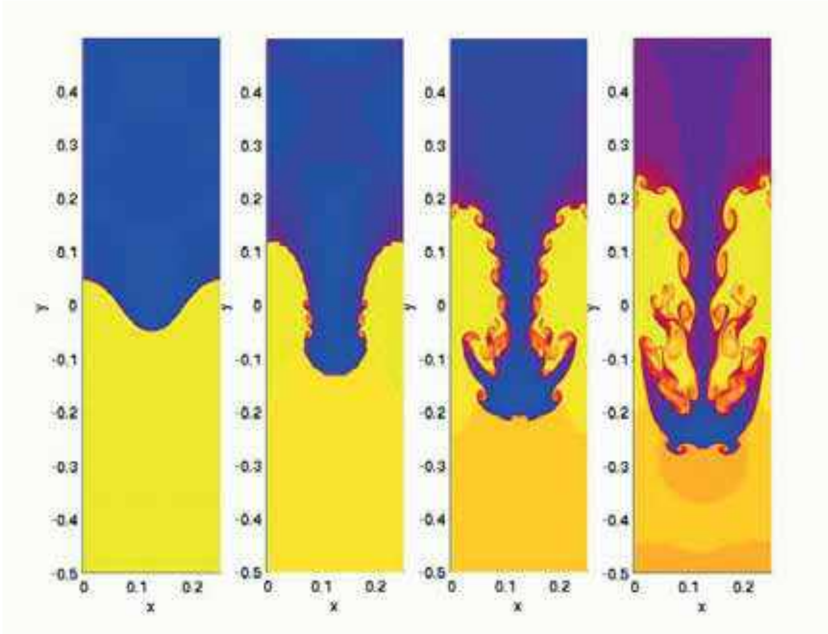

Fig.A-2.51 Development of Rayleigh-Taylor instability. (CC/GFDL)

A-2.II.3. Wavy-bumpy clouds

Fig.A-2.52 Wave-hummocky clouds (CC/GFDL)

Wave-bumpy clouds (Asperitas) have always been around, but they have only recently come to attention, and this type of cloud remains poorly understood. Despite their menacing appearance, these clouds are not accompanied by a hurricane or thunderstorm.

A-2.II.4. Thunderstorm collar

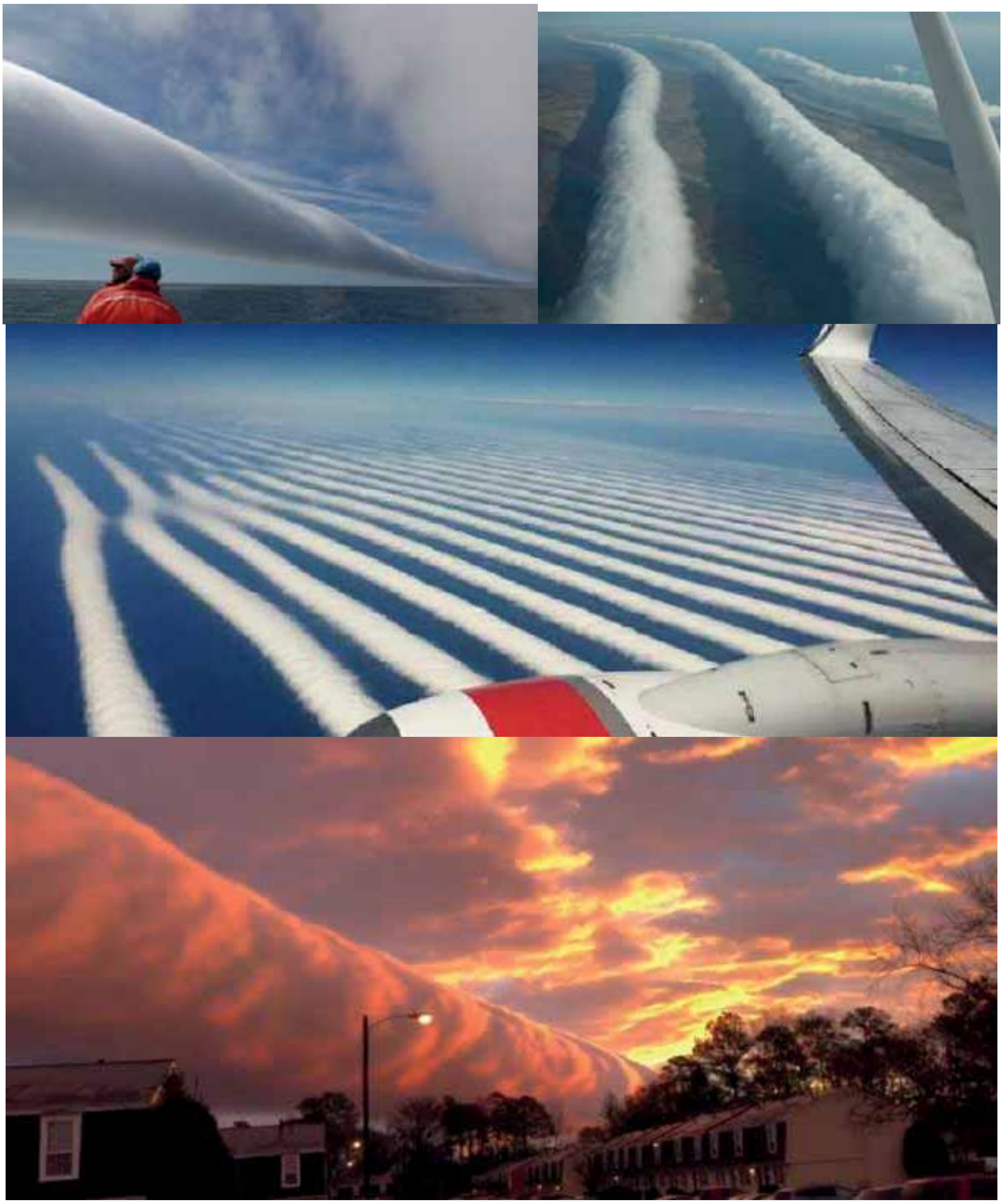

Fig.A-2.53 Morning Glory (CC/GFDL, M. Petroff)

Such clouds are a thunderstorm collar, 1 to 2 km high, often located only 100-200 meters above the ground (but usually higher), which can reach 1000 km in length and move at a speed of no more than 60 km / h. The thunderstorm collar is often accompanied by squalls, wind shear and a jump in pressure on the surface. In front of the cloud, there is a rapid vertical movement, which moves the air up and "twists" the cloud itself, and in the middle and final part of the cloud, the air goes down.

Fig.A-2.54 Another option (CC/GFDL)

Fig.A-2.55 Scud (Z.Lane)

Scuds are low-altitude, ragged or thin, irregularly shaped clouds that are very often found at the leading edge of a storm front, caught in the downdraft of a thunderstorm, and often moving faster than the storm clouds themselves. When in the updraft zone, they tend to rise and may exhibit lateral motion. These clouds form when the warmer (and often wetter) updraft of a thunderstorm lifts relatively warm air near the surface. These clouds condense as the warm, moist air becomes saturated during the lift and is forced outward from the storm.

Fig.A-2.56 Virga (CC/GFDL)

<u>Virga</u> is precipitation that evaporates before reaching the ground. It is observed as a noticeable band of precipitation coming out from under the cloud. This phenomenon occurs in stratus-rain, high cumulus, cirrus-cumulus, cumulonimbus clouds.

Fig. A-2.57 A microburst is a type of squall. The wind speed during a squall can reach 20-25 m/s or more, and its duration can range from several minutes to an hour and a half. A squall often causes damage - it breaks trees, damages light buildings, etc. A squall is often accompanied by heavy rain and thunderstorms, in some cases - hail, and in dry weather - dust storms. A squall differs from a hurricane in its short-lived nature. (CC/GFDL)

A-2.II.5. Holey clouds

Fig. A-2.58 Holey clouds (CC/GFDL)

These holes are formed as a result of cooling, when the temperature of the water in the clouds reaches below freezing, but the water has not yet had time to freeze. As soon as the water particles begin to freeze, this causes a domino effect, with more and more particles freezing and falling to the ground.

A-2.II.6. Clouds - "White-maned horses"

Fig.A-2.59 Kelvin–Helmholtz instability (CC/GFDL)

Kelvin-Helmholtz instability occurs when two contacting media have a sufficient difference in speeds. In this case, in the section perpendicular to the interface between these media, the velocity profile has an inflection point.

A-2.II.7. Vortex

Fig.A-2.60 Fire-smoke tornado (CC/GFDL)

Tornado – is a collective name for a number of vertical vortices that form as a result of the rise of warmer air from the earth's surface. There are: fire-smoke, dust, ash, snow, water (tornado), and invisible air vortices. Sometimes they can reach a height of up to 1000 meters, and 100 meters in diameter, and last for about half an hour.

Fig.A-2.61 Dust tornado (CC/GFDL)

Fig.A-2.62 Waterspout and its continuation underwater (CC/GFDL)

Fig.A-2.63 Tornado (J. Weingart)

Cyclone – is an atmospheric vortex of enormous diameter with clearly reduced air pressure in the center, sometimes even several thousand kilometers in size.

The air in cyclones circulates counterclockwise in the northern hemisphere and clockwise in the southern. In addition, in the air layers at a height from the Earth's surface to several hundred meters, the wind has a component directed toward the center of the cyclone, along the baric gradient (in the direction of decreasing pressure). The value of the component decreases with height. A cyclone is not simply the opposite of an anticyclone, they have a different mechanism of occurrence. Cyclones constantly and naturally appear due to the rotation of the Earth, due to the Coriolis force.

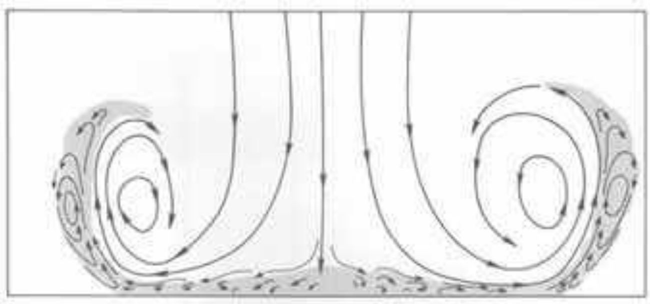

Fig.A-2.64 Microburst vortex rings (CC/GFDL)

A vortex ring or toroidal vortex – is a phenomenon in which a region of rotating fluid or gas moves through the same or another region of fluid or gas, with the flow pattern taking the shape of a toroid or doughnut. An example of this phenomenon is the ring of smoke blown out by a cigarette smoker. One way to create a vortex ring is to embed a compact mass of rapidly moving fluid A into a mass of stationary fluid B (A and B may be chemically the same fluid). Viscous friction at the boundary between the two fluids slows the layers of mass A relative to its core, and the forward motion of mass A forms a 'shadow' of low pressure behind. Due to this, layers of mass B bend around mass A and collect behind, where they enter A following the faster moving inner part. The result is a poloidal flow that forms a vortex ring. Vortex rings are often formed by volcanoes.

Fig. A-2.65 Soliton in air environment (CC/GFDL, L. Marissa)

Soliton – is a structurally stable solitary wave propagating in a nonlinear medium. It can also exist in the air, in which case it is a rotating vortex. A vortex ring around a helicopter is formed during rapid descent with low translational speed due to the formation of turbulent air flows passing down through the propeller, reflecting back from the ground, and then again entering down through the same propeller. When entering a vortex ring, the lift force decreases sharply and the rate of descent increases.

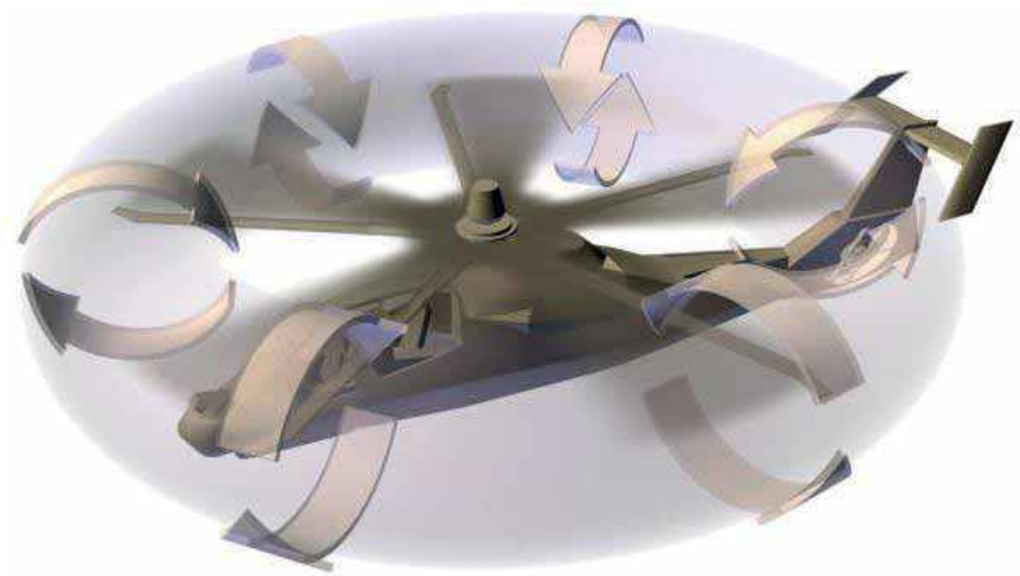

Fig.A-2.66 Schematic diagram of the formation of a vortex ring around a helicopter (CC/GFDL)

A-2.II.8. Dust storm

Fig.A-2.67 Dust storm on water and land (CC/GFDL)

Dust storm – is an atmospheric phenomenon in the form of transfer of large quantities of dust (particles of soil, grains of sand) by the wind from the Earth's surface in a layer several meters high with a significant deterioration in horizontal visibility (usually at a level of 2 m it is from 1 to 4 km, but in some cases it can decrease to several hundred or even several tens of meters). In this case, dust (sand) rises into the air and simultaneously settles over a large area. Depending on the color of the soil in a given region, distant objects acquire a grayish, yellowish or reddish tint. Usually occurs with a dry soil surface and a wind speed of 10 m / s or more. With an increase in the strength of the wind flow passing over unfixed particles, the latter begin to vibrate and then "jump". With repeated impacts on the ground, these particles create fine dust, which rises in the form of a suspension. The particles are released mainly due to the dryness of the soil and increased wind. Wind gust fronts can be formed by cooling air in the zone of a thunderstorm with rain or a dry cold front.

After the passage of a dry cold front, convective instability of the troposphere can contribute to the development of a dust storm. In desert regions, dust and sand storms most often occur due to thunderstorm downdrafts and the associated increase in wind speed. The vertical dimensions of the storm are determined by the stability of the atmosphere and the weight of the particles. In some cases, dust and sand storms can be limited to a relatively thin layer due to the effect of temperature inversion.

Sand storms can move entire dunes and carry huge volumes of dust, so that the storm front can look like a dense wall of dust up to 1.6 km high.

A dust storm, when mixed with a cyclone, can also serve as a source of snowfall: orange, brown, gray, black, red, blue colors in other climatic zones.

Fig.A-2.68 Orange snow (CC/GFDL)

A-2.II.9. Frontal fog

Fog is an atmospheric phenomenon, an accumulation of water in the air, when the smallest products of water vapor condensation are formed (at an air temperature above -10°, these are the smallest water droplets, at -10…-15° – a mixture of water droplets and ice crystals, at a temperature below -15° – ice crystals sparkling in the sun or in the light of the moon and lanterns). The relative humidity of the air during fog is usually close to 100% (at least exceeds 85-90%). However, in severe frosts (-30° and below) in populated areas, at railway stations and airfields, fog can be observed at any relative air humidity (even less than 50%) – due to the condensation of water vapor formed during fuel combustion (in engines, furnaces, etc.) and emitted into the atmosphere through exhaust pipes and chimneys. The continuous duration of fogs usually ranges from several hours (and sometimes half an hour or an hour) to several days, especially in the cold season.

Frontal fogs form near atmospheric fronts and move with them.

Air becomes saturated with water vapor due to the evaporation of precipitation falling in the front zone. The observed drop in atmospheric pressure, which creates a slight adiabatic decrease in air temperature, plays a certain role in the intensification of fogs before fronts.

Fig.A-2.69 The formation of a fog dome requires a heat source inside (CC/GFDL)

Fig.A-2.70 Frontal fog (CC/GFDL)

A-2.II.10. Prandtl-Glauert effect

Fig.A-2.71 Prandtl–Glauert effect (CC/GFDL)

The Prandtl-Glauert effect - is a phenomenon that consists in the formation of a cloud behind an object moving at transonic speed in conditions of high air humidity. Most often observed in airplanes. At very high humidity, this effect also occurs when moving at lower speeds. The reason for its occurrence is that an airplane flying at high speed creates an area of high air pressure in front of itself and an area of low pressure behind it. And after the airplane flies by, the area of low pressure begins to fill with surrounding air. In this case, due to the sufficiently high inertia of air masses, at first the entire area of low pressure is filled with air from nearby areas adjacent to the area of low pressure. This process is locally an adiabatic process, where the volume occupied by air increases, and its temperature decreases. If the air humidity is high enough, the temperature can decrease to such a value that it will be below the dew point. Then the water vapor contained in the air condenses in the form of tiny droplets, which form a small cloud. As the air pressure normalizes, the temperature in it equalizes and again becomes above the dew point, and the cloud quickly dissolves in the air. Usually, its lifespan does not exceed fractions of a second. Therefore, when an airplane flies, it sometimes seems that the cloud is following it - due to the fact that it constantly forms immediately behind the airplane and then disappears.

A-2.II.11. Sound barrier shock wave

Fig.A-2.72 Sound barrier shock wave (CC/GFDL)

When a supersonic gas flow passes around a solid body, a shock wave (sometimes more than one, depending on the shape of the body) is formed on its leading edge. At the shock wave front (sometimes also called a compression shock), which has a very small thickness (fractions of a millimeter), almost abruptly, cardinal changes in the properties of the flow occur - its speed relative to the body decreases and becomes subsonic, the pressure in the flow and the gas temperature increase abruptly. Part of the kinetic energy of the flow is converted into the internal energy of the gas. All these changes are greater, the higher the speed of the supersonic flow. At hypersonic speeds (10-30 M), the gas temperature reaches several thousand degrees, which creates serious problems for devices moving at such speeds. The shock wave front, as it moves away from the device, gradually takes on an almost correct conical shape, the pressure drop on it decreases with increasing distance from the top of the cone, and the shock wave turns into a sound wave. The angle between the axis and the cone generatrix α is related to the Mach number by the relation:

$$Sin(a)=1/M \quad (A\text{-}2.6)$$

When this wave reaches an observer, for example, on Earth, he hears a loud sound, similar to an explosion. A common misconception is that this is a consequence of the aircraft reaching the speed of sound at this moment, "breaking the sound barrier." In fact, this is the passage of a shock wave past the observer, which constantly accompanies an aircraft moving at supersonic speed. Usually, immediately after the "bang", the observer can hear the roar of the aircraft's engines, which was not heard before the shock wave passed, since the aircraft is moving faster than the sounds it makes.

Table A-2.1. Classification of velocities in the atmosphere

Mode	Mach	km/h	m/sec
Subsonic	<1.0	<1,230	<340
Transonic	0.8-1.2	980-1,475	270-410
Supersonic	1.0-5.0	1,230-6,150	340-1,710
Hypersonic	5.0-10.0	6,150-12,300	1,710-3,415
Fast hypersonic	10.0-25.0	12,300-30,740	3,415-8,465
Return speed	>25.0	>30,740	>8,465

When moving in a medium at supersonic speed, a body necessarily creates a sound wave behind itself. With uniform rectilinear motion, the front of the sound wave has a conical shape, with the apex in the moving body. The radiation of the sound wave causes an additional loss of energy by the moving body (in addition to the loss of energy due to friction and other forces).

A-2.III. Electroplasma phenomena:

A-2.III.1. Ball lightning

Ball lightning is a rare phenomenon that is most often observed before, after or in connection with thunderstorms and the phenomenon can last from a few seconds to several minutes. The size of the ball lightning can vary greatly among the reports of the phenomenon, but often the ball lightning is described as no larger than a football. Ball lightning usually ends by fading away or going out, but it can also happen that they disappear by emitting a sound or when they collide with an object. Ball lightning has been reported to move in very strange, irregular ways and, among other things, "jump" between different objects, follow fences or wires, make perpendicular course changes and even go straight through window panes without breaking the glass.

Fig.A-2.73 Ball lightning can be either single or group (CC/GFDL)

A physical theory of this phenomenon has not been developed, but there are several hundred hypotheses. The color of the phenomenon can be: white, yellow, orange, red, sometimes with shades of green, blue, blue, violet or a mixture of colors.

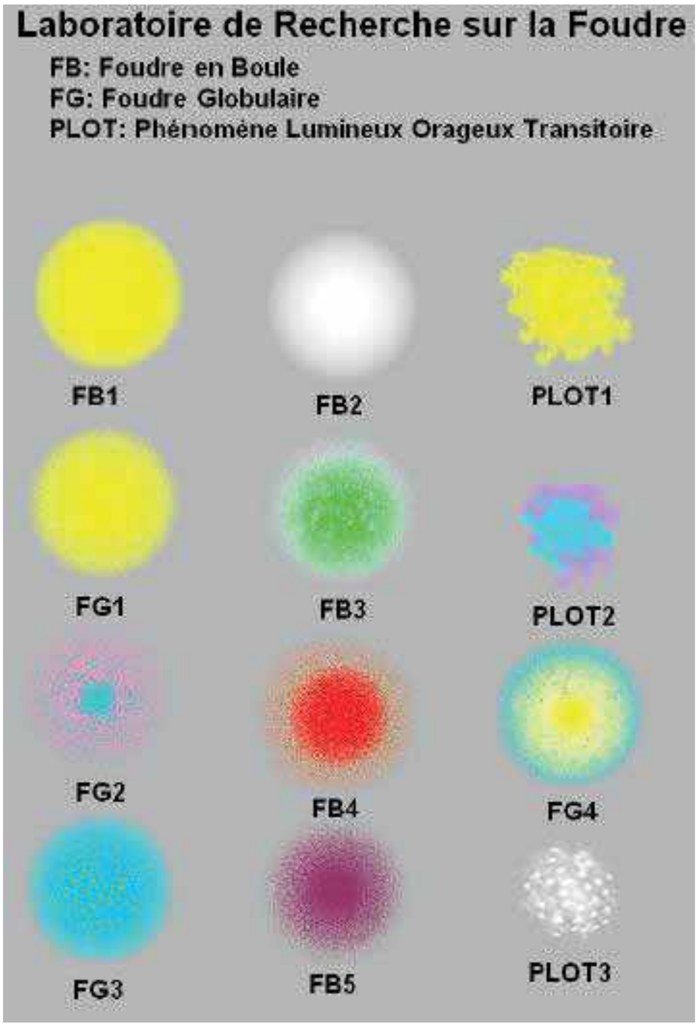

Fig. A-2.74 Types of ball lightning (R. Piccoli, Laboratoire de recherché sur la foudre)

The phenomenon produces a hissing buzzing sound, can often fall to the ground and roll, sharply change its trajectory by 90º, move with the help of conductive objects, crash into the ground and reappear, throwing out layers of Earth (Jordkast) and decreasing in size, burn circles in glass and explode repeatedly, leaving a sulfuric smell. Observed at relatively low altitudes, during thunderstorms or gloomy weather. At close distances, it can cause hallucinations in witnesses. The maximum diameter of ball lightning is about 5 meters. SM creates radio interference, recorded both on conventional radio receivers and radar.

A-2.III.2. Sprites, Elves, Blue Jets

Without a doubt, these are impressive phenomena, their duration is extremely short! The chances of seeing them visually are practically zero.

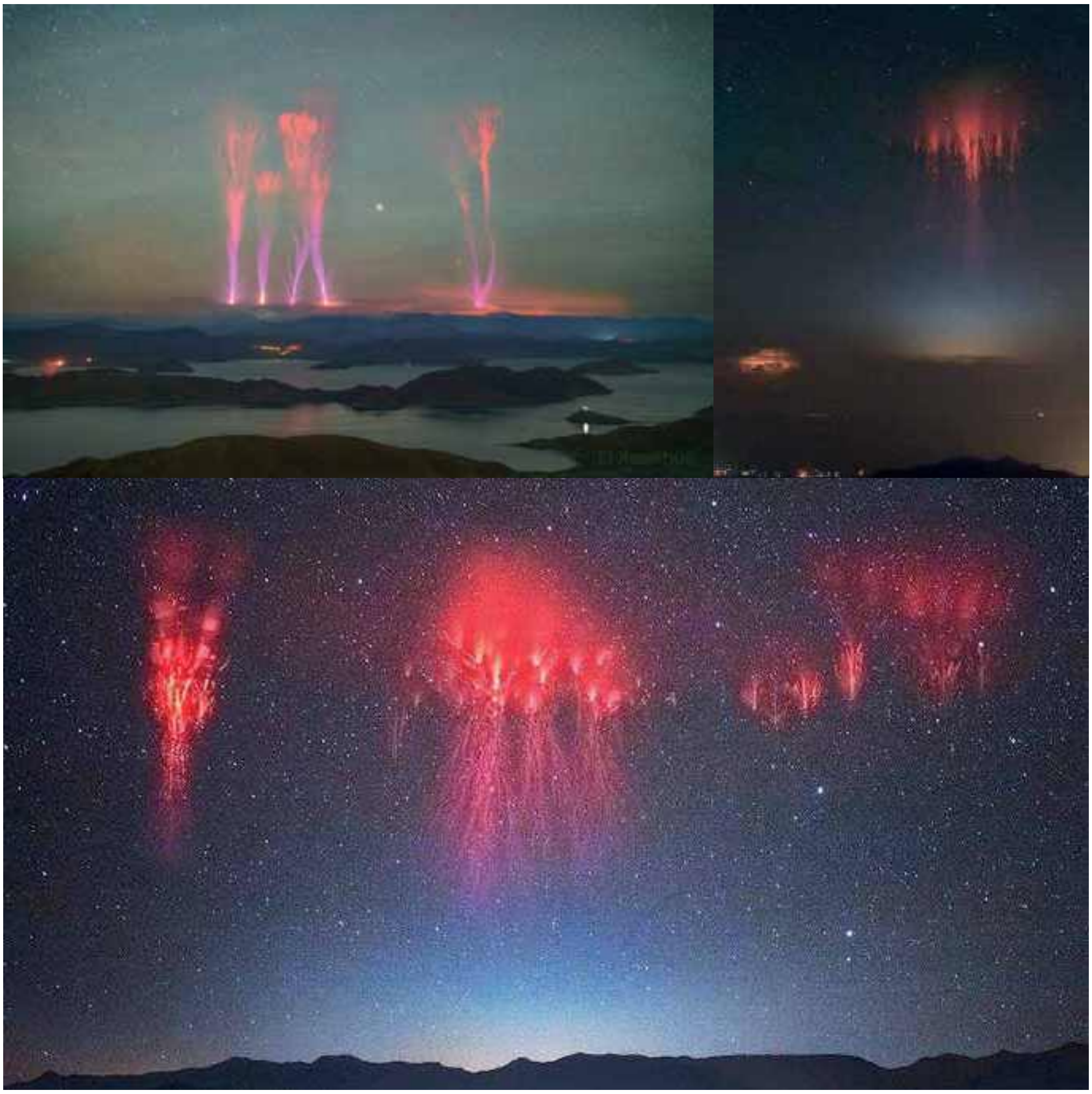

Fig.A-2.75 Red sprite (CC/GFDL, L. Xuanhua)

Fig.A-2.76 Blue Jets (CC/GFDL)

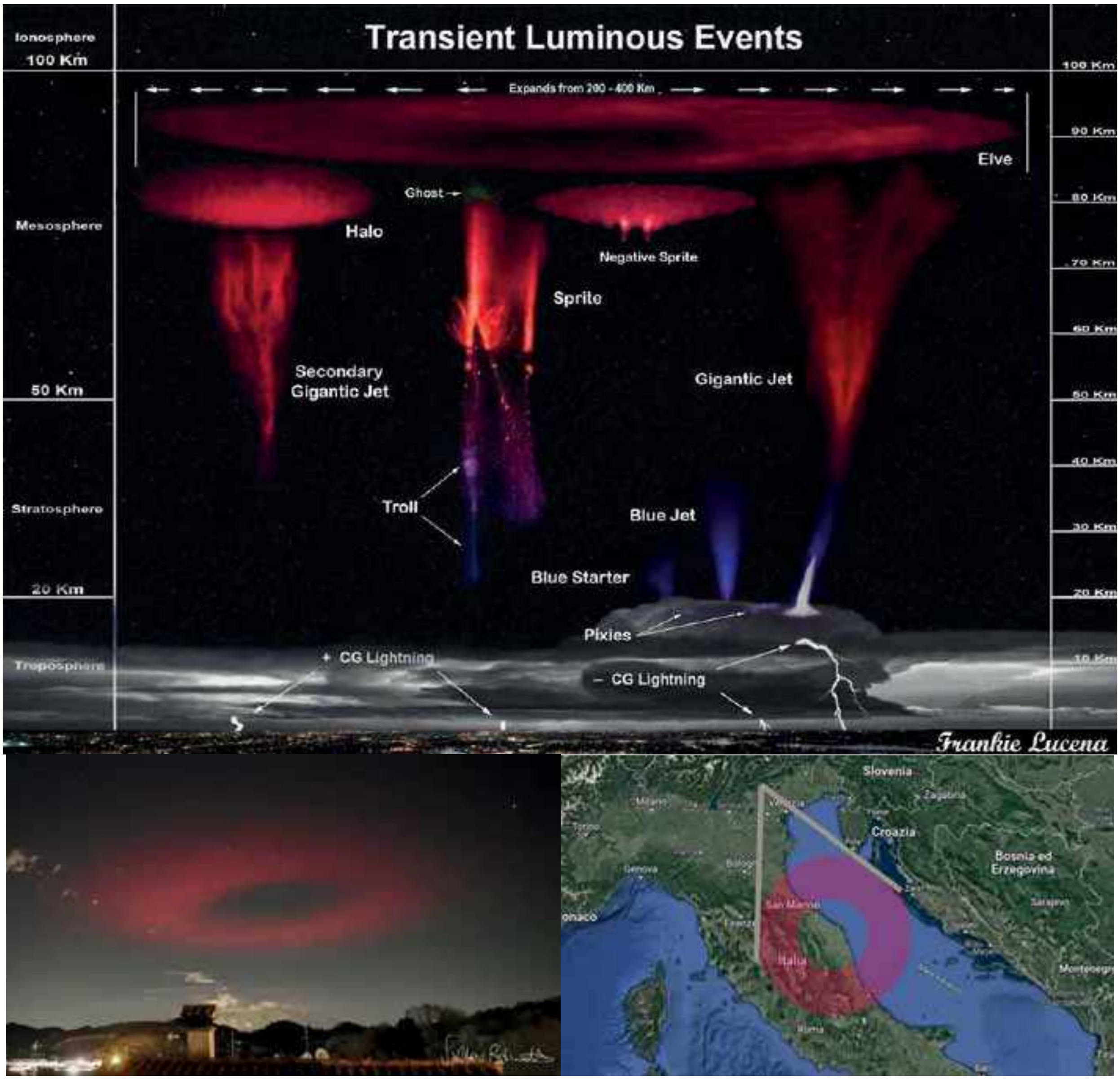

Fig.A-2.77 Sprites, Elves, Blue Jets (F. Lucena, CC/GFDL)

A-2.III.3. "Elmo's Lights"

In a weather situation with low clouds that are strongly electrically charged, slow small discharges can occur from the ground towards the clouds. If the discharges are strong, they can be accompanied by light phenomena and can be seen on mast tops on boats, for example, but the phenomenon can also occur on pointed objects on the ground such as fences and bushes, etc. The discharge can be up to a few decimetres long, emit a faint light and a whistling sound and often occurs in connection with hailstorms or thunderstorms. In some cases, even human bodies can become luminous. St. Elm's lightning can only occur if the clouds are very close to the ground, these conditions occur most often in winter, but they can also occur on high mountains.

Corona discharge in the form of luminous balls or brushes arising on the sharp ends of tall objects (sharp peaks of rocks, solitary trees, towers, masts, etc.) at high electric field intensity in the atmosphere. They are formed at precisely those moments when the electric field intensity in the atmosphere at the tip reaches a value of about 500 V/m and higher, which most often happens during a thunderstorm or when it approaches, and in winter during snowstorms. At present, methods have been developed that allow obtaining such a discharge artificially. And some of them are available at home - for example, by taking off a synthetic T-shirt (or sweater) and pointing a needle at it. From a certain distance, a discharge appears at the tip of the needle, clearly visible in the dark, and a crackling hiss can be heard. It is also possible to induce a discharge at the tip of a needle by bringing it close to the screen of a color television set with a picture tube, or next to an apparatus similar to a Tesla transformer, at a distance greater than that necessary for an arc discharge.

Fig.A-2.78 "St. Elmo's Lights" (CC/GFDL)

A-2.III.4. Kopp-Etchells triboluminescence

Fig.A-2.79 Static electricity glow (CC/GFDL)

Triboluminescence – is the glowing effect that occurs when crystalline bodies, in this case sand grains, are split. In most cases, the glow is explained by electrical discharges that occur in the crystal during deformation. For example, splitting a sugar crystal produces a bluish flash, and a processed diamond can begin to glow blue or even green. In the United States, triboluminescence observed during helicopter takeoffs and landings in the desert is called the Kopp-Etchells effect, in honor of the American soldiers who died in Afghanistan in July 2009.

A-2.III.5. Will-o'-the-wisps

Fig.A-2.80 Will-o'-the-wisps (CC/GFDL)

On warm dark nights, a glow of faintly flickering lights can be seen in the swamps, sometimes tracing a complex trajectory. The color of this light can vary, from a ghostly white, bluish or greenish to a living flame, without the formation of smoke. Their occurrence is explained by the spontaneous combustion of methane (swamp gas) released from the swamp, the light of rotten wood (rotting plants), phosphorescent organisms, radioactive mineral sediments, and other reasons. Phosphorus compounds, which are part of the corpses of animals and humans, decompose under the influence of groundwater to form hydrogen phosphide. If there is a loose embankment over a grave or a small layer of water in the swamp, the gas, coming to the surface, ignites from the vapors of liquid hydrogen phosphide.

The phenomenon is called irrbloss and is also known by some other names such as jack-o'-lanterns (or in English-speaking countries Will-o'-the-wisp, Ignis Fatuus or Jack-o'-lantern) which were rather used as older names for the folkloric interpretation of the phenomenon, but thus have their scientific explanation in the form of self-igniting gases. This mainly concerns phosphine and methane gas. The gas phosphine self-ignites when released and can in turn ignite other gases such as methane gas. Phosphine occurs in dead organic material such as dead and rotting plants and this phenomenon is limited to swamps and lakes.

The phenomenon itself consists of a flame that can flare up for a very short time or can persist for a longer period and can then travel over the bog. The self-igniting gases usually occur near ground level, but there are also examples where the ignited gases have risen to a height of several meters and moved away. On the other hand, the light phenomena that arise as a result of the gases are essentially limited to the area around the gas source, although they can spread a little in the surroundings around the source.

The gas source itself consists of a marshland area such as a bog or a marsh, but lakes can also give rise to self-igniting gases as these can form at the bottom of the lake, even in winter. There are a number of reports where these gases have exploded and even created large wakes with pieces of ice thrown many meters to the side.

The investigator should really only consider an explanation in the form of self-igniting gases when it comes to observations of light phenomena that have either been observed directly above or right next to a gas source (bog, marsh or lake) at the same time as the description should suggest that the phenomenon also originated from the underlying gas source. If, for example, the phenomenon comes from above and descends towards the gas source, it is less likely that it is self-igniting gases.

If the phenomenon was not observed in direct connection with a gas source, there should still be such a source very close to the observation site (preferably within 100 meters) and the description in the report should indicate that the observed phenomenon originated from the gas source.

Checking whether there was a lake or a watercourse next to the observation site is easiest done using modern map services such as Eniro, Hitta or Google Earth. If there are no peat or soil type maps, it is sometimes possible to see what the terrain looks like on a regular satellite image, as well as through street view images and sometimes through drone images in the regular map programs. Otherwise, it is only possible to check on site whether there have been wetlands in the surrounding area.

You can also call someone living in the area and ask. Often those who live there know how it is or can refer you to someone with local knowledge.

A-2.III.6. Other little-studied electro-plasma phenomena

A lightning strike in a thundercloud can temporarily change the electric field above the cloud, where charged ice crystals will reflect sunlight. The new electric field will quickly reorient the geometric crystals to a new position, appearing as "sunbeams." Soon, the old electric field is restored, causing the ice crystals to return to their original orientation.

Fig.A-2.81 "Sun bunnies" in the sky - reflection of sunlight from ice crystals changing their position in an electric field (CC/GFDL)

Fig.P-2.82 Electrification of insects (CC/GFDL)

Dense, compact swarms of insects may begin to glow in an electrified atmosphere.

The Kuril light – is a cloud glow phenomenon of static volcanic origin. It is occasionally observed in the region of Kamchatka, the Kuril and Japanese islands. It is also called the "burning circle". The consensus of experts divides the Kuril light into two phenomena of a common nature, one of which is observed on the sea surface, and the other - high in the stratosphere. During a volcanic eruption, clouds of intensely electrically charged ash aerosol arise, which can be carried by the wind over long distances without a significant loss of the initial charge. If a metal object (for example, a ship) gets into the coverage area of such a cloud, it causes a corona discharge, which affects electronic devices and forms a glow. Greenish glows of the sky, observed from aircraft, are also caused by electrically charged particles in the high layers of the atmosphere.

A-2.IV. Biological phenomena:
A-2.IV.1. Bioluminescence

Bioluminescence – is the ability of living organisms to glow, achieved independently or with the help of symbionts. Chemiluminescence can occur in many chemical reactions, such as the recombination of free radicals or oxidation reactions (oxidation of luminol in an aqueous solution or free-radical oxidation of white phosphorus vapor in the gas phase, etc.). In this case, as in bioluminescence reactions, the released energy is not dissipated as heat, as occurs during most exothermic chemical reactions, but is spent on the formation of one of the reaction products in an excited electronic state. For light to be emitted during a chemiluminescent reaction, at least two conditions must be met: first, the energy released during the reaction must exceed ~41-71.5 kcal/mol and, second, the difference in energies of the ground and excited states of the reaction product must be lower than the enthalpy of the chemical reaction. A necessary condition for bioluminescence is the high enthalpy of the luciferin oxidation reaction: the energy released during the reaction should exceed ~41-71.5 kcal/mol, which corresponds to the energies of electromagnetic radiation in the visible range of ~400-700 nm, this energy is comparable with the energy of the C-C bond in alkanes (~79 kcal/mol).

Such an energy effect significantly exceeds the energy effects of most biochemical reactions - including those involving macroergic compounds - energy carriers in living systems; for example, the energy released during the hydrolysis of ATP to AMP is 10.9 kcal/mol. Energy corresponding to the energies of the visible spectrum in living systems can be obtained only in single-stage oxidation reactions involving molecular oxygen (or active forms of oxygen), therefore most luciferases belong to the class of enzymes - oxygenases, catalyzing reactions in which oxygen is added to the substrate - luciferin (with a few exceptions of luciferases of annelids, which have peroxidase-like activity) and, accordingly, all luminous organisms are aerobes.

Bioluminescence performs the following biological functions:
1) Attracting prey or mates
2) Communication
3) Warning or threat
4) Repel or distract
5) Camouflage against natural light sources

In many cases, the function of bioluminescence in the life of individual luminous organisms is not fully understood or has not been studied at all.

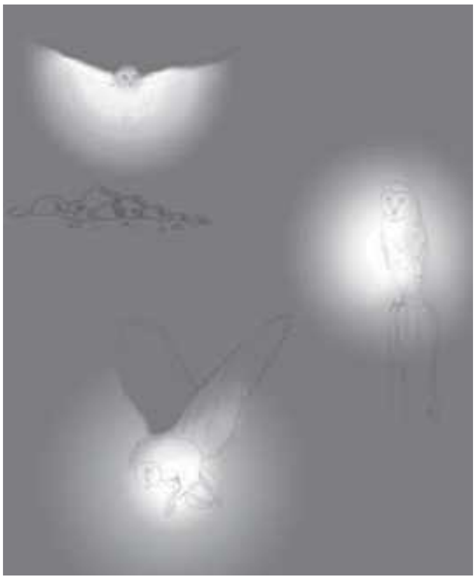

Fig.A-2.83 Glowing birds (CC/GFDL)

Fig.A-2.84 Bioluminescence (CC/GFDL)

Owls are accustomed to nest in tree hollows; the hollows are formed, as is well known, as a result of the slow decay of the wood, produced by a microscopic fungus, which launches root-like threads into the wood and gradually destroys it. These threads have the ability to glow. Owls, living in hollows, perhaps too small for their size, rub their feathers against the walls, and on them remain in large quantities the products of wood decay. Flying out of the hollow, they glow in the dark, just as the rotten wood itself glows. This is, of course, an example of purely accidental luminescence of birds; but, under certain conditions, the feathers of birds acquire an independent ability to glow when they are affected by special phosphorescent bacteria.

A-2.IV.2. Red and green snow

The red hue is created by the presence in the snow of a special type of green algae, chlamydomonas nivalis, which contains a secondary red pigment – carotenoid and chlorophyll. This rare cold-loving type of algae can only live in icy water or snow.

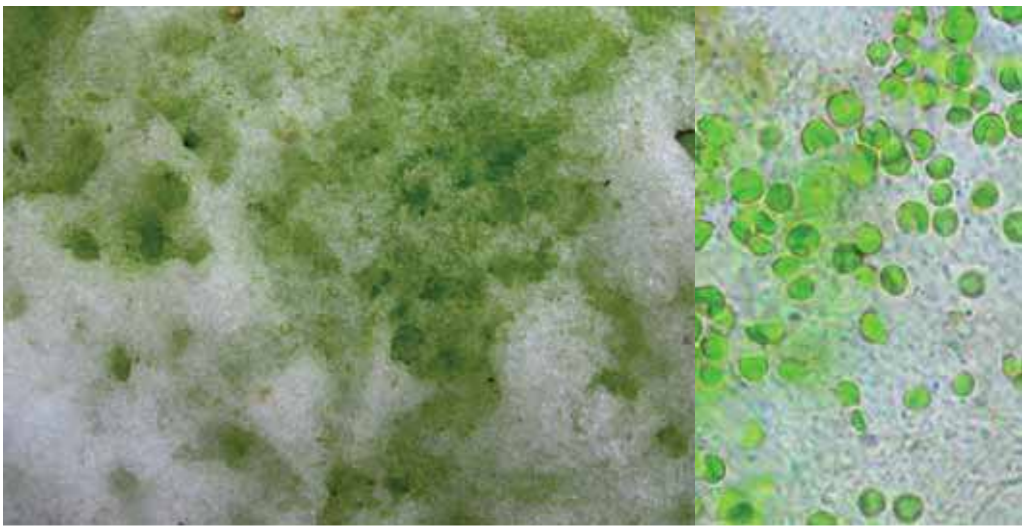

Fig.P-2.85 Green snow Chlamydomonas antarcticus (CC/GFDL)

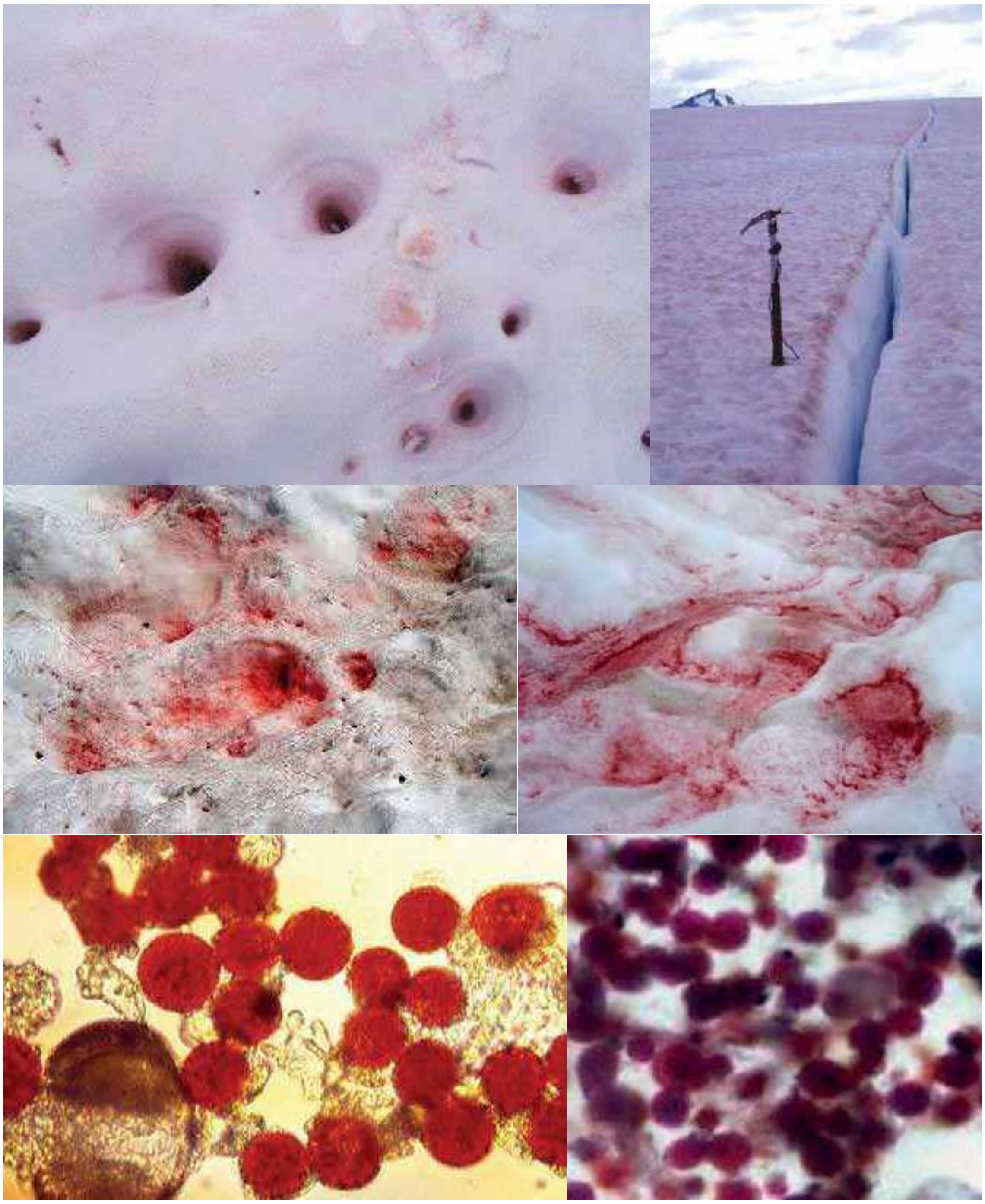

Fig.A-2.86 Red snow Chlamydomonas nivalis (CC/GFDL)

A-2.IV.3. “Witches’ circles”

Fig.A-2.87 Mushroom "Witches' circles" (CC/GFDL, C. Ableiter)

"Witches' circles" - are circles with a diameter from several tens of centimeters to several meters, formed by mushrooms. Some "Witches' circles" are formed by mushrooms of different species: milk mushrooms, talkers, champignons, fly agarics, morels, etc. Under the same conditions, the mycelium of the mushroom grows from the center at the same speed, forming a circle. Over time, the central part of the mycelium dies due to lack of nutrition, and the outer part continues to bear fruit. Every year, such a ring expands by 10-15 centimeters.

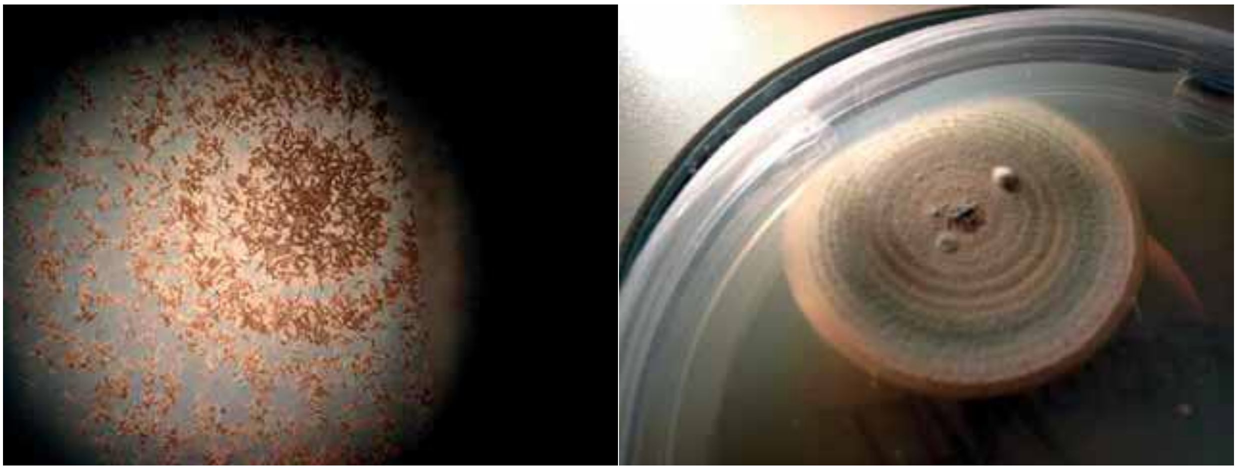

Fig.A-2.88 Radial growth of fungal mycelium in a Petri dish (J.J. Gallego)

A-2.IV.4. "Ice Hair"

Fig.A-2.89 "Ice ribbon" - bacteria Pseudomonas syringae (CC/GFDL)

The bacterium pseudomonas syringae is the cause of this rare phenomenon. It raises the freezing point of water inside plants, and when the water leaves the plant and meets cold air, these icy hairs form.

A-2.IV.5. "Dancing Clouds"

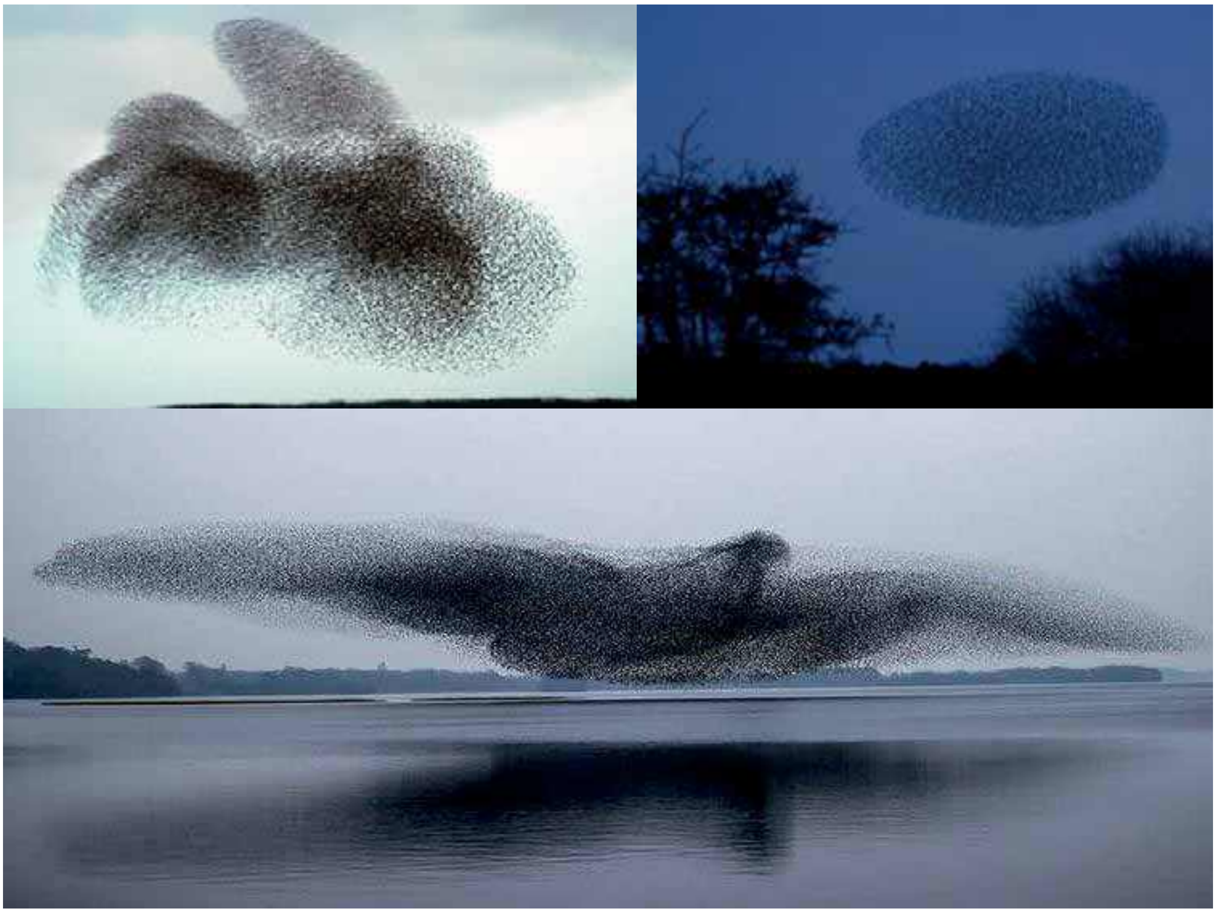

Fig.A-2.90 "Black Sun" - more than a million European starlings (CC/GFDL, J. Crombie)

Murmuration is the coordinated flight of huge flocks of birds, forming three-dimensional, very dynamic figures of variable density. Even complex algorithmic models cannot explain the acrobatic stunts of starlings, which change their direction in a hundredth of a millisecond to avoid collisions, and at the same time, attacks by predators. Particularly amazing are the flights of luminous "dancing clouds" in the dark sky illuminated by city lights.

A-2.IV.6. "Bio-duck"

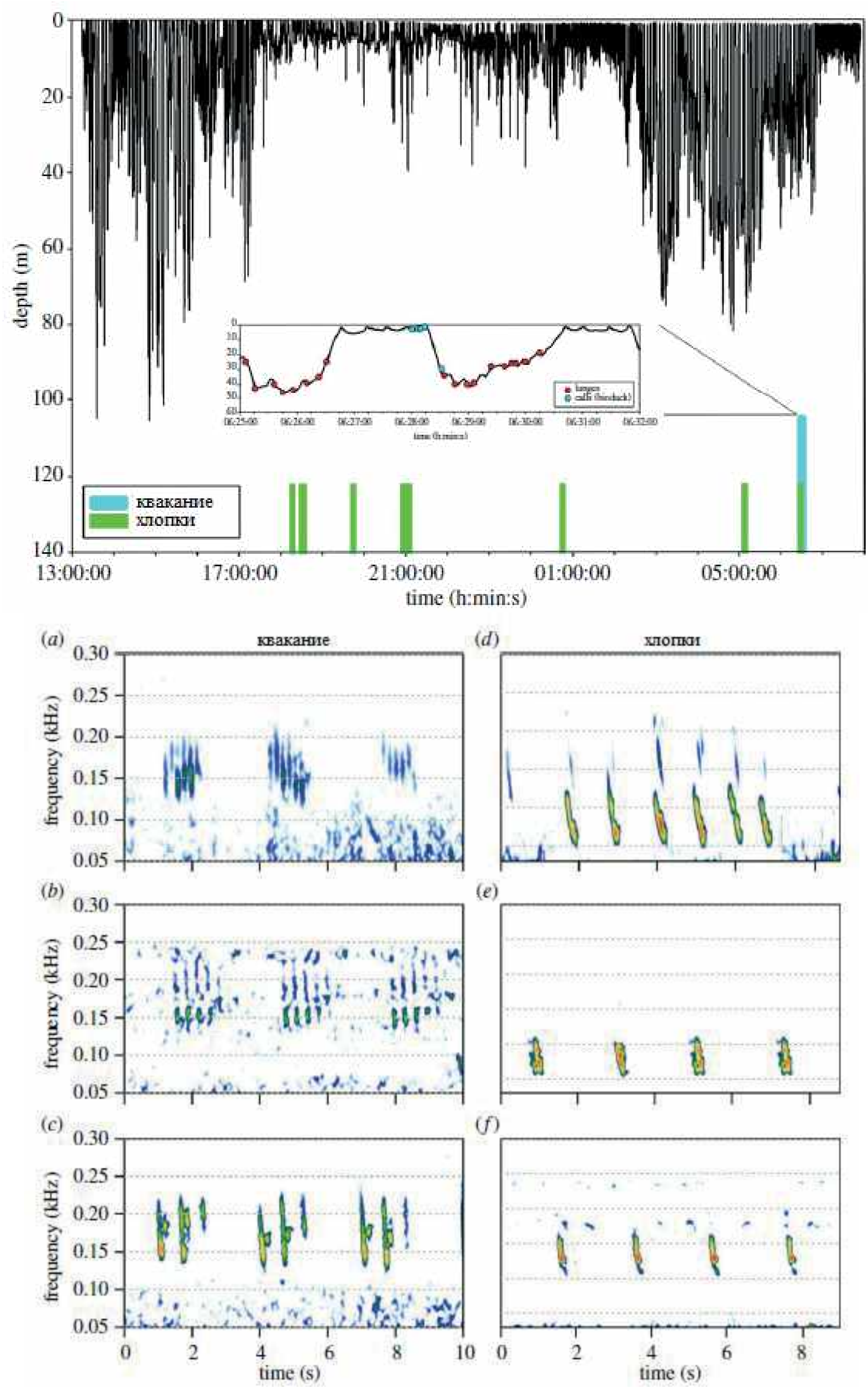

Fig.P-2.91 Croaking and clapping on the timeline (M. Wahlberg)

These phenomena called bio-duck, they are recorded near Antarctica in the Weddell Sea and off the Australian coast. Research has shown that sounds identical to "quakers" are made by a certain species of whales - southern minke whales (Balaenoptera bonaerensis). These animals weigh about 9 tons, the body length reaches 11 meters, and live in all the oceans of the Southern Hemisphere.

In 2013, near Antarctica in Wilhelmina Bay, scientists conducted the following experiment. They attached sensors with hydrophones to the bodies of several whales, operating in a wide range of frequencies, and recorded the "conversations" of the minke whales. Then specialists analyzed the recorded sounds and identified them with those previously recorded by marine biologists and submarine crews. The animals make these sounds before diving to depth. Other suspicious signals in the northern hemisphere were mistakenly identified as Soviet submarines in the 1980s, but after the end of the Cold War, the mysterious signals continued to arrive. In 1996, Professor Magnus Wahlberg conducted a study and found that it was the sound that herring make when their swim bladder contracts and excess gases escape through the anal canal in the form of air bubbles. This structure is unique to herring and is found only in herring.

A-2.V. Hydrological phenomena:
A-2.V.1. Ice cycle

Fig.P-2.92 Baer effect (CC/GFDL)

<u>Baer effect</u> – is a rule according to which in the Northern Hemisphere, rivers flowing in any direction erode the right bank, and in the Southern Hemisphere, the left bank.

It is explained by the combined action of the inertial Coriolis force and the friction force, which create a rotational movement of the water masses around the axis of the channel, which causes the transfer of matter between the banks. The resulting pressure difference ensures the rotation of the liquid in a circle.

Fig.P-2.93 Floating islands of peat and vegetation (V. Gushcha)

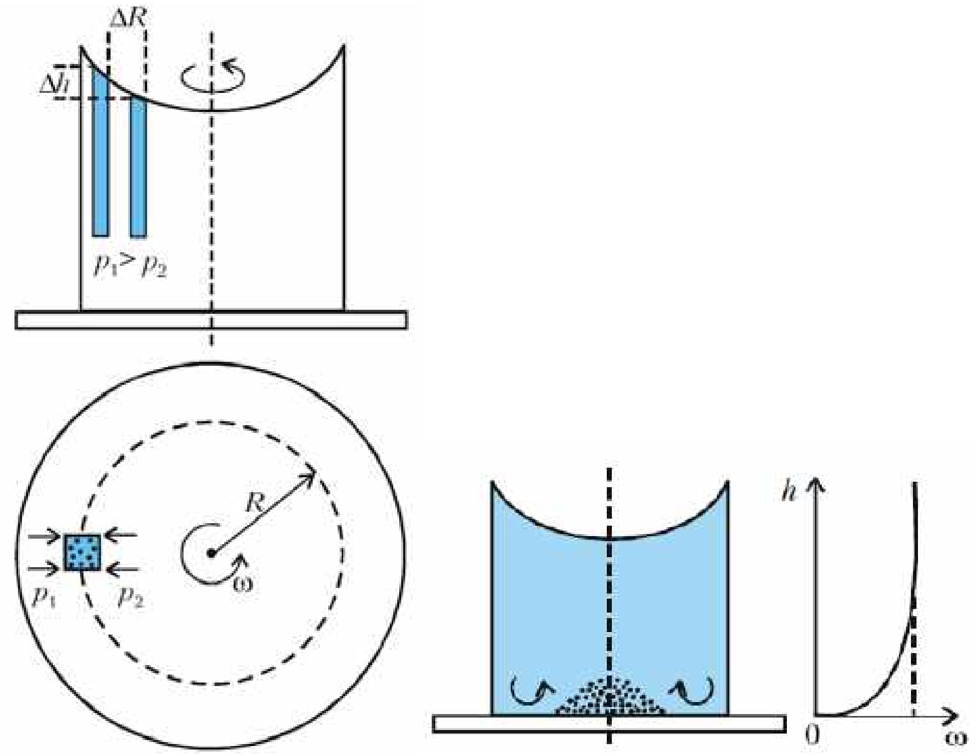

Fig.P-2.94 The increase in pressure with distance from the center of rotation plays the role of centripetal force. The angular velocity of rotation of the liquid at the very bottom decreases due to friction. The balance of forces is disturbed - vertical circulation of the liquid occurs. In the northern hemisphere of the Earth counterclockwise, and in the southern hemisphere clockwise. (V. Surdin)

In winter, the water temperature is close to zero, and near zero, the maximum density of water is reached at a temperature of +4ºC. Namely, this water will rise from the bottom of the pit to the top and wash the lower surface of the ice, and the ice above the pit will melt.

A-2.V.2. Ice balls

Fig.A-2.95 Ice balls (CC/GFDL)

The balls are formed by waves and temperatures slightly above freezing. Each piece of ice, instead of fusing with others into a single ice field, turns into a "growth point" and grows layers, and the waves roll it and turn it into a more or less even ball. Such a ball can reach a meter in diameter.

A-2.V.3. Ice Flowers

Fig. P-2.96 Crystals several centimeters high that form on the surface of a thin layer of ice (CC/GFDL, T. Matvienko)

If the air temperature is below -20° C, and the ice surface is about 0° C, and there is no wind, then a layer supersaturated with moisture forms at the very surface of the ice. And this moisture, when in contact with the cold air, cools sharply and condenses again on the surface of the ice, but this time in the form of crystals.

A-2.V.4. Pancake ice

Fig.A-2.97 Pancake ice (CC/GFDL)

Pancake ice occurs when the air temperature is close to zero, then a slush of granular snow forms on the surface of the water, and when snow falls and the temperature drops, the slush becomes covered with a snow shell, forming a snowdrift, which, in the presence of wind, separates into separate parts and freezes. Then the wind and icy water polish the formed ice floes, making the edges rounded and pancake-like.

A-2.V.5. Merging of waters of different color

Fig.A-2.98 Merging of waters of different color (CC/GFDL, D. Morris)

When water of different density, salinity and temperature, as well as the organisms that live in it, merge, visual differences in color are observed, which can also create bizarre images of the "flight" of ships and other man-made objects in the air.

Fig.A-2.99 Matrix Tide

Matrix Tide – is a rare natural phenomenon that occurs when two so-called undular waves (or undular bores) from different directions collide with each other, forming a grid-like or matrix-like pattern on the water surface. This phenomenon is extremely rare and difficult to study, as it only occurs under certain conditions. Particularly famous cases of observation have been recorded on the Qiantang River in China, which is famous for its powerful tidal waves.

A-2.VI. Astronomical and geophysical phenomena:
A-2.VI.1. Planets and the Moon, stars and zodiacal light

Fig.A-2.100 Full Moon and Volcano, Moon through dense clouds (CC/GFDL)

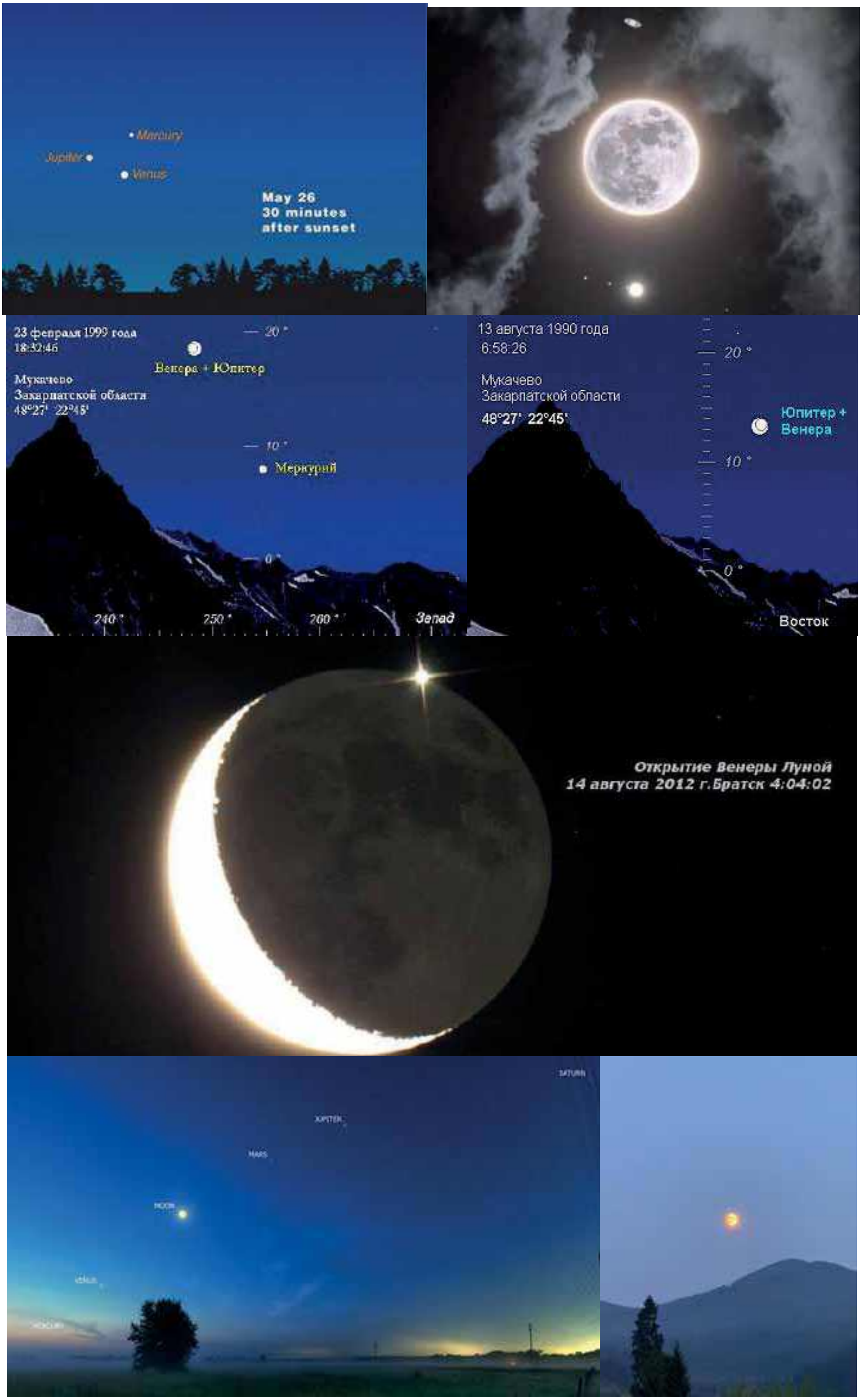

Fig.A-2.101 Planets and the Moon in the night sky (Y. Sochka, CC/GFDL)

Sometimes observers also mistake the Moon for something unusual. However, this happens almost exclusively when the moon is either partially covered by clouds or trees and when the moon is close to the horizon. When the moon is low in the sky, it takes on a more yellow-orange hue, which is because the moonlight travels through a larger layer of the atmosphere and is thus refracted into a more yellowish hue instead of the otherwise white. The Moon also appears larger when it is close to the horizon, but this is an illusion. In fact, if you measure the size of the Moon with a ruler on a straight arm, it will be exactly the same size (about 0.5 centimeters) both when it is high in the sky and when it is low closer to the horizon. On these occasions, it is easy to perceive the moon as something else and it can then also be perceived as being quite close (probably because it looks larger).

The Sun has also exceptionally been mistaken for something else when it has been observed through a cloud cover and has only been partially visible.

Although there have been reports of all kinds of stars and planets over the years, the following objects are the most common in the report crop: Venus, Jupiter, Sirius, Mars.

<u>Stars and planets</u> can always be seen in the same direction and at approximately the same height above the horizon for several nights in a row. They can always be seen for a long time (several hours) unless they are observed just before their descent below the horizon. The most common objects that are perceived as something strange are Venus, Jupiter and the star Sirius. Several striking objects are visible throughout the year in the northern hemisphere sky.

• The planet Venus is the brightest object in the evening sky after the moon and is significantly larger and brighter than ordinary stars. Venus, on the other hand, can only be observed in the hours after sunset in the west and in the hours before sunrise in the east, which means that Venus is always relatively low in the sky. For this reason, Venus is sometimes called the evening star or the morning star.

• The planet Jupiter can be seen for much of the evening/night during the winter months and Jupiter also reaches a brightness that is significantly brighter than stars.

• Sirius is the brightest star in the northern hemisphere and can be seen low in the sky in the south, also during the winter months. Characteristic of Sirius is that it changes quite frequently in different colors, which is due to the light being refracted as it moves through the Earth's atmosphere, and other stars can also show similar color shifts

<u>Among the stars</u>, the most common ones mistaken for UFOs are the "non-trivial" ones. Number 1 is Sirius, it is very bright and therefore produces beautiful colored flashes near the horizon (others have weaker flashes and appear white).

To a person unfamiliar with astronomy, the "Orion Belt" seems strange - 3 equally bright stars located in one line with equal intervals. Especially if they "hover" over something in a horizontal or vertical position. The zodiacal light is a white glowing cone visible in the west a few hours after sunset or in the east before dawn. Its brightness is comparable to the radiation of the Milky Way.

The zodiacal light extends upward from the place where the sun has set below the horizon in the evening or is about to rise in the morning. Its direction coincides with the ecliptic - the path of the Sun and planets through the starry sky, on which the zodiacal constellations are located.

Fig.A-2.102 Zodiacal light (D. Lopez)

Table P-2.2 For planets

Position in the sky	The position in the sky depends on the date and can be determined by the astronomical calendar. For Venus - not high above the horizon, in the morning - in the east, in the evening - in the west.
Nature of motion (trajectory, angular velocity)	No motion - slow movement (15 degrees per hour) in a straight/arc-shaped trajectory from east to west. "Shaking", zig-zag trajectory due to autokinetic effects.
Angular size	The angular size can be described by eyewitnesses in the range from "large star" to 0.5 diameter of the Moon.
Form	The eyewitness cannot identify the shape of the object due to its small angular size, or calls it spherical
Brightness	The brightness is higher than the background (sky) brightness
Color	White, blue, reddish, greenish, yellowish
Date, time, weather conditions	The date and time correspond to the planet's position in the sky. Clear, cloudy with breaks
Duration of observation	The duration of observation is not limited. It depends on the planet's movement across the sky

Bright comets rarely appear in the sky, so there are few such UFOs. Comets are celestial bodies made of frozen gas, dust and ice that periodically circle the sun. Comets move in highly elliptical orbits and spend most of their time far away on the outskirts of the solar system. When they occasionally approach the sun, parts of the comet body are gasified and a long tail develops. It should be noted that the tail usually points away from the sun, and not backwards in the direction of travel of the comet. Comets that are visible to the naked eye are rare and usually well known. Perhaps the most famous is Halley's Comet, which returns every 76 years and was last seen in 1986. The observer sometimes believes that what he/she has observed may have been a comet, but this is entirely due to ignorance of the nature of comets.

A not entirely uncommon phenomenon when observing a star or planet for a long time is that the star/planet appears to move back and forth sideways or up and down within a small area. However, this is not a real movement, but the illusion arises as a result of the eye's focusing difficulties and is called the autokinetic effect. When the human eye tries to focus on a point-shaped object against a dark background without underlying references, focusing difficulties arise and the illusion of a jerky and jumping movement can arise as the eye searches for a place to relate the object to.

Many are also puzzled by the star/planet suddenly disappearing, which is often due to dark clouds that are not so easy to see during the dark hours of the day. At the same time, clouds, when visible at night, can create the illusion that stars and planets are moving in the opposite direction to the clouds' own movement. If a star or planet disappears behind a cloud, this can also result in the object appearing to quickly disappear straight up at very high speed.

Another illusion that occurs is that celestial bodies observed from a car appear to follow the vehicle. When the car stops, the object also stops. However, this is completely natural because stars/planets are so far away that they only appear to move when compared to stationary objects closer at hand. When a car moves forward and you see a bright planet or star on the horizon, it appears to move in the same direction as the vehicle compared to the trees or other objects near the road.

Another detail that can distort an astronomical object is binoculars. When an observer observes a star or planet through binoculars, the object is magnified and risks being distorted from its actual appearance, which has often given rise to imaginative interpretations on the part of the observers. If astronomical objects are photographed freehand without a tripod, they can also be distorted.

<u>Characteristics of stars and planets:</u>

• Point-shaped objects that are stationary or move slowly from east to west.
• Long observation time (several hours).
• Recur several nights in a row.
• Often perceived as moving irrationally back and forth within a small area due to the autokinetic effect.

<u>Checking stars</u> and planets is now fairly easy with a computer. There are fairly sophisticated astronomy programs that provide access to an authentic illustration of the starry sky at a specific time and place. Programs of this kind usually allow you to go back in time and they often contain a number of different functions to adjust the program to the user's purposes. Two programs that are often used by UFO investigators are: Stellarium, StarCalc, WinStars, SpaceEngine, Starry Night. Stellarium, StarCalc and WinStars is a free programs that is available both online and for download, while SpaceEngine and Starry Night can be downloaded for a fee.

A-2.VI.2. Meteorites

Every day, the Earth's atmosphere is hit by a large amount of gravel and dust particles. These are called meteors or, colloquially, "shooting stars". Meteorite is a body of cosmic origin falling onto the surface of a large celestial object. A meteorite enters the Earth's atmosphere at a speed of 11 to 72 km/s. At this speed, it begins to heat up and glow. Due to the burning and blowing away of particles of the meteorite's substance by the oncoming flow, the mass of the body itself, which reaches the surface, may be less, and in some cases significantly less, than its mass at the entrance to the atmosphere. For example, a small body that enters the Earth's atmosphere at a speed of 25 km/s or more burns almost completely. At this speed of entry into the atmosphere, only a few kilograms or even grams of substance reach the surface from tens and hundreds of tons of the initial mass. The trail becomes luminous about 100 kilometers above the Earth's surface (where the atmosphere is considered to begin) and ceases to shine after a few seconds, often at an altitude of 70 to 80 kilometers. However, larger stones that give rise to brighter meteors are often visible down to 30 to 40 kilometers, but meteors almost never go out at altitudes higher than about 30 kilometers.

Fig.A-2.103 Fireballs (CC/GFDL, G. Song)

Many (but not all) meteoroids are the remains of comet matter (including those that have completely disintegrated and are therefore not observable). On days when the Earth crosses the orbits of such comets, the probability of meteorite falls is higher.

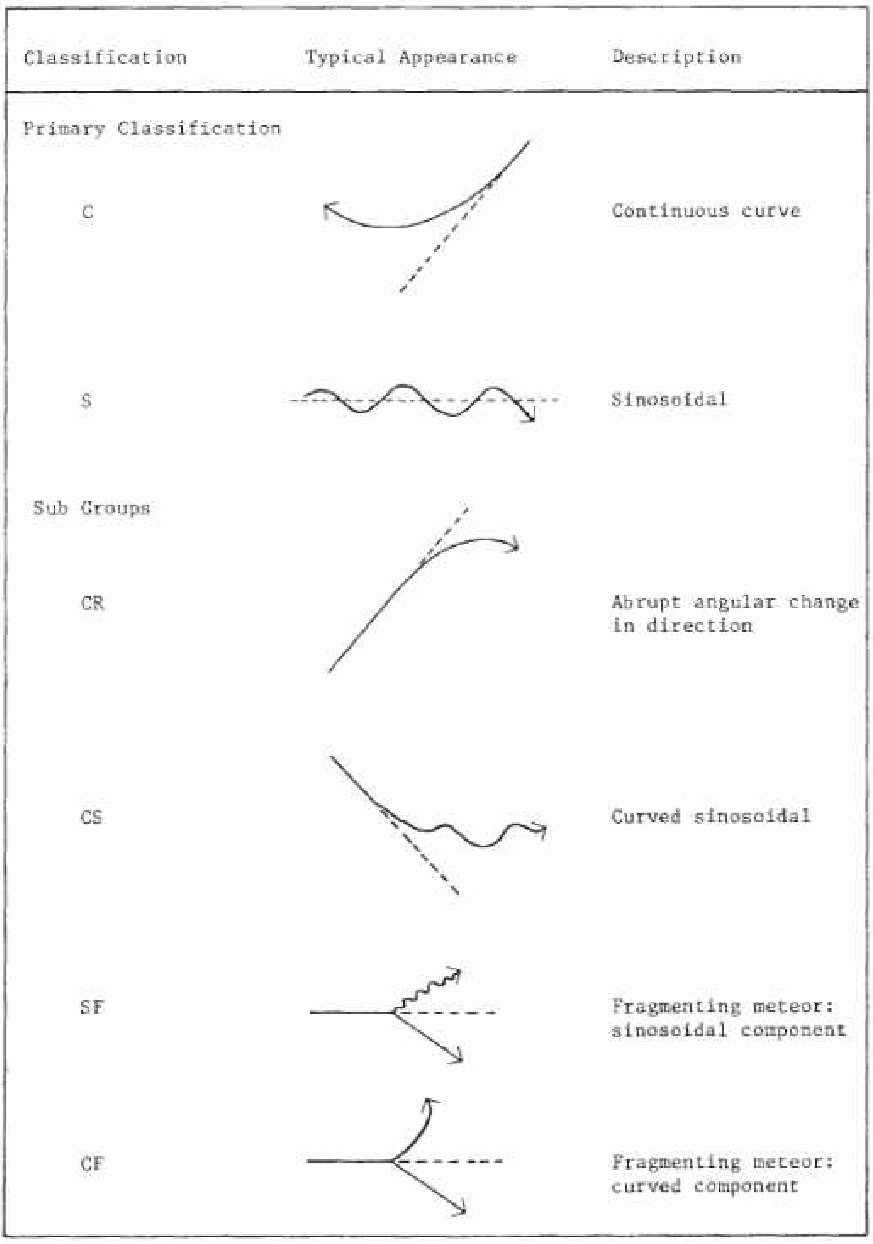

Fig.A-2.104 Non-linear meteor trails (CC/GFDL)

During the same periods, meteor showers (not to be confused with meteorite falls!) can be seen. Meteors are also mostly the remains of comets, but smaller ones. Due to their small size, they completely burn up in the atmosphere.

Meteorites larger than a fist can also reach the Earth's surface without completely burning up, but this is comparatively rare. The parts of a meteor that reach the Earth's surface are called meteorites. Larger rocks that give rise to bright meteors are called bolides. A bolide can become very bright and has on several known occasions become so strong that it has thrown light down to ground level and illuminated the surroundings, and even cast shadows on the ground. Usually, but not necessarily, you see a tail behind a meteor/bolide, but in some cases the tail may also be missing, which may depend on the angle from which you see the meteor and what stage of entry into the Earth's atmosphere it is in. It is not entirely unusual for meteors and bolides to appear in all possible shades, although they are usually described as a white or yellow/white glow.

Meteors and bolides that give off a green glow are also relatively common, which may partly be due to an illusion in the eye, but they can also shine in a real green glow depending on the metals that the space rock is made of. It is common when observing bolides that witnesses believe that the object passed their position at a relatively short distance and at a low altitude. In those observations where a bolide is seen to disappear behind, for example, a distant forest line, it is also common for the observer to believe that the bolide has hit the forest area in question, but this is in almost all cases an incorrect conclusion as it is many miles away.

If you see a meteor disappear behind a forest line, you usually see the meteor at a low elevation angle and considering that the meteor is actually at a very high altitude during the time it is visible, this means that it is also at a very great distance and consequently not in the vicinity of the forest area that it has disappeared behind. Another detail that makes it very difficult to determine where a meteorite hits is that the meteor then goes out at an altitude of at least about 30 kilometers. At that point, the deceleration of the atmosphere has also reduced the meteor's speed all the way down to between about 350 and 700 km/h.

At that speed, it takes several minutes to reach the ground from an altitude of 30 kilometers and it is therefore not possible to see the impact immediately after the meteor was visible in the sky. Traces of combustion of a meteoroid in the atmosphere can be found along almost the entire trajectory of its fall. If the meteoroid has not burned up in the atmosphere, then as it slows down, it loses the horizontal component of its speed. This leads to a change in the trajectory of the fall, often almost horizontal at the beginning to almost vertical at the end. As it slows down, the glow of the meteoroid decreases, it cools down (often indicating that the meteorite was warm, not hot, when it fell). In addition, the meteoroid may break up into fragments, which leads to a meteorite shower. The destruction of some bodies is catastrophic, accompanied by powerful explosions, and often there are no macroscopic traces of meteorite matter on the Earth's surface.

Table P-2.3 Meteor shower calendar

Meteor shower name	Activity	Maximum	Number of meteors per hour (ZHR)	Speed km/sec (V)	Radiant (r)
Quadrantis, QUA	12.28-01.12	01.03	110 (from 60 to 200)	41	α =230º, δ=+49º
Lyrids, LYR	04.14-30	04.22	18 (maximum 90)	49	α =271º, δ=+34º
η-Aquariids, ETA	04.19-05.28	05.05	50 (from 40 to 85)	66	α =338º, δ=-01º
Perseids, PER	07.17-08.24	08.12	100	59	α =48º, δ=+58º
Draconids, DRA	10.06-10	10.08	10+	20	α =262º, δ=+54º
Orionids, ORI	10.02-11.07	10.21	20+	66	α =95º, δ=+16º
Leonids, LEO	11.06-30	11.17	10	71	α =152º, δ=+22º
Geminids, GEM	12.04-20	12.13-14	150	35	α =112º, δ=+33º

Fig.A-2.105 Meteorite cloud of gas in the glow and night luminous clouds (CC/GFDL, K. Cho)

When a meteorite hits the Earth's surface at high speeds (around 2000-4000 m/s), a large amount of energy is released, as a result of which the meteorite and some of the rocks at the impact site evaporate, which is accompanied by powerful explosive processes that form a large round crater, much larger than the size of the meteorite, and a large volume of rocks undergoes impact metamorphism.

Noctilucent clouds (night luminous clouds) are extremely rarefied clouds that form at an altitude of 76-85 km above the Earth's surface and are visible in deep twilight. They are observed in the summer months at latitudes between 43° and 65° (north and south latitude) after volcanic eruptions or the fall of large meteorites.

A-2.VI.3. Optical effect during earthquakes

Seismic glows can be in the form of many multi-colored sparkling balls, swirling clubs of "flaming" fog, iridescent "pillars" reaching a height of up to 1 km, the appearance and disappearance of greenish flashes, blazing shining "tongues" over each mountain peak, blinking polar lights. They are classified into: dashed and zigzag glows, solid lightning, glows of varying brightness and snow belts from an arched source. They occur only in zones of geological and ecological risk of tectonic nature.

Radiation-optical emission is caused by electronic excitation of molecules, their subsequent spontaneous emission, on the one hand, and ionization of molecules, subsequent recombination of ions, on the other. During chemical reactions of formed ions, excited molecules and free atoms, chemiluminescent glow also occurs. Ions or excited particles formed during physicochemical effects, interacting successively with molecules of oxygen, nitrogen oxides, ozone, organic substances, water vapor, gradually become larger, turning into aerosols, condensation nuclei. Reactive molecules, atoms, ions, and primarily ozone, nitrogen oxides, aldehydes, ketones, alcohols, ethers, hydrocarbons begin to be adsorbed on the surface of aerosols. When shock waves propagate in the air, aerosols collide and coagulate, break up and heat up, which ultimately causes intensive desorption of reactive molecules from the surface of particles, a rapid increase in their concentration in the air and, accordingly, the rate of chemical reactions between them. As a result, when sound acts on irradiated air, an intense flash of chemiluminescent glow occurs. In the range of sound wavelengths of 250-1400 nm, there are several maxima, including indigo blue ultramarine at 430 nm, blue Prussian blue at 500 nm, orange red lead at 600 nm.

Chemiluminescence is characteristic of air in natural conditions. The maximum radiation intensity is observed at 700-800 nm, the radiation spectrum is very close to the solar one. Along with visible light, infrared radiation and radio waves are also generated. In the atmosphere, the air is intensively irradiated with ultraviolet radiation (reactive substances and photochemical aerosols are also formed), nitrogen-containing condensation nuclei are formed under the action of cosmic rays. A large number of aerosols enter the atmosphere from the surface of the Earth, the ocean, with volatile emissions of plants. Concentrations of ozone, nitrogen oxides, and organic substances are quite high in the atmosphere. The intensity of air chemiluminescence is affected by a variety of factors: concentrations of microimpurities, humidity, precipitation, explosions of various origins, thunderclaps, and even bell ringing. With an increase in air humidity, the intensity of chemiluminescence decreases sharply, it is almost completely suppressed by liquid precipitation. Therefore, the acoustic-optical glow during thunderclaps is usually very insignificant. Various glows were often recorded during military operations.

Of significant scientific and practical importance can be the observations of acoustic-optical effects during earthquakes and volcanic activity, which are recorded in the form of columns of light, tongues of flame, torches, concentric rings, bright arcs, fireballs. The stronger the shocks, the more the air "flares up", the brighter the flashes. Air glows accompany both audible noise, hum, and infrasound, noticed by animals. The strongest air glow is caused by the first, albeit small, shocks, usually preceding the main earthquake.

This is due to the "burnout" of the primarily chemiluminescent substances contained in the air. It is interesting that the strongest air flashes were noted during earthquakes occurring in years with maximum solar activity. There is nothing surprising in this. It is precisely at high solar activity that more chemiluminescent substances, photochemical and radiation-chemical aerosols accumulate in the atmosphere. The acoustic-optical effect is also supposed to be used in technology, in particular for monitoring toxic substances especially dangerous to humans in exhaust gases and air, adsorbed on dust. There is also an alternative version of the origin of seismic glow, where the main attention is paid to the synchronicity (within 1-2 minutes) of the ionospheric response and seismic shock, which excludes the acoustic nature of the generation of pulse disturbances.

Fig.A-2.106 Seismic glows (J. Conacher)

A-2.VI.4. Cosmic geomagnetic storm

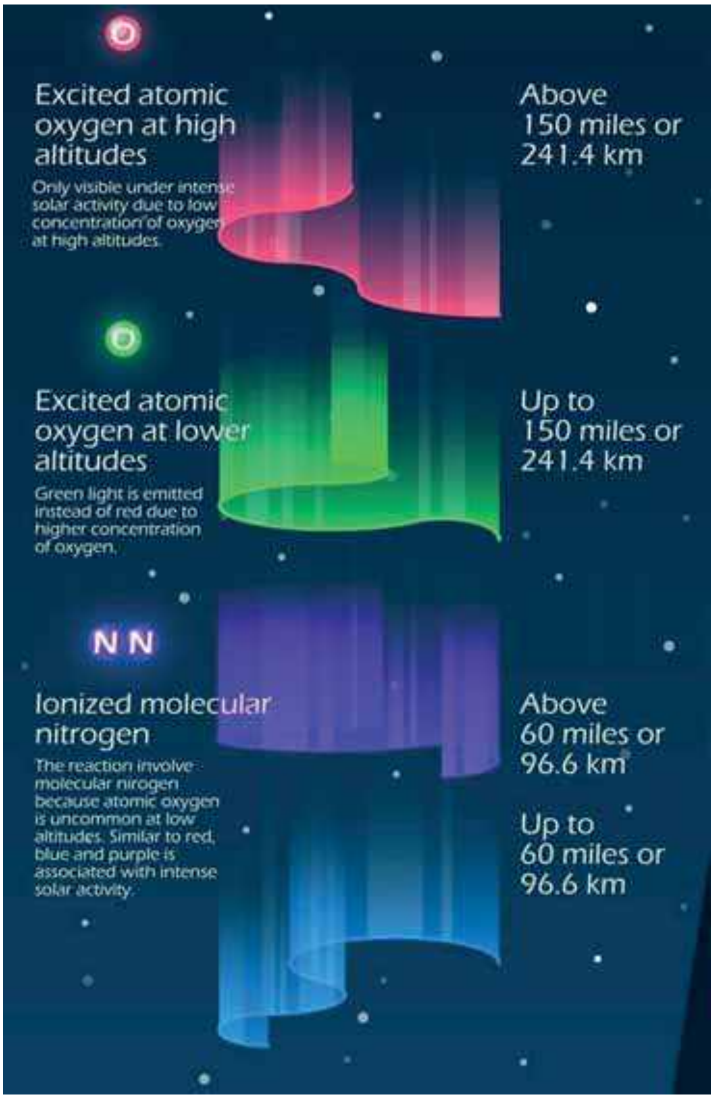

Fig.A-2.107 Aurora borealis color dependence (CC/GFDL)

As a result of a coronal mass ejection of solar plasma in the direction of the Earth, it causes consequences for the geomagnetic environment in the form of: the appearance of polar fields in those latitudes where they should not be, mass failures in radio communications, disruptions in the operation of electrical equipment and sparking of electrically conductive objects, the fall of man-made objects from orbit. Geomagnetic storms are a manifestation of the strengthening of the Earth's ring current, which constantly exists in the area of the Earth's radiation belts.

Fig.A-2.108 Purple and green clouds of aurora borealis and proton arc during a geomagnetic storm are observed at latitudes in which they are not observed in the normal state of the magnetosphere (CC/GFDL)

Fig.A-2.109 Purple tape "Steve" (CC/GFDL)

The mechanism of occurrence of this phenomenon is as follows. During the day, solar radiation (sunlight) breaks down air molecules into atoms (charged atoms, ions), electrons are knocked out. When ions meet again (or attract an electron), a molecule is formed, and excess energy is released as light. At an altitude of 80-120 km, mainly oxygen and sodium molecules recombine with the emission of green and yellow light, respectively; at an altitude of 250-300 km, electron-ion recombination occurs, but the radiation of this layer lies in the infrared (invisible) region of the electromagnetic spectrum.

The most common mechanism that causes skyglow is the combination of a nitrogen atom with an oxygen atom to form a molecule called nitric oxide (NO). This reaction produces a photon. Other substances that can contribute to skyglow include the hydroxyl radical (OH), molecular oxygen, sodium, and lithium.

The physics behind the purple band is not fully understood. One of ESA's Swarm satellites flew right through Steve during its previous appearance. Data showed a relatively hot river of gas, about 25 km wide, flowing rapidly through Earth's outer atmosphere. “Steve” appears to be thermal emission from hot gas, not from flying electrons.

Fig.A-2.110 Skyglow (CC/GFDL, J. Martinez, Y. Beletsky)

Fig.A-2.111 Polar lights and lunar halo (G. Strand)

Fig.A-2.112 Milky Way, Northern Lights and Volcanic Eruption (CC/GFDL)

The sky glow is caused by several factors:
-recombination (the process, the reverse of ionization) of ions formed during the day under the influence of solar radiation,
-luminescence under the influence of cosmic rays,
-chemiluminescence (glow during chemical reactions, mainly occurring between oxygen, nitrogen and hydroxyl radical).

Fig.A-2.113 Noctilucent clouds and northern lights (CC/GFDL)

Table P-2.4 Colors of the aurora borealis

Color	How it works	Altitude
Red	Solar particles interact with atomic oxygen at high altitudes. Only visible during periods of intense solar activity	200-400km
Green	Charged particles (mostly electrons) collide with high concentrations of oxygen molecules in the Earth's atmosphere at lower altitudes	100-200km
Blue and purple	Only during periods of high solar activity. Solar particles collide with molecular nitrogen in the Earth's atmosphere even lower	90-120km
Yellow and pink	Results of a mixture of red auroras with green or blue	100-250km

A-2.VI.5. Comet-like sodium tail of the Moon

The bombardment of the Moon by high-energy particles of the solar wind and meteoroids releases sodium atoms from the regolith, which in turn are collected by the same solar wind into a kind of tail, extending almost 800 thousand km behind the Moon. And during the new moon, the Earth falls into the sodium tail. With its gravity, the planet "focuses" the flow of particles. At such moments, a relatively bright spot of light with a diameter of about 3° (that is, 5-6 times larger than the Moon itself) appears in the point in the sky opposite the Moon. Not so bright to be seen with the naked eye, but sensitive cameras with a sodium filter (589 nm) distinguish it.

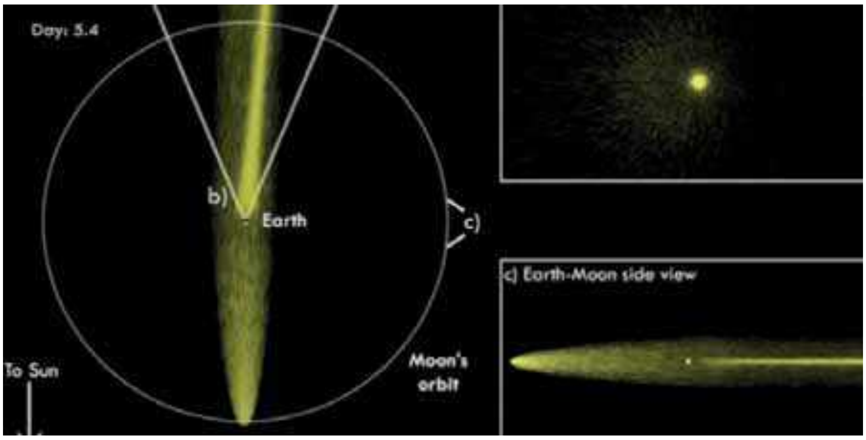

Fig. A-2.114 On the left and bottom right is shown the modification of the sodium tail by the Earth's gravity, on the top right is the appearance of a spot in the sky at the antisolar point (J. O'Donoghue)

A-2.VI.6. Supernova

A <u>supernova</u> is a star whose brightness increases by tens of stellar magnitudes during an outburst over several days. At maximum brightness, a supernova is comparable in brightness to the entire galaxy in which it has flared up, and may even exceed it. During a supernova outburst, energy of about $10^{50} – 10^{51}$ erg is released, and the glow can last for several days. If the supernova explosion is very close (several parsecs from Earth), the results can lead to great disasters, then the supernova can be brighter than the Sun.

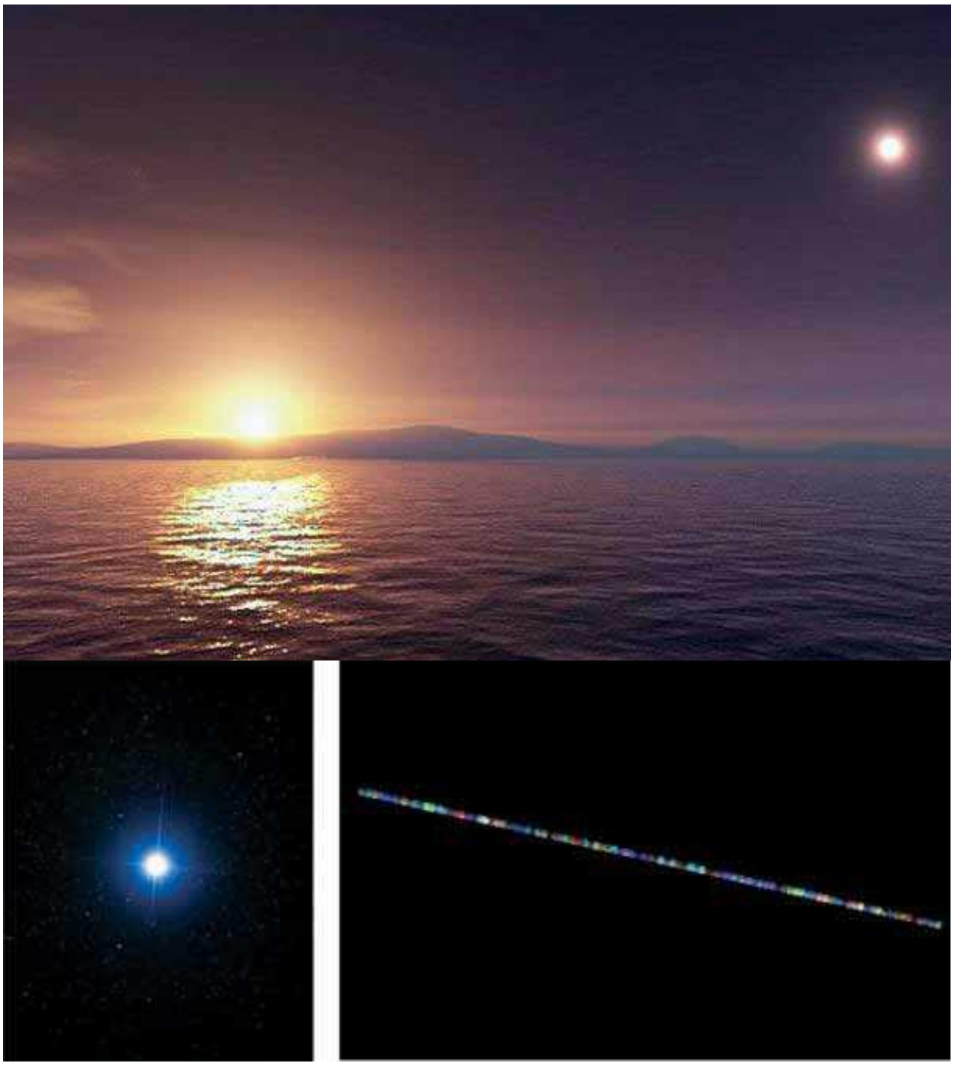

Fig.A-2.115 Supernova during the day, as well as an example of the change in the color of a star depending on the density of the atmosphere - magnification of the scintillation effect (CC/GFDL, A. Cross)

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Appendix 3. Man-made phenomena that may serve as a source of misinterpretation, as well as environmental impacts observed or recorded in connection with reports of UFO-related events.

A-3.I. Optical Effects

A-3.I.1. Glare, Bokeh and Aberrations

It is a common misconception that a camera always provides an accurate and flawless depiction of reality. The technology in a camera is complicated and the camera's flaws and shortcomings can give rise to a number of unintended effects that affect how different lights and objects appear in the image.

Lens flare is the reflections in the camera's lens elements that are created by strong light sources, such as direct sunlight falling straight into the lens, and thus creating reflections among the various lens elements inside the camera. This often means that a person who has taken a picture in the direction of a strong light source (i.e. the sun, the moon or a strong lamp) subsequently discovers a miniature copy of the light source in the picture. If you take a picture of the sun, you will see both the real sun and a small copy of the sun in the picture. If, on the other hand, the light falls obliquely onto the lens, the reflection can be more like a veil over parts of the picture.

Fig.A-3.1 Glare of different forms of light reflection in objective lenses (CC/GFDL)

Glare – is a light spot on a brightly lit reflective surface. It occurs as a result of specular or specular-diffuse reflections on the subject of a bright light source. When photographing, glare appears as bright spots due to the reflection of light in the objective lenses.

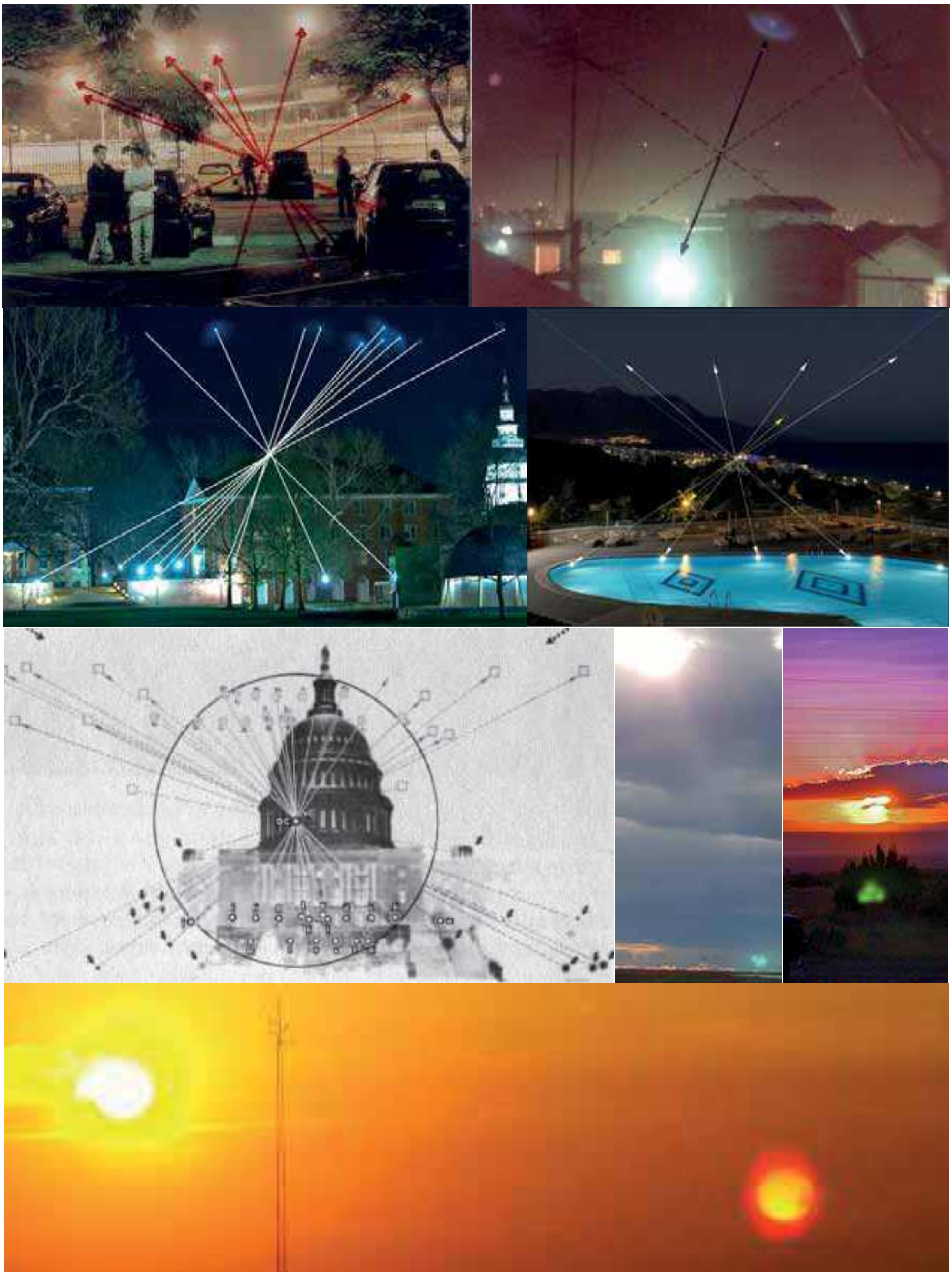
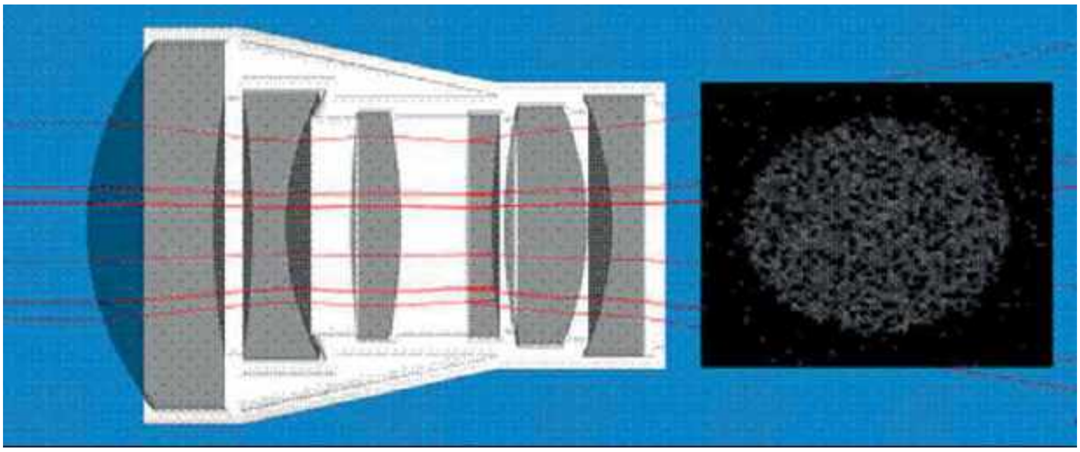
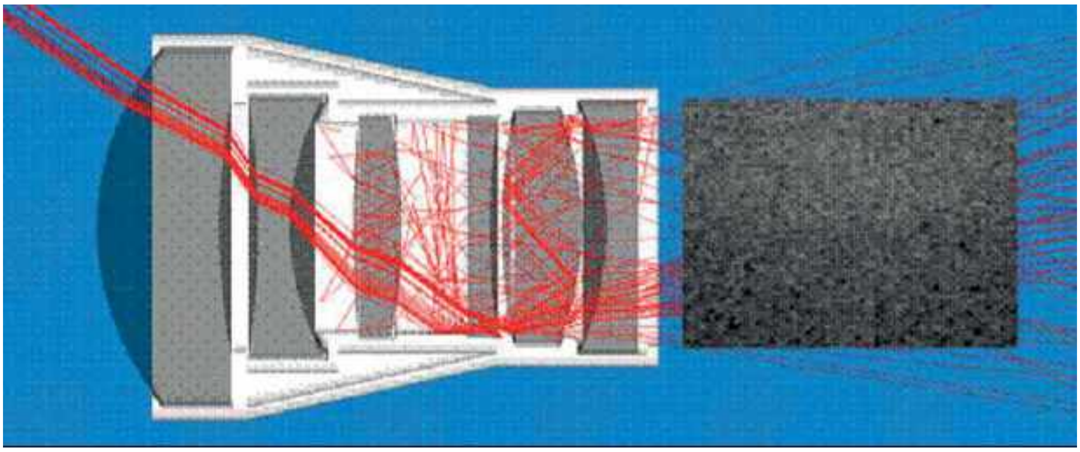


Fig.A-3.2 Glare that occurs from sources symmetrically relative to the center of the frame (CC/GFDL)

Fig.A-3.3 Glare (CC/GFDL)



a



b

Fig.A-3.4 Sources of formation of parasitic illumination in the lens system: (a) glare on the lens, (b) diffuse scattering on fastening elements (A. Voloboy, S. Vishnyakov, V. Galaktionov, D. Zhdanov)

Fig.A-3.5 Diaphragm sheets (CC/GFDL)

Glare is caused by light that, instead of passing through the intended optical path, is reflected by the optical elements inside an arbitrary number of times before hitting the film or digital sensor, since most lenses consist of several "optical elements". To reduce the amount of glare, it is worth using a lens hood.

Fig.A-3.6 Blocking stray light using petal or circular hoods (CC/GFDL)

Fig.A-3.7 Bokeh, different forms of out-of-focus blur (CC/GFDL)

Bokeh – is out-of-focus blurriness against the background of the back focus when photographing. Often, bokeh can be identified through blur disks, where each bright point becomes a disk, and the shape and contrast vary depending on the shape of the lens aperture. If there is a need to eliminate possible bokeh when photographing, then it is worth using a polarizer.

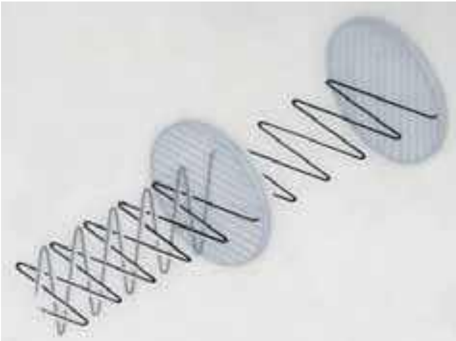


Fig.A-3.8 Polarization filter operation system (CC/GFDL)

Focus – is the point at which parallel rays intersect after passing through a collecting or diffusing system. There are front and back foci (planes).

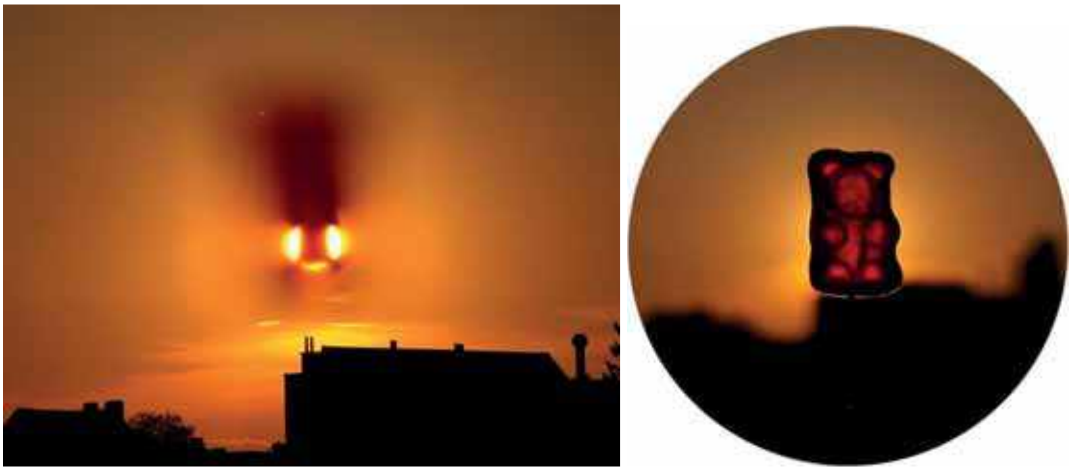


Fig.A-3.9 Example of back and front focus (CC/GFDL)

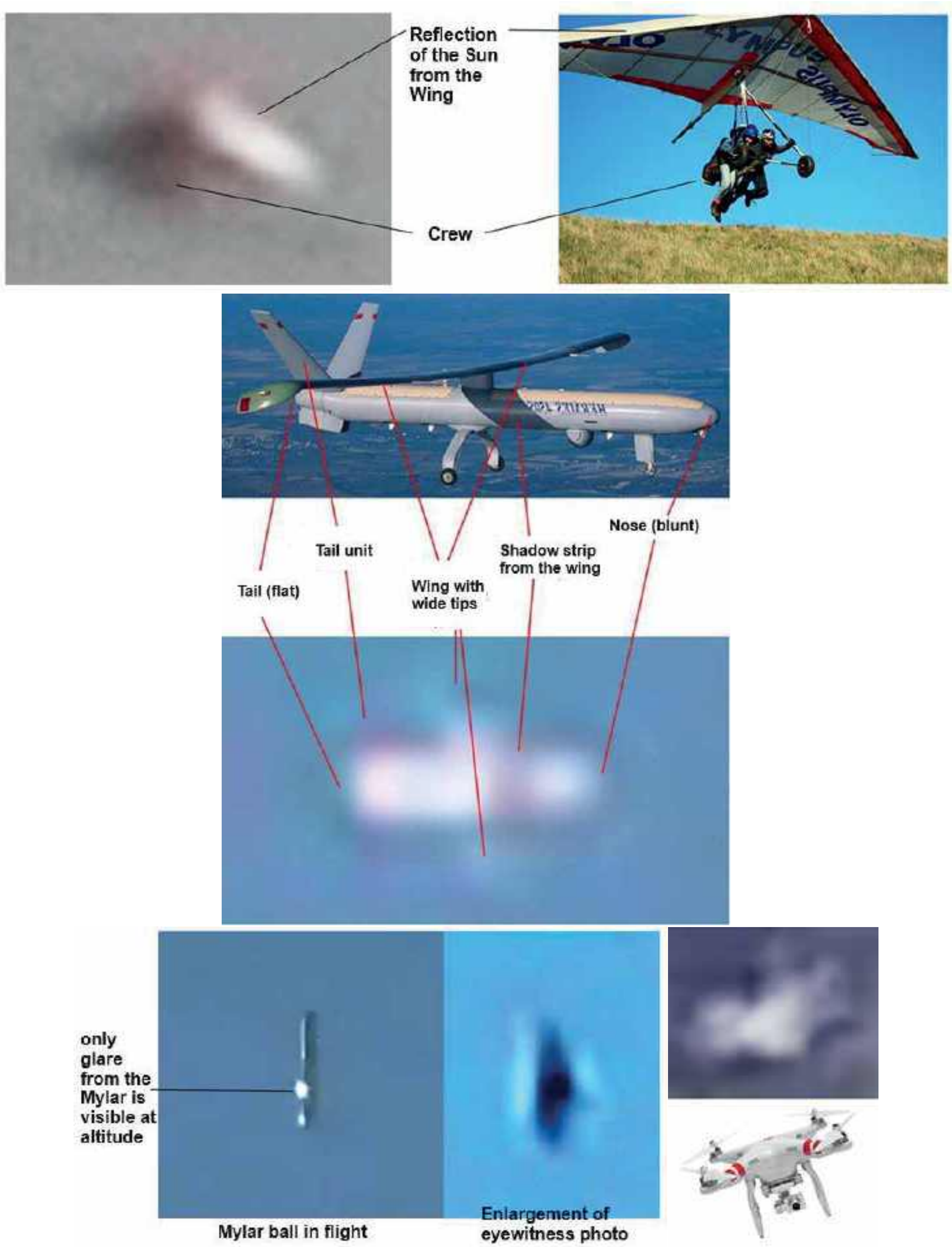


Fig.A-3.10 Man-made objects out of focus (M. Gershtein, CC/GFDL)

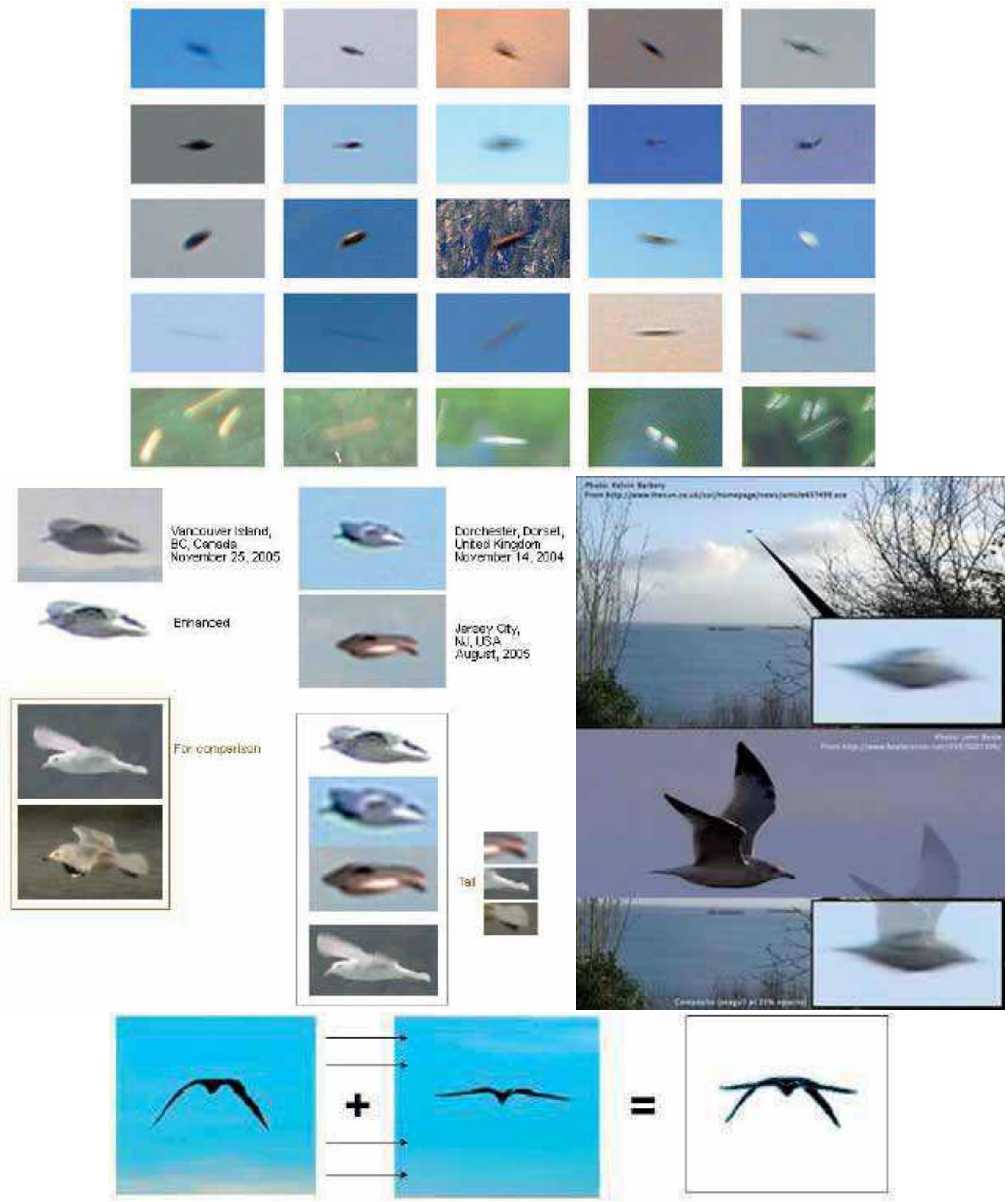


Fig.A-3.11 Birds and insects out of focus (S. Shpakovsky, R. Lianza, CC/GFDL)

You can estimate the speed of an object by the blurriness of its boundaries. *For example, if the finest details of an object correspond to 2-3 pixels, then this is not the displacement itself, but its upper estimate. The requirement that during the exposure time of 1/858 s the displacement should not exceed 3 pixels, and during the time between frames (1 s) it should be more than 1300 pixels, leads us to an approximate estimate of R/2 < V < R, where R is the distance to the object in meters, and V is its speed in meters per second.*

All quantities are easily scaled depending on the size. For example, for a distance of 1 km we have V from 500 to 1000 m/s.

Table P-3.1 Distance and speed estimates for different object sizes

size	distance (m)	speed (km/h)
1 mm	1.6	6
1 cm	16	60
1 dm	160	600
1 m	1600	6000

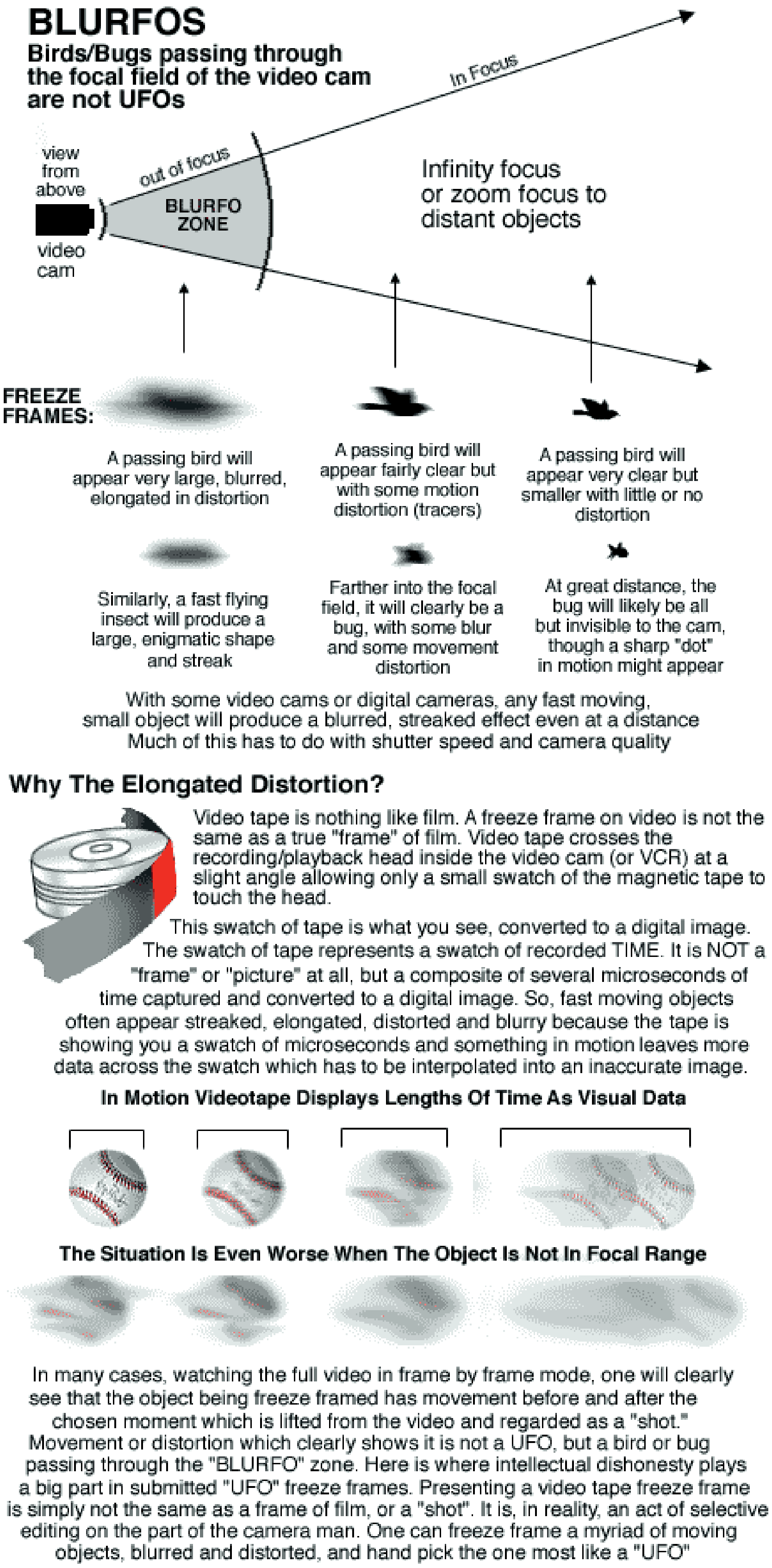


Fig.A-3.12 Blurred objects when shooting back focus or in motion (J. Neff)

*Example: 3 pixels * 858 = 2574 pixels/s = 46.3 degrees = angle a (1 pixel = 0.018 degrees)*
*In linear measure, this corresponds to D = R * tg (a) = R * 1.05*
If the object had flown a greater distance in a second, blur would have been noticeable (smaller is possible)
*The departure of the object from the central axis of the frame beyond its border corresponds to approximately 1300 pixels = 23 degrees. In linear measure, this corresponds to D = R * tg (b) = R * 0.43*

This is the minimum distance that the object had to fly so that it would not appear in the adjacent frame (more is possible). Thus, we have speed restrictions (distance traveled in 1 second): $R*0.43 < V < R*1.05$

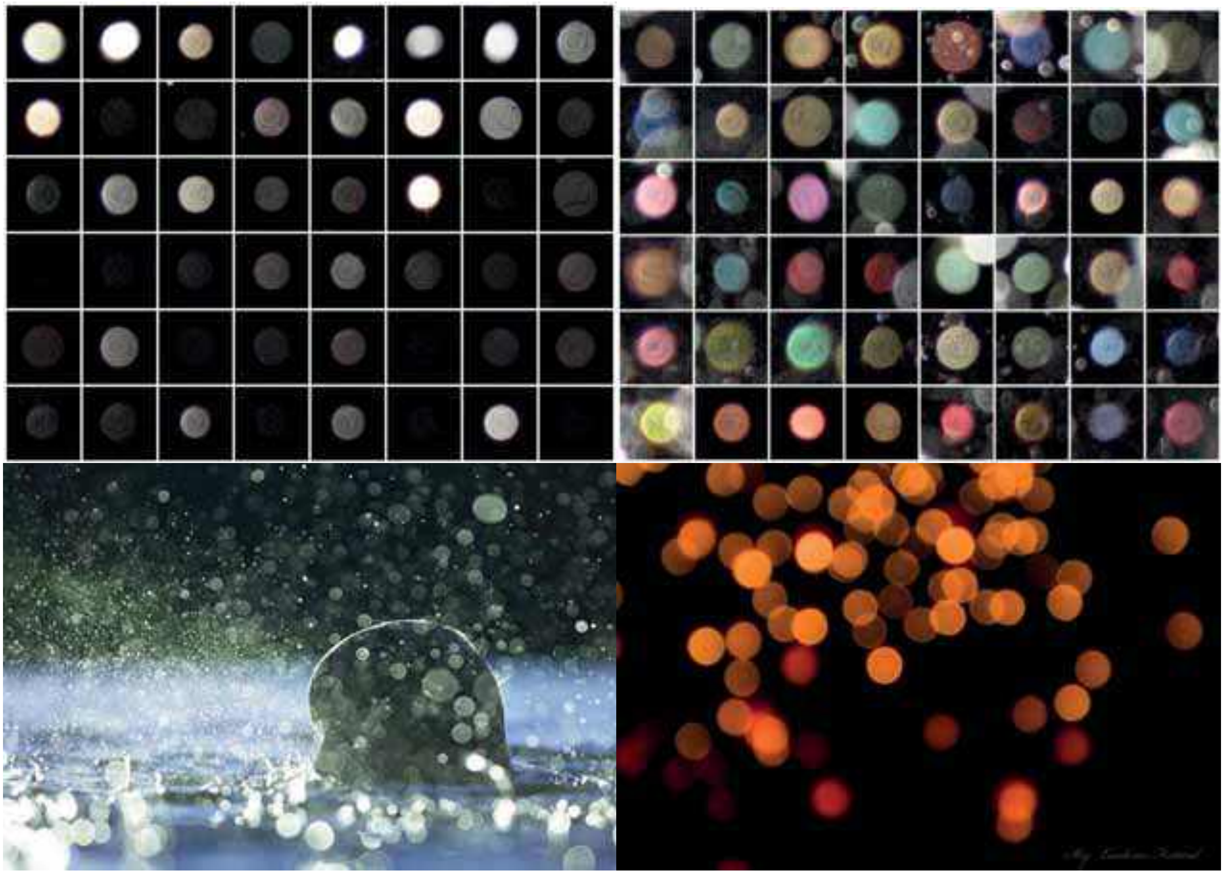


Fig.A-3.13 Dust and drops when shooting back focus (S.Shpakovsky, CC/GFDL)

Orbs are small ball-like light phenomena that are visible in the image afterwards but not at the moment of the photo. These balls of light are often very clearly visible in the image and it is not uncommon for more than one ball to be visible. In practice, this is about one or more very small particles being very close to the camera at the moment of the photo. As a rule, these are small moisture or dust particles and the fact that they are so close to the camera results in the particles being severely blurred. The reason why the particles are illuminated is that they reflect bright light, usually from the camera flash itself.

Fig.A-3.14 Shooting through a floppy disk and a green bottle (M. Zeikan SRCAA "Zond")

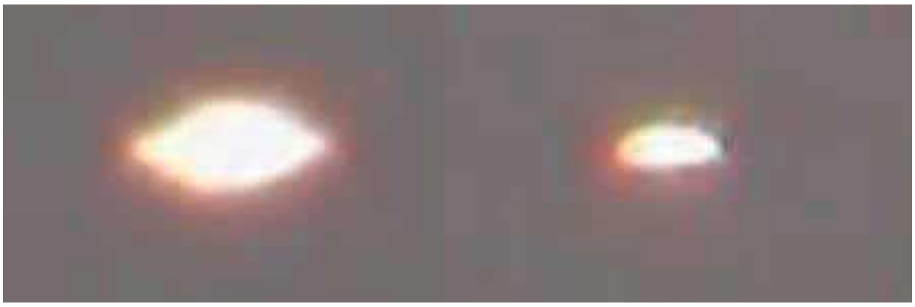


Fig.A-3.15 Aircraft lights when shooting front focus (I.Kalytyuk, CC/GFDL)

Airplanes regularly give rise to reports and it is still one of the most common misinterpretations. However, we need to distinguish between airplanes in daylight and airplanes in the dark. In daylight, the illusion of an oblong or cigar-shaped craft without wings often arises when the airplane is at a relatively great distance and is illuminated by the sun. The sunlight falls obliquely from above (the angle depends on the time of day), and is reflected by the round fuselage down towards the Earth's surface. The incident angle is the same as the outgoing angle. The wings, on the other hand, are also hit from above and this light bounces upwards and does not reach the eyes of the ground-bound observer. For this reason, the fuselage shines brightly while the wings hardly reflect any light at all (they are in shadow). To us on the ground, it appears as if the craft lacks wings and the illusion of a cigar-shaped craft arises.

However, a sunlit airplane does not always take the shape of a cigar without wings. Several factors such as the dispersion of light in the atmosphere, distance and angle of observation affect the shape of the aircraft and a sunlit aircraft can also take on a more round or oval shape. At dusk and dawn when the sun is close to the horizon it illuminates both the aircraft and its contrail from below which can result in both the aircraft and the contrail shining in a bright yellow-orange light and it is not uncommon for the aircraft to be perceived as if it is on fire. If an observer is travelling in a car in the opposite direction to an aircraft it can appear as if the aircraft is standing still because its relationship to objects on the ground, such as trees or houses, is maintained during the car's movement.

Aberrations – are errors in optical systems caused by rays deviating from the directions they were supposed to go in the optical system. Chromatism is light rays of different wavelengths that are focused at different distances.

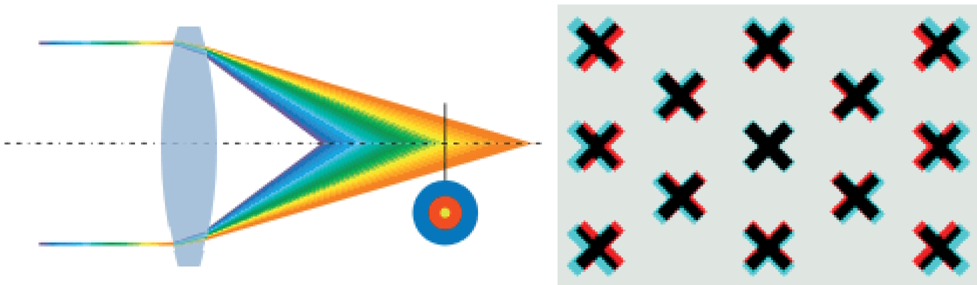


Fig.A-3.16 Chromatism of position – decomposition of rays (dispersion) into a spectrum (CC/GFDL)

Aberrations are divided according to Seidel's classification:

1. Spherical (S_I) – rays of light passing at different distances from the optical axis are focused at different distances from the lens.

Diameter δ' the circle (disk) of scattering is determined by the formula:

$$\delta' = \frac{2h_1 \delta s'}{a'} \qquad \text{(A-3.1)}$$

Where $2h_1$ – system hole diameter, a' – distance from the system to the image point, δs' – longitudinal aberration. For objects located at infinity $a' = f'$ where f' – back focal length.

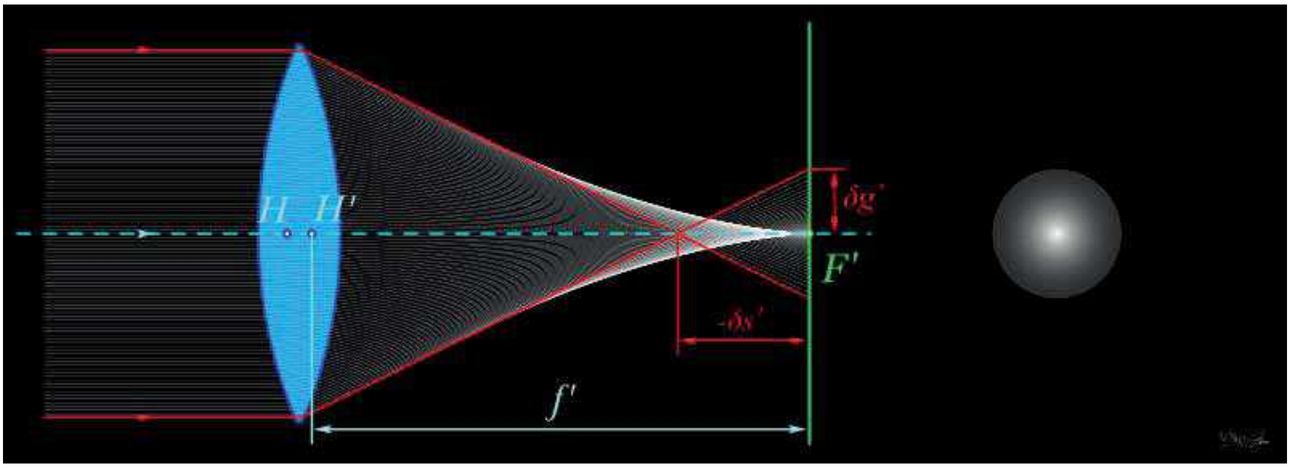


Fig.A-3.17 Spherical aberration diagram (CC/GFDL), where H, H' – position of the principal planes, F' – back focal surface, f' – back focal length, -δs' – longitudinal spherical aberration, δg' – transverse spherical aberration

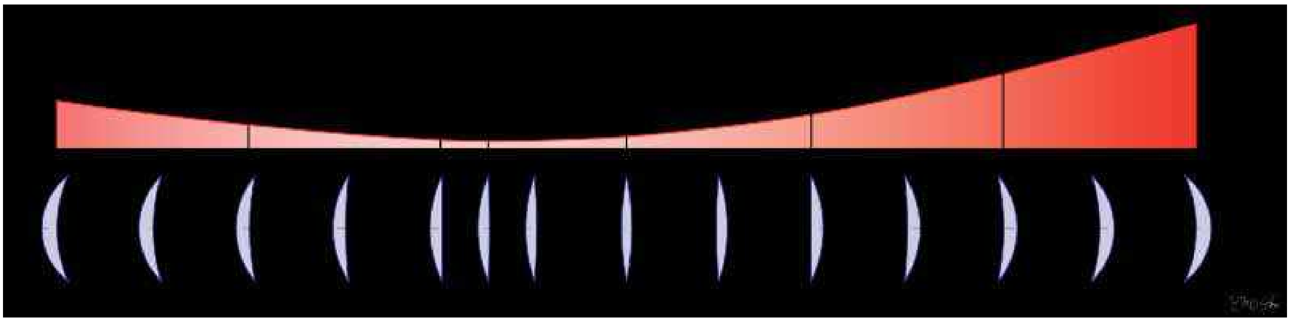


Fig.A-3.18 Dependence of the magnitude of longitudinal spherical aberratio (δs') from the shape of the lens (CC/GFDL)

2. Comatic (S_{II}) – a type of spherical aberration for rays entering the system at an angle to the optical axis, in which the image of a point object is stretched and becomes like a comet.

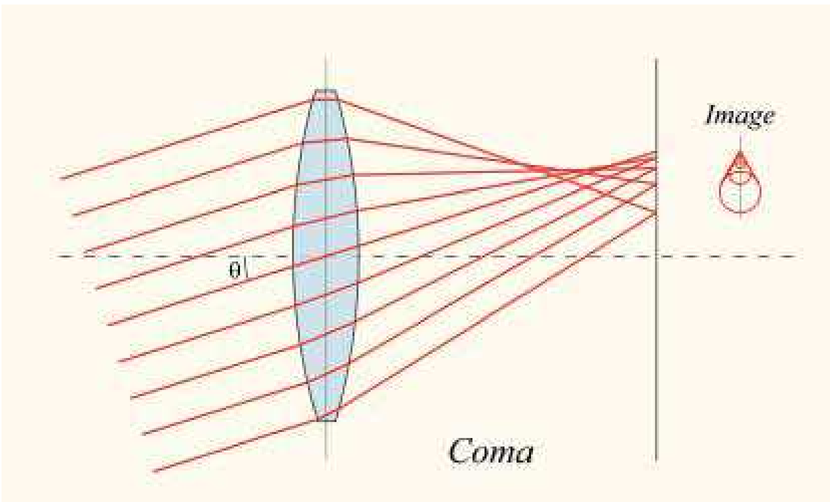


Fig.A-3.19 Coma (CC/GFDL)

3. Astigmatic (S_{III}) – where the images of a point located off-axis and formed by narrow rays are two straight line segments located perpendicular to each other at different distances from the plane without an aberration focus.

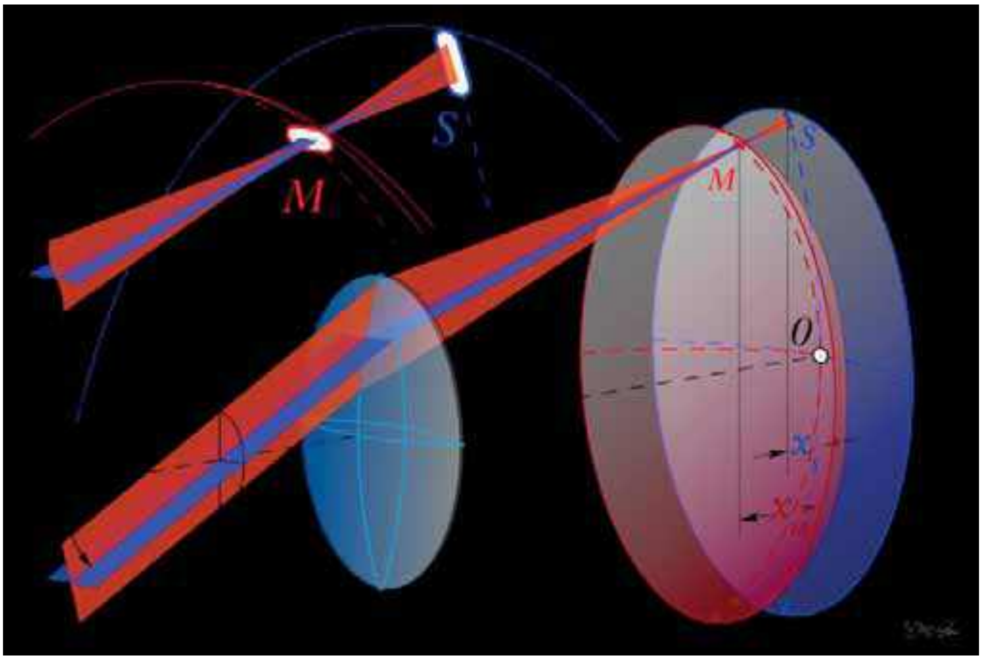


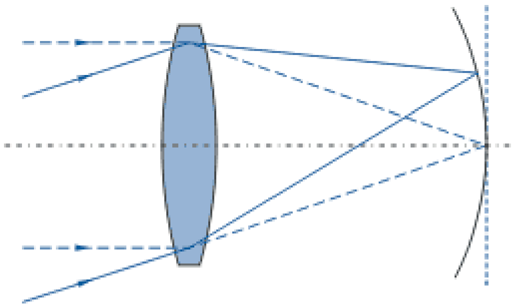
Fig. A-3.20 Astigmatic of oblique rays, where M is the meridional focal surface (perpendicular to the main optical axis passing through the focus), S is the sagittal focal surface. (CC/GFDL)

The meridional component is determined:

$$x'_m = -0,5l'^2(3S_{III} + S_{IV})/f' \quad \text{(A-3.2)}$$

Where f' – focal length of the system, l' – image dot height.

4. Image field curvatures (S_{IV}) – focusing of the beams by an optical system not on a plane (film or digital matrix), but on some surface that does not coincide with it.



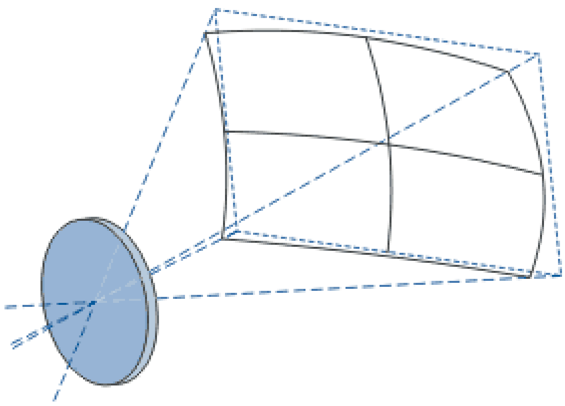


Fig.A-3.21 Image field curvature (CC/GFDL)

5. Distortions (S_V) – geometric distortions that cause straight lines to bend. With barrel distortion, the image of a uniform grid becomes denser at the edge of the field of view, and with pincushion distortion, it becomes denser in the center.

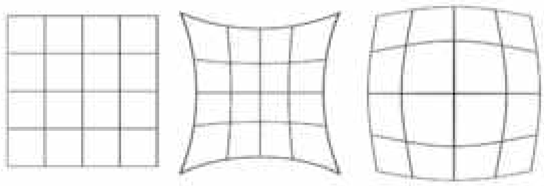


Fig.A-3.22 Image distortions (CC/GFDL)

The amount of distortion can be expressed in terms of relative distortion $V = [(b-b_0)/b_0] \cdot 100\%$, where b_0 – linear magnification of an ideal system without distortion, b – real magnification (at the edge).

Fig.A-3.23 Failed panoramic image due to the parallax, since the axis of rotation of the tripod is not the same as the focal point (CC/GFDL)

Parallax – is a visual perception effect in which the apparent position or motion of an object changes relative to background reference points due to the movement of the observer. In aerial observations this effect can create the impression that a distant object is following the observer, maintaining a constant distance, or changing direction without visible propulsion. This phenomenon commonly occurs when observers view distant luminous objects such as planets, satellites, aircraft lights, or high-altitude drones while moving in a vehicle. Nearby objects such as trees, buildings, or clouds move rapidly across the visual field, while distant objects appear almost stationary, producing the illusion that the distant object is moving relative to the observer. Parallax effects can also occur during stationary observations when the observer shifts their position slightly, causing the object to appear to move relative to foreground objects. For this reason, reliable interpretation of aerial observations requires stable observation points, reference landmarks, and preferably independent observations from multiple locations allowing triangulation. Understanding parallax-related perception errors is essential for reducing misidentification in investigations and improving the reliability of observational reports.

A-3.I.2. Defects in the photo

The probability of artifacts appearing during shooting is not small, since anomalous phenomena in the picture, as a rule, occupy only a small part of the picture field, and since the shooting is carried out with a significant reduction, the absolute sizes of the phenomenon in the picture are small, often commensurate with local defects in it. In addition, it should be taken into account that a person's encounter with an anomalous phenomenon, with few exceptions, is unpredictable both in place and in time; therefore, photography is often carried out by persons who are insufficiently trained as camera operators, and the errors they make are not only varied, but also difficult to foresee, sometimes remaining at a completely elementary level. If we add to this the possible development of photographs in field, poorly controlled conditions, then we can say that this task simply provokes the maximum number of errors in shooting and processing photographic material, and the isolation of the sought-after phenomenon against the background of shooting and development artifacts becomes a difficult operation, requiring from the observer not only good training and considerable experience, but also a stock of information about the forms and origins of many typical artifacts.

First of all, an artifact of any origin is a physically real detail of a photographic image, not directly related in origin to the sought or supposed phenomenon or object. There are, in principle, several ways for artifacts to appear in a photograph. One of them is the entry of any foreign objects into the imaging beam of rays, be it dust particles, fingerprints, defects in mechanical units or anything else, as a result of which their image is constructed and photographed in the frame in the same way as the image of all the details of the plot. Another is general and local unevenness of illumination caused by the features of the primary and especially secondary light sources participating in the formation of the imaging beam. The third is the unevenness of development and other operations of processing the photographic material, for which the multi-stage nature and complexity of processing creates many opportunities. The fourth is an unsuccessful and incorrect shooting angle, errors in sharpness and depth in the frame, violating the correct geometric and brightness relationships of details in the resulting image. Finally, we cannot fail to mention a special group of conditional artifacts - psychological artifacts associated with the ability of the observer to "invent" images, based either on a priori information available to him, or on subjective ideas about the nature and type of the sought-after phenomena; the appearance of hypothetical details, which, moreover, differ in the perception and interpretation of the same image by different observers, seems by no means an exception.

Artifacts caused by photographic material. It is appropriate to mention the presentation of one feature of photographic materials that does not directly create artifacts, but favors the emergence of artifacts, real or imaginary (psychological type) - about the aging of photographic materials, especially distinct among materials on a transparent substrate (films), which worsens the distinction of details in the picture and the recognition of imaginary from physically real artifacts. Aging is understood as a change in the main indicators of the photographic material during the time between its manufacture and use. For the overwhelming majority of negative or reversal films, it comes down to a monotonous (with a tendency to saturation) decrease in sensitivity with a simultaneous decrease in contrast and a slow increase in fog. All these changes are greater, the higher the initial sensitivity of the film and the longer the wavelength region it is sensitized to (infra > pan > ortho). Although the resolving power, i.e. the transfer of small details usually does not undergo significant changes, the image itself becomes sluggish, there is a significant probability of incorrect exposure (underexposure) and, as a consequence of both, obtaining uninformative images, in which it is sometimes difficult not only to distinguish between true details and artifacts, but also to determine what is depicted in the picture. The aging of color photo films is especially great, and in addition to the weakening of the image, i.e. a decrease in its optical density and color saturation, there is also a color shift, i.e. a change in the ratio of the component colors and, as a result, distortion of color reproduction, and therefore the loss of a large amount of information transmitted by color.

An additional contribution to color distortion is made by the aging of the transparent polymer substrate, causing it to turn yellow. These circumstances must be taken into account when shooting and attention must be paid to the passport data of the film, indicated on its packaging. It is also worth mentioning that poor sealing of the package is undesirable for three reasons: firstly, the photographic material is exposed to the effects of man-made components of the surrounding atmosphere, secondly, it is open to dust penetration, and thirdly, it can be exposed through the resulting cracks, especially at the exit of the film from the cassette. The first reason can lead to uniform or spotty fogging or sensitization if there are some chemically active components in the atmosphere, such as SO_2, H_2S, NH_3, nitrogen oxides, exhaust gases, etc., the second - to the appearance of dots on the pictures, the third - to the appearance of typical "crack" blackening. In some special cases (such as the ingress of radioactive aerosols), the occurrence of spotty blackening is also possible. The operator, as a rule, is not given to know either about the conditions in which the film was stored before it came to him, or, even more so, about the degree of hermeticity of the packaging, and he is confronted only with the final result. If the operator has a large batch of film from one manufacturer, one type, one production date of one emulsion number, then one can recommend some trial tests before starting to work with the film; this also checks how aged the film has become. If the available film is heterogeneous in origin, type and age, it remains to rely on a lucky coincidence. In any case, in order not to aggravate all kinds of undesirable phenomena in the photographic material, be it aging, the effect of the external environment or something else, it is necessary to create favorable conditions for storing the film during the entire time that it is at the operator's disposal. Such conditions are moderate humidity (~50÷60%), slightly lower temperature (+10÷12°C), away from chemicals, from pipeline systems of any purpose (heating, sewerage, water supply, gas supply) and local sources of heat or cold.

Another point that deserves serious attention is the occurrence of microbiological damage, bacterial or fungal (mold). Although phenol or other organic substances specially designed for antimicrobial protection are introduced into the photographic material at the end of the manufacturing process, the latter is often insufficient under unfavorable conditions (high humidity, elevated temperature) of storage. In this case, the resulting colonies can cause the appearance of spots due to the liquefaction and washing away of the emulsion in places where they destroy gelatin. Such colonies cannot be destroyed in principle; their appearance and development can only be prevented by reasonable storage conditions. The appearance of round spot-like details of microbiological origin, light on a negative or slide and dark on a positive print, in many cases occupies a significant place among image artifacts.

The appearance of other types of artifacts - lines, stripes, chaotic grids - due to cracking of the emulsion layer during storage is also associated with storage conditions. If we discard the causes associated with violations of the manufacturing technology (improper drying, insufficient plasticization of the emulsion layer and its substrate), which are generally rare and unsystematic, then the main cause of cracking is thermomechanical stresses caused by an incorrect choice of temperature and humidity storage conditions - an excessively dry ambient atmosphere, usually in combination with elevated temperatures. The likelihood of the appearance of these artifacts is sharply reduced by a reasonable choice of storage conditions, and the temperature and humidity mentioned above are quite sufficient in this case. At the same time, it should be noted that excessively low storage temperatures are also unacceptable: starting from +4°C and below, icing of the moisture always contained in the gelatin of the emulsion layer occurs, which causes chaotic local contractions of the emulsion layer, moreover, not coordinated with the thermal changes of the substrate, and the consequence is a violation of the integrity of the emulsion layer.

The dielectric properties of photographic films are also essential for the occurrence of artifacts, and they differ greatly in their parameters for the two component layers - the substrate and the photoemulsion. The production of photographic film is associated with the continuous transport of a flexible polymer base through the units and tracts of coating and finishing machines; starting with the application of the emulsion and auxiliary layers (and in the case of multilayer color photographic films, the number of successively applied layers exceeds ten) and ending with drying, perforation, marking, winding on axles, etc. In each unit and tract, mechanical friction is present to one degree or another, leading to triboelectrification of the photographic material and the accumulation of static charges on its layers. This cannot be completely avoided, despite the presence of a special antistatic coating among the auxiliary layers. Residual charges during storage cause local streamer discharges, specifically in the emulsion layer (these are the consequences of the dielectric differences between the two layers), which are registered by it in the form of Lichtenberg figures, i.e. branched black lines. These artifacts can easily be confused with discharges in the supposedly anomalous phenomenon being photographed. Moreover, the described form of discharges is not the only possible one: for example, chains of elongated dash-like spots (with discharge from the side of the substrate) and some other discharge patterns are known, which can be attributed to certain details of the phenomenon being photographed, although in fact they are not.

Among the sources of artefacts, the non-uniformity of the emulsion layer itself, caused by various reasons, should also be mentioned. One of them is the clumping of the emulsion before irrigation; with the exception of some very special cases, clumping is caused by the emulsion enveloping solid aerosols that have gotten into it, and the latter is possible only if the dust removal systems of the irrigation areas are imperfect and is excluded in a well-established production. Another reason for non-uniformity is more difficult to eliminate - the presence of air microbubbles that have not left the emulsion layer at the drying stage. This defect is most often not distinguishable by the eye (the bubbles are too small), but even in an indistinguishable state it can cause some blurring of the edges of parts, especially small ones, due to the scattering of light during shooting, i.e. partial loss of true information and the formation of false information. Bubbles, indistinguishable on the negative, become noticeable when printed with enlargement and can be one of the causes of artifacts on a positive print. Finally, the non-uniformity of the emulsion layer in thickness is completely impossible to eliminate - either a wedge shape, creating an increase or decrease in all the blackening in the frame in the direction of the film length, or the so-called ironing board (waviness), causing striping perpendicular to the length of the film.

There is another group of emulsion defect that can significantly reduce the information content of the resulting images, but their contribution to the occurrence of artifacts is insignificant. This refers to mechanical damage to the emulsion layer, primarily scratches, punctures, layer shifts (most often near perforation holes), etc. These damages are usually recognized without any particular difficulties, it is difficult to confuse them with image details, and the appearance of imaginary details due to them occurs much less often than the loss of the necessary details.

The list listed here does not exhaust the entire variety of defects in photographic materials and their emulsion layers that are known to date, but within the limits of the task set to identify defects that can lead to the appearance of artifacts in images on negative and reversal photographic and motion picture films, the list presented can be considered sufficient. We do not consider it necessary to note those defects that arise from the operator's incorrect and careless handling of the film and which are considered necessary to talk about in various manuals such as "To help the novice amateur photographer"; firstly, the operator photographing anomalous phenomena is more advanced in this matter than the addressees of the aforementioned manuals, and, secondly, of all the possible defects associated with unskilled handling, only one is artifact-dangerous - fingerprints on the emulsion layer; it is hardly necessary to warn about this someone who often and a lot uses photography

<u>Artifacts caused by shooting</u>. This group of artifacts, as well as the causes that generate them, is very broad. Here, even within the limits of a rough classification, there are at least several types of causes, such as defects in the operation of the optics and mechanics in the shooting camera, errors in the choice of lighting and the installation of light, incorrect choice of exposure (including failure to take into account the age of the film) and incorrect aiming, failure to take into account the real speeds of dynamic processes related to shooting, etc. The presentation will be built in accordance with this internal structure of this group.

Speaking about camera operation defects, we should, in essence, limit ourselves to the initial stages of systematic defects or single non-repeating failures in its operation. As soon as the defects become significant or repetitive, they will obviously attract attention, and such a camera will stop being used. In addition, not all defects lead to the formation of artifacts, although they can significantly spoil the image: for example, the uneven movement of the shutter curtain creates unequal exposures in different parts of the frame, and, as a result, either striping in the direction of its movement, or an increase in the dark background from one edge of the frame to the other, but, as a rule, does not create artifacts due to the relatively large area of such defects in the picture. In reality, only one defect in the operation of the mechanics creates artifacts - the unlocking of the frame rewind and shutter cocking mechanisms, which generates their independent operation and, as a result, makes double shooting possible on one frame. The result is obscure images, in which the human ability to "invent" itself gets a wide scope and often allows us to see almost anything: from the Moon with a human face to a satellite flying around a lantern. As for optical defects, their participation in the formation of artifacts is more significant and more diverse. The lens of any modern camera is a multi-lens system consisting, except for special cases, of spherical lenses with a common main optical axis. In the production of lenses, its lenses, after appropriate centering, are fixed in a rigid frame, and if their tight contact is necessary, they are glued together. As long as this rigid fixation is maintained, there are only two main reasons for the appearance of artifacts due to optics: front lighting during shooting, direct or oblique, and the presence of dirt, primarily on the front surface. The first reason causes internal reflections inside the lens (at glass-glass, glass-air, glass-glue interfaces, and also from the inner surface of the lens frame), which hit the photographic layer in the form of highlights, spotted or ring-shaped, of varying geometry; in the developed image, their shapes, sizes, and often other features are determined by the angle of incidence of light from the sources and the design of the lens.

Since in this case there is a defect in the camera operator's work, it is impossible to eliminate the artifacts that arise, but the method for eliminating them in the future is radical and extremely simple - replacing the operator or improving his skills (the word "skill" is hardly appropriate here). As for contamination, as long as the dirt remains in the form of individual particles on the lens surfaces, the artifacts look like out-of-focus, blurry light spots (on the negative), reproducing dirt particles in shape and identical in position in successive frames. The front surface of the first lens is especially easily soiled, where atmospheric dust and dirt are often accompanied by fingerprints on the glass - traces of unskilled handling; the latter form a system of stripes on the image, common for fingerprinting. Prevention of such artifacts is simple - by regularly washing the lens, but for some reason this is always done, perhaps due to the well-known composition of the cleaning fluid.

A more serious defect, lens delamination, which disrupts both the mutual distance and the centering of the lenses, cannot be eliminated by one's own efforts. Advanced delamination leads to lens defocusing, which worsens the sharpness of the resulting images, but only indirectly affects the appearance of artifacts, to the extent that any blurriness opens up wide opportunities for "speculation." At the initial stage, when the lens displacements are small but not strictly axial, additional internal reflections and interference rings of equal thickness arise; as a result, an interference pattern is superimposed on the image being formed, sometimes in combination with glare.

The greatest number and variety of artifacts of filming origin are associated with incorrect lighting and incorrect camera positioning relative to light sources. What can happen when front light hits the lens during filming has already been partly said above, and it remains to add that the use of additional optical elements in the lens itself (anamorphic attachment, movable front lens, etc.) or in combination with it (color, attenuating, polarizing and other light filters) only expands the variety of artifacts due to errors in the choice of lighting conditions. In addition, an increase in the number of elements that make up the lens makes it especially sensitive to distortions of the added elements relative to the previous ones, increasing the variety of glare shapes and their number even more. There is no need to see salvation from glare in front lighting in the use of protective "visors" placed on the lens: although they prevent direct front light from entering the lens to some extent, they also obscure the field of view of the lens, and asymmetrically and to a greater extent, the more they shield the lens from direct light; as a result, uneven illumination occurs across the frame. As for the interpretation of the listed glare and streaks, it strongly depends on the subject of the frame, which sometimes provokes the discovery of anomalous phenomena where there are only artifacts.

Another source of glare in the frame, associated with the reflection of the front light, is the lens blade diaphragm. Although it is blackened, there are known cases and reasons for its gradual or "emergency" blackening, which leads to the appearance of additional glare, and if the "emergency" blackening was associated with an "emergency" violation of the symmetrically coordinated movement of the blades (for example, by impact), then the picture becomes even more complicated and the possibilities for the appearance of artifacts expand. It is hardly necessary to specifically stipulate that "emergency" changes in the movement of the blades in central-type shutters lead to similar consequences; the only consolation here is that such shutters are quite rare in modern cameras, and curtain shutters do not create such artifacts.

There are several other reasons for the appearance of artifacts due to unsuccessful distribution of lighting, and they are by no means unknown, but not always taken into account. The first such reason is the presence of bright glare in the subject itself; thus, the reflection of the Sun or bright arc light sources (the latter is typical for outdoor or studio filming) from window panes or metal objects, especially non-flat ones, in the background creates black disks, spots, rings in the negative image, sometimes with a halo, interpreted quite arbitrarily if the presence of glare in the photographed subject was not noticed. A similar situation can be created by headlights, lanterns, lamps and other details in the subject, especially when shooting at dusk. Another reason from the same series is the presence of fog, steam, smoke and other strongly light-scattering or light-absorbing media in the subject; in color photography, colored smoke, typical of many chemical and metallurgical plants, should certainly be added to them. The presence of such objects significantly distorts the distribution of illumination in the image, and in color photography - also the distribution of colors, and leads to the appearance of artifacts. Another reason is the presence of pools, fountains, jets, water surfaces in the plot: depending on the specific situation, with the participation of active light sources, they can form in the plot, along with glare, also halos, rainbow arcs, etc., giving food for "imagining" the situation when familiarizing yourself with the resulting images.

The next group of shooting errors that can cause artifacts is related to exposure errors. This will lead to the most undesirable consequences if the subject contains an object that is significantly brighter than all other elements of the subject, and the exposure error is such that it results in overall underexposure. Then the resulting negative image will contain a fairly black detail on a weakly expressed or completely absent background, i.e. a strongly distorted picture in which the main detail, due to its unusual surroundings, can produce the impression of a completely different object and cause false associations.

Although the considered unfavorable combination of incorrect exposure with the features of the subject is not the only possible one, its example clearly shows how such unsuccessful combinations initiate erroneous conclusions. Here it is appropriate to make the following remark. Along with the obvious reasons for incorrect exposure, such as poor performance of the exposure meter or input of erroneous data into it, defects in the shutter operation, etc., there is another reason, not very well known to operators and almost never taken into account. We are talking about the age of the photographic material and the associated degree of aging, i.e. (in the first approximation) about the loss of sensitivity, and, as noted above, with a tendency to saturation, i.e. reaching a new constant, but reduced level of sensitivity. Existing industry standards and specifications proceed from the fact that a decrease in sensitivity by a factor of $\sqrt{2}$, i.e. by 40%, is allowed for the entire warranty period indicated on the packaging; if this condition is met, then, it is assumed, no corrections for the discrepancy between the actual and nominal sensitivity of the material need to be introduced when solving the exposure metering problem. There are many doubts as to how true this is. More directly related to the occurrence of artifacts are errors in camera orientation, camera setup, and focusing. At first glance, such circumstances as camera orientation relative to the subject of the shot, composition of the subject, and choice of boundaries of the subject being shot should not, by their nature, lead to the generation of artifacts. However, this statement bypasses the ability of the observer of the image to "speculate", in this case to imagine the subject together with objects not included in the frame, which, in the observer's opinion, may have been outside the frame; this directly leads to an increased semantic load on details along the edge of the frame, a desire to see in them a part of something that remained outside the frame. The same logic is generated by an unusual or unsuccessful position of the camera during shooting, distorting the perspective or the usual angle. As for focusing, in addition to the possible general blurriness, which opens up scope for "speculation", there is also such a defect as a discrepancy between the lens and the subject in terms of the depth of the sharply depicted space; the direct consequence of this discrepancy is the isolation of clear details on a blurry background or blurry details on a clear background in the resulting image, which again opens up wide possibilities for "speculation", and in fact - inadequate judgments and conclusions.

The appearance of artifacts without introducing unnecessary details, but only on the basis of speculation, can also result from failure to take into account or incorrect accounting of dynamic processes and their speeds in static shooting conditions. We are talking about shooting moving objects at speeds of their shift in the frame much greater than the shutter speed, as a result of which various forms of "blur" occur. In principle, "blur" is also possible in dynamic shooting (i.e. cinema), if the shooting frequency is small compared to the inverse value of the time of visually distinguishable displacement of the object in the frame. Finally, "blur" can also appear as a result of the imposition of vibrations, for example, of a tripod or hands, on the connection in the "object-camera-film" system. All the "blur" variants result in a split or more multiple decomposition of one image of an object into a series (sometimes continuous) of its similar images, making the object blurry, partially transparent relative to the objects located behind it, introducing changes into its usual configuration, in a word, opening up wide scope for "speculation". As the simplest and most obvious example, here we can name the familiar pictures of evening streets with clearly expressed "dematerialization" of cars and their replacement by stripes from moving headlights, but this is only one example, and the variety of expected artifacts in such situations is obvious.

Artifacts caused by development, fixation and drying. The process of chemical-photographic processing includes several working stages (development, rinsing, fixation, washing, drying), not to mention preliminary preparative, and often also optional or auxiliary (stop bath, strengthening or weakening, vibrating, etc.). That is why this process is especially rich in sources of artifact formation. They are laid already at the stage of preparation of working solutions, when excessively cold water or the wrong order of dissolution of the developer components can lead to incomplete dissolution of chemicals and, as a consequence, to their individual and not combined action on the photographic material or even precipitation of chemicals in the form of crystalline deposits; in all such cases, the result is the appearance of spots or stripes, even if the deposit itself can be destroyed and washed off. Furthermore, when working with solutions that have already been used or stored for a long time, there are also a number of reasons for the appearance of artefacts. These include, for example, the formation of solid precipitates in solutions (a case similar to incomplete dissolution of components), as well as partial oxidation in the presence of air, which is expressed in the appearance or change of the color of the solution; associated with the subsequent depletion of the developer, it manifests itself in the form of light stripes or spots on the negative, especially with poor mixing, and the depletion of the fixer and its saturation with silver complexes - in the form of precipitation of the latter on the film, which causes spotting, black (undesirable in any case) or brown (especially undesirable in color photographs). Artifacts are also often formed during the preparation of the film for processing, especially at the development stage. Thus, touching the dry emulsion layer with conditionally dry hands forms a thin greasy film on it, corresponding in shape to fingerprints, preventing the initial penetration of the developer and forming an inverted fingerprint on the developed image.

Touching with wet hands, on the contrary, softens the gelatin in the places of finger contact and facilitates the penetration of the developer in the corresponding areas, creating a direct fingerprint on the developed image; additional complications in this artifact picture are introduced by fingerprints moistened with the developer when immersing the film in the fixer. Artifacts of the origin considered here can also arise without the participation of hands due to careless handling of vessels or baths, which may cause at least minor splashing of solutions or the transfer of one to another; Thus, drops of fixer falling on the film before it is fixed causes "premature" lightening in individual points, which does not disappear after the film is fixed and remains in the form of light spots on a darker background. In the case of color development with reversal, when there are two stages of development - black and white and color, separated by bleaching, as well as additional washes and uniform exposure - the possibilities for the occurrence of artefacts are even wider.

A significant number of artifact varieties arise during development. It is generally accepted that development is always carried out with sufficiently intensive stirring of the solution, manual (with a brush, by shaking), mechanical (by the same methods or by rotating blades immersed in it), gas-dynamic (by blowing a stream of gas that does not oxidize the developer, for example, nitrogen) or other. At the same time, stirring cannot be brought to the intensity of "shaking", since the entry of air bubbles through the solution to the photoemulsion layer can lead to their adsorption on the emulsion surface and to its peculiar screening from the developer, which after development is revealed as a multitude of small light spots on the image. It is also possible that the developer gets to the emulsion through the perforations instead of moving along the layer, and this leads to the appearance of striped leaks directed across the film, sometimes radial. However, it is impossible to completely abandon mixing or reduce it to a minimum, since other types of artifacts arise: either multiple dots due to insufficient removal of oxidized developer from the layer, or so-called marbling, most often due to uneven and incomplete removal of the resulting potassium bromide and other products of oxidation-reduction reactions. Thus, the mixing speed is limited quite strictly both from above and from below.

It is also necessary to note here the artifacts caused by incorrect or careless placement of the film in tanks and developing trays. Thus, film sticking together before or during development, which is especially likely in tanks, leads to underdevelopment in the stuck areas, which is expressed in the form of either spots or stripes, depending on the adhesion geometry. In flat trays, the adhesion sites are sometimes the ribs of the bottom, and the result is stripes with the corresponding width and mutual distance. If a tape such as Correx is used when winding the film on an axis, adhesion to the tape is possible, and the shape of the artifacts reflects the geometry of such adhesion. It is not always possible to prevent the appearance of such artifacts, but the existence of adhesion is usually discovered at the end of development when transferring the film from the tank or tray and should serve as a warning about the probable presence of artifacts, and therefore about the need to neglect them when analyzing the image.

Along with sticking and insufficient mixing, artifacts are caused by temperature fluctuations in the developer (uneven development of the film occurs, especially along its length), as well as its incorrect setting (leads to a strong fog at an elevated temperature and a general sluggishness of the image with a loss of some details - at an underestimated temperature). In eliminating temperature fluctuations, which most often occur when replenishing the developer with fresh, an important role is again played by mixing, and immersing the bath or tank in a second bath with running water (if there is no simple thermostat at hand) prevents incorrect temperature setting. Marbling, already mentioned above, consists in the formation of wide and arbitrarily contoured light areas (usually wider across the frame than along its height) on the negative and, accordingly, dark ones on the positive; Although they generally resemble billowing smoke, they have an internal structure of the "vein" type (lighter or darker relative to the background), which, together with the complex and steep changes in blackening at the edges, really gives a resemblance to a block of marble.

Another reason for the occurrence of extended artifacts is the formation of deposits and sediments from insufficiently dissolved components of processing solutions and reaction products of solutions with the photoemulsion layer, especially at the development stage. When these deposits or sediments are superimposed on the developed image in transmitted light, imaginary image details arise, and since deposits and sediments are not always neutrally gray in tone, they especially easily form artifacts in images on color film. Among non-neutral deposits, sulfide deposits are most common, which are possible already at the development stage (if the developer is greatly depleted), but are much more frequent at the fixing stage. Let us recall that almost all fixing solutions contain sodium or ammonium thiosulfate as their main component, i.e. a salt of the MS-(SO_2)-OM structure, where M is a monovalent metal or ammonium; therefore, the substitution of M by Ag in the MS group during fixation will inevitably lead to the formation of Ag_2S, if not immediately, then gradually. The only way to avoid subsequent formation of Ag_2S and to remove the existing one is to thoroughly rinse in running water after fixation; for films intended for long-term (many years) storage and use of the resulting images, rinsing is strictly regulated, and the permissible maximum content of residual thiosulfate in the fixed layer is specially stipulated and controlled.

Any other solution operation, whether it is the main one (like a stop bath in the case of color films) or additional (like toning, reinforcement, etc.), also makes a certain contribution to the formation of artifacts, but in their appearance these artifacts are similar to those considered above, and in terms of the frequency of their appearance they are comparatively safe. More complications, despite their apparent simplicity, are introduced by the obligatory stages of washing and drying. The swelling of the developed photoemulsion layer, considerable already by the beginning of the final washing, increases even more during its course and can contribute to the peeling of the gelatin matrix carrying the finished image from the substrate, especially in excessively cold water. If the peeling is local, it leads to deformation of the image and disruption of the geometric shapes and proportions in it. Sometimes adhesion is restored during subsequent drying, but if air bubbles remain between the gelatin and the substrate, a peculiar spotting occurs, and the image geometry remains distorted; if the peeling goes far, then adhesion cannot be restored, and the image deprived of the substrate is geometrically deformed to the point of complete loss of information value. Drying is no less dangerous: in the case of an unsuccessful thermal regime, it can cause contracture in the image and directly form artifacts, but even if the thermal regime is chosen correctly, other possibilities remain. Thus, the collection of water in drops during drying leads to the appearance of light spots under them on the drying film, and uneven drying due to insufficient circulation of warm air along the sagging film creates water streaks, which leave stripes. Thus, the process of chemical-photographic processing practically does not contain artifact-safe stages.

Artifacts caused by printing of photographs and viewing of negatives. If the object of study is the obtained negative, it is assumed that for this purpose it is placed in some projection or other magnifying optical system, at least if the film format does not exceed 35 mm. However, more often it is not the negative that is studied, but the positive printed from it, again obtained by magnifying. This gives a significant similarity to the artifacts in the two cases and allows both cases to be considered in one section. However, it is impossible not to immediately point out certain differences that arise due to the fact that when viewing a negative, only the "innate" artifacts of the negative and the artifacts of the optics-screen system are present, and when printing, a whole set of artifacts brought in by the positive photographic material (paper) and the process of its chemical-photographic processing are added to this. Therefore, it is reasonable to begin the presentation with the artifacts of viewing.

The artifacts introduced by the optics and mechanics of any viewing system should generally coincide with those of photographic equipment, but there are fewer possibilities for them, primarily because the design of the optical system is much simpler: it is enough to recall that projection lenses and micro objectives for the purpose under discussion rarely contain more than three lenses, and viewing magnifiers - more than two; accordingly, the possibilities of glare and ring formation when lenses come apart are greatly reduced, and in combination with the almost complete impossibility of incorrect lighting, the absence of a number of artifacts characteristic of camera optics is practically guaranteed. For similar reasons, artifacts caused by mechanics are also eliminated, which in the case of, for example, a magnifier is completely absent. The presence of measuring scales and grids in some magnifying glasses, eyepieces and more complex viewing devices does not introduce artifacts, unless they have become unglued or cracked (otherwise, these defects are superimposed on the viewed image). In some cases (such as projection equipment), an additional artifact-prone element is the screen, the surface of which is often non-uniform, but it is easy to exclude artifacts here: it is enough to move the screen to the side and see if the expected details of the projected image shift. Thus, when viewing negatives, the only details that are suspicious in terms of artifact are the inherent "innate" artifacts of the viewed image, which remained unnoticed due to their small extent when viewing the negative by eye and were revealed only after optical magnification.

Bearing in mind the above, it is easy to assess the significance (or insignificance) of some ways in which artifacts may arise in the case of photographic printing of positive images. Of course, there are still “innate” artifacts of the negative. The role of the mechanics of the projection printing apparatus is vanishingly small, and some exceptional combination of circumstances is needed for “smearing” to occur during printing. At the same time, the optics of the projection device can make some contribution, since it includes a multi-lens projection objective, often with a leaf shutter and a color filter. The presence of a large distance between the lens and the photographic paper on the table opens up wide opportunities for the occurrence of dust and dirt artifacts in the projecting light beam. Of the other previously considered possibilities for the occurrence of artifacts, all that remain are those associated with the photographic material. Although the heterogeneity of the emulsion plays a smaller role here, the role of the heterogeneity of the paper substrate, which carries a layer of highly dispersed $BaSO_4$ powder, increases significantly. All artifacts associated with chemical-photographic processing also remain. At the same time, some types of artifacts specific to the production of prints also arise. It is also necessary to note the appearance of graininess, barely noticeable in the negative, but distinct in the positive, if the magnification during printing is high.

One of these specific types is caused by interference effects of equal thickness (ideally, Newton's rings). They may arise already when the negative film is introduced into the projection head, if the required degree of film flatness is not ensured, but much more often they occur due to the non-flatness of the photographic paper. This is especially noticeable in copy frames, where the required tight contact of the negative and the pressure glass is often disrupted by incompletely displaced air, creating thin local gaps; however, the same situation is reproduced in projection copiers if the paper on the table is leveled with a plane-parallel pressure glass. This glass is also capable of forming artifacts such as striped highlights due to multiple reflections.

Specific artifacts, inherent only to photographic papers, but not to films, are some artifacts associated with drying after completion of the wet stages of processing. If washed prints are left in a free state to dry naturally, they curl so strongly that without straightening they are completely inaccessible for examination; any straightening of them is associated with strong mechanical stresses, often ending in cracking of the gelatin of the fixed layer and the formation of a web-like network. If wet prints are rolled onto sheet glass or metal before drying, several types of artifacts are possible. For example, a metal sheet that is excessively hot at the time of rolling causes bubbling and spotting of the “lichen” type on the positive at the time of peeling off the photograph. These artifacts can be aggravated by triboelectrification of the metal or glass at the time of rolling the print, if the latter is not sufficiently wet.

The lighting of the photo room when printing photographs deserves special attention as a source of artifacts. The fact is that films, as a rule, are developed in complete darkness; papers, on the other hand, are usually considered to be unaffected by the orange-red, and sometimes yellow, parts of the visible spectrum. This statement, while generally true, requires two reservations. First, the red part of the spectrum is not as harmless as is commonly believed: its prolonged exposure can cause partial destruction of the latent image in undeveloped prints, the so-called Herschel effect, which will be revealed after development. Second, the lamps with color filters that illuminate the photo room are often not sufficiently light-tight, either because of the looseness of their housing or because of cracks and gaps in the light filters in their windows; Due to this, white light gains access to the photographs, including before the end of development and fixation, and causes the appearance of darkening in the form of stripes, angles, uneven background, etc. If the first circumstance plays a role rather as an exception, then the second is quite likely in many cases, although it is easily eliminated by careful inspection of the lamps and sealing or painting over the cracks.

Finally, it is necessary to mention the aging of photographic papers, which is as characteristic of them as of any other photographic materials. The change in sensitivity with aging is of little importance for papers, since the accepted practice of choosing exposure with the help of test prints eliminates the influence of this factor. The change in fog during storage of photographic papers is generally much less than during storage of photographic films, although on strongly aged photographic papers a uniform gray fog is often encountered. A drop-in contrast as a result of storage is also more the exception than the rule, although on some high-contrast papers the decrease in contrast is significant and irreversible. The most serious source of artefacts associated with the emulsion layer of photographic papers is the substrate, which always contains iron and copper ions in varying concentrations, capable of locally forming oxidation-reduction pairs Fe^2/Fe^3 and Cu/Cu^2 and, as a consequence, spotty desensitization (brightening) and spotty fog (darkening). To prevent this, the iron and copper content in substrates was first strictly regulated, and later polyethylene coating of the substrate was introduced to isolate it from the emulsion.

Fig. A-3.24 Defect of Polaroid type cameras that take instant photographs, where in case of deformation of the plate or contamination of one of the rollers, which distribute the developing solution evenly over the entire emulsion layer (V. Andreev)

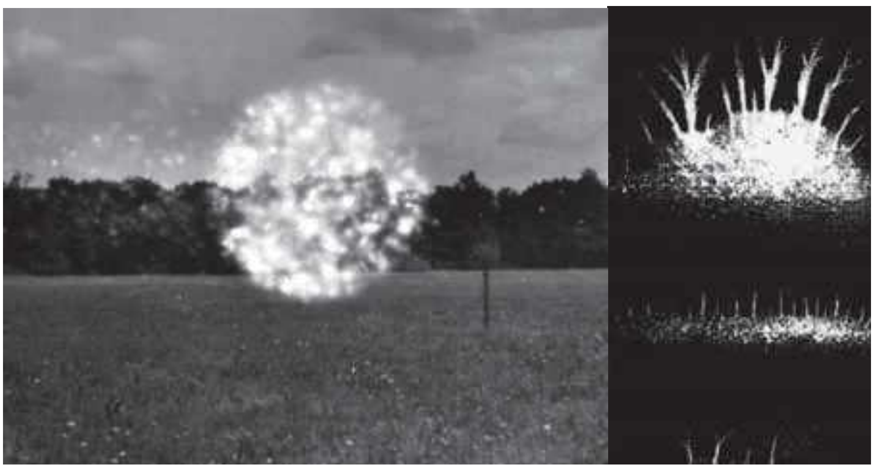


Fig.A-3.25 Flares caused by camera malfunction and foreign particles on the film (CC/GFDL)

Fig.A-3.26 Traces of air bubbles that got into the solution during the process of developing the photograph (S. Yefimov, I. Lazarov)

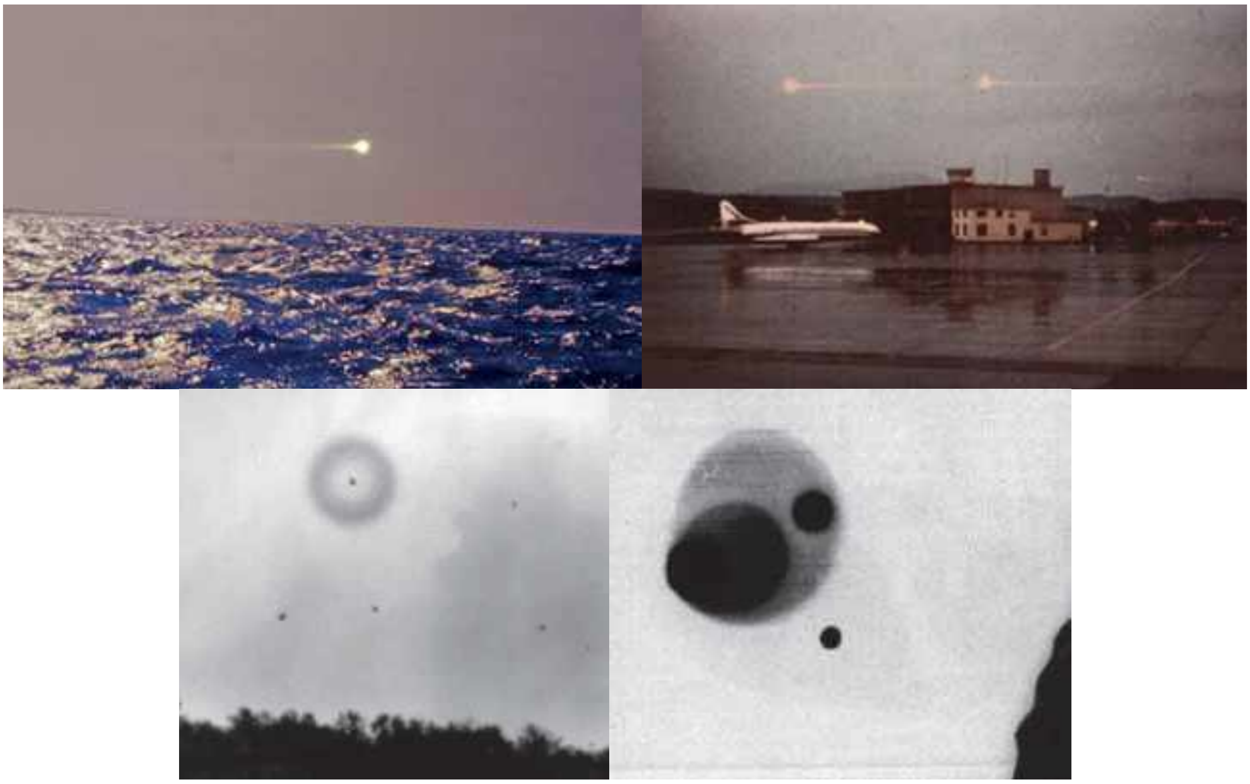


Fig.A-3.27 Chemical defect of emulsion (CC/GFDL)

General information about the structure and function of the camera

A camera is a light-collecting instrument for making a visual image. The light that is collected is often reproduced as a photograph, physically or digitally. All results depend on the light that is collected and how it is made during the exposure time.

Analog camera – the type where light is collected chemically using film, which is then developed into a negative.

Table A-3.2 Defects in film development

Nature of the defect	Cause
Transparent spots on black and white negative. Dark spots on positive.	When the film was lowered into the developer, air bubbles formed on it, preventing the areas of the image underneath from developing.
Dark spots on black and white negative. White spots on positive.	When the film was lowered into the fixer, air bubbles formed on it, preventing parts of the image from being fixed. Subsequently, such parts are overexposed and acquire a dark color.

Digital camera – the type where light is collected electronically using a light-sensitive sensor, which then produces an image via software. The image is made up of a large number (several million) of separate image elements, called pixels.

Optical zoom is the physical adjustment of the focal length of the lens, and thus the size of the angle of view that is included in the image, which is done using optics. Optical zoom does not crop the image sensor and the full resolution is utilized in the digital camera.

Digital zoom is a concept designed to mimic optical zoom, but which actually only falsifies the angle of view and thus what is captured. Digital zoom is image-destructive or possibly in some cases just image-degrading. To counteract the destruction of digital zoom, the light information is interpolated based on a more or less good algorithm, often depending on the price and age of the camera. This means that the result has the same number of picture elements, but much less information. Mobile cameras interpolate images that are digitally zoomed in, which makes the result even worse. This is often compensated for by having more cameras with different optical/physical focal lengths.

Damaged pixels – tiny, delimited spots that are visible on all images regardless of the lighting conditions and aperture used, can be dead pixels on the camera sensor. A dead pixel can no longer register light. This means that you always get a black dot in the image where the pixel is located.
A stuck pixel, on the other hand, locks at the maximum light value in one of the color channels red, green or blue. This can then form a dot that affects surrounding pixels.

Overexposure and underexposure – these two terms mean that the time for light collection is too short or too long, which means that the amount of light is too little or too much and that the information is distorted in relation to an optimal depiction of reality. In practice, this means that the image is too bright (possibly with the consequence that parts of the image are drowned in light) or too dark.

Burnout – when the light becomes too much for the camera, it eventually reaches a wall, called burnout. There is no detail or color information in the burnout. When this occurs in a photo, it has been burned out. In some older digital cameras, the burnout turned black instead, which can sometimes look like a black sun (if the camera has been pointed at the sun). Burnout means that the image is so underexposed that no information is recorded. All that is visible is then a dark image or dark parts of an image.

Camera shortcomings and reality-distorting effects:

Spherical aberration means that light outside the lens' optical axis is refracted at a focal point in front of the film plane, the sensor plane - the further away from the axis, the greater the error. This results in poorer sharpness at the edges of the image and especially at the corners.

Chromatic aberration negatively affects the quality of the image because the material used to make lenses has different refractive indices for different colors, and for this reason parts of the image can become colorful in different shades that were not visible to the naked eye at the time of the photo. Simply put, plastic is worse than glass lenses. There is also a natural correlation between the price of the camera and the quality of the result.

Coma is an effect that can occur when using extremely wide-angle lenses, when objects take on a deformed shape in the image. An example would be that a ball does not become round but more like an egg, but of course it affects everything that is depicted, even though human perception perceives known geometric shapes more easily.

Vignetting is an effect that can occur because the lens on a camera is round while the sensor is rectangular. This means that the image can be darker in the corners than in the middle.

Distortion is when straight lines in an image are not depicted as straight. Some lenses can change the type of distortion from the shortest to the longest focal length. Other subject details than straight subjects are also affected by the distortion but are more difficult for human perception to perceive.

Diffraction is simply expressed when light is bent at sharp edges such as at the edge of the aperture, which can cause the reproduction to be incorrect. Diffraction is due to the physical nature of light as wave motion. Diffraction-limited lenses, which are often found in a telescope, usually have a very limited field of view where sharpness is optimal.

Bokeh is defined as "the way in which optics render objects that are not in focus". Out-of-focus light points in the background appear with the shape of the lens aperture. Blurred points in the background can also appear to rotate around the optical axis. Round points then become oval and curved radially around the optical axis.

Debris on the sensor – can occur in system cameras, where the sensor can be exposed between lens changes. Because the sensor is electrically charged, it acts almost like a vacuum cleaner for dust and dirt that has found its way into the camera body itself, which is why many system cameras have a "shake function" whose sole purpose is to try to keep the sensor surface clean of particles. When shooting at low apertures, say up to 5.6, sensor dirt is usually not a major problem when shooting still images because the dirt becomes so blurry. However, if you start to use higher apertures, which can easily happen on a bright and sunny day, the sensor dirt takes on a much more distinct shape. A larger dirt particle on the sensor can become very clear and sharp in outline. This is often a much greater source of misinterpretation than dirt on the front lens.

For obvious reasons, dirt on the sensor is not applicable to mobile and compact cameras because the sensor cannot be exposed by removing the lens, which is the case with system cameras, including so-called mirrorless cameras.

Self-motion can create an illusory effect – the movement that a camera can have because it is, for example, in a moving car, and that it is not fixed, at the time of the photo or film. The effect can result in the filmed/photographed object having a difficult-to-interpret illusion of movement.

The effect of exposure time on an image – exposure is the time during which an image is created. During the exposure, a certain amount of light will hit the photographic medium and the overall result of this will be the image. Movement is the reason why the image does not give an accurate picture of reality, regardless of how the movement enters the moment of photography. Time is the problem, it moves. *Example: A house with a car in front. The car is driving at 36 kilometers per hour.*

• *A photograph is taken with an exposure time of one thousandth of a second. The movement of the car will be 1 cm, which is hardly visible in the final photograph, as the angular size is small.*

• *A photograph is taken with an exposure time of one second. The movement of the car will be 10 m, which gives a long-extended trace on the image, with a thousand times larger angular size (i.e. how much of the image the car takes up).* Even very short periods of time can cause unwanted effects. A problem that often arises is that it is difficult to hold the camera still, even for very short periods of time. If the picture is taken without a tripod and with an exposure time of several seconds, it is more or less impossible to keep the camera completely still during the entire exposure.

Scintillation – in astronomy, it is sometimes called the color changes accompanied by twinkling, which can be observed in the light of stars. This is what makes stars appear to be blinking. Scintillation occurs when the air in the Earth's atmosphere makes continuous and irregular changes in density, which causes the light to constantly take different paths from source to receiver. The difference in the length of these paths enhances or weakens the intensity of the light rays, through interference, which generally results in color variations, which sometimes also find their way into images with longer exposure times.

Fig.A-3.28 Damage of several bytes in jpeg-files (CC/GFDL)

Fig.A-3.29 A dark object in a light halo in the pictures is the Sun. Not every exposure of the digital camera matrix causes darkening instead of lightening, but only very strong exposure and not always. (CC/GFDL)

Fig.A-3.30 Camera CCD sensor defect (P. Laven)

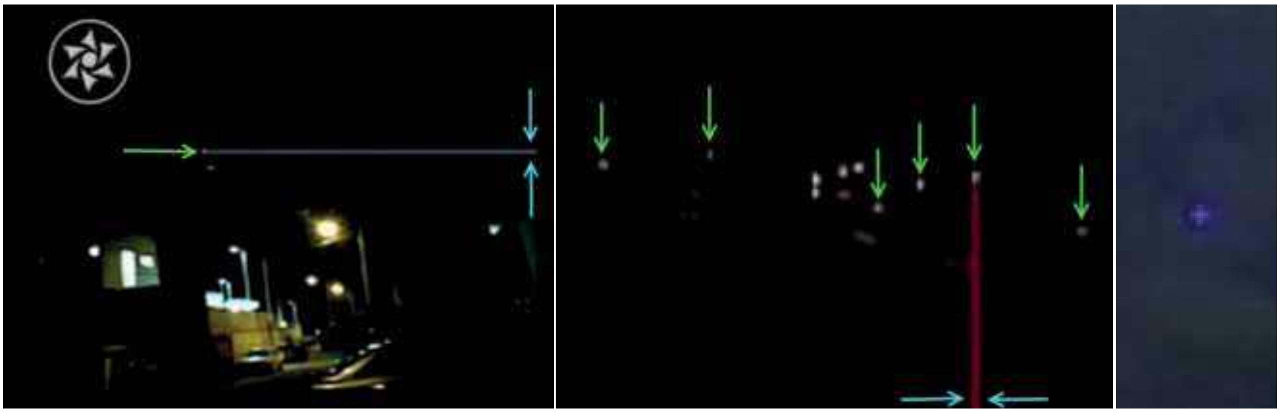


Fig.A-3.31 Matrix defects (CC/GFDL)

Fig.A-3.32 Short-term flash during exposure in digital cameras (M. West)

When light from the sun or another light source enters the camera through any part other than the regular lens and hits the camera sensor, some noticeable light effects can be seen in the image afterwards. For example, if a photographer has the sun at their back when they take a picture and sunlight leaks into the camera from behind, these effects can occur.

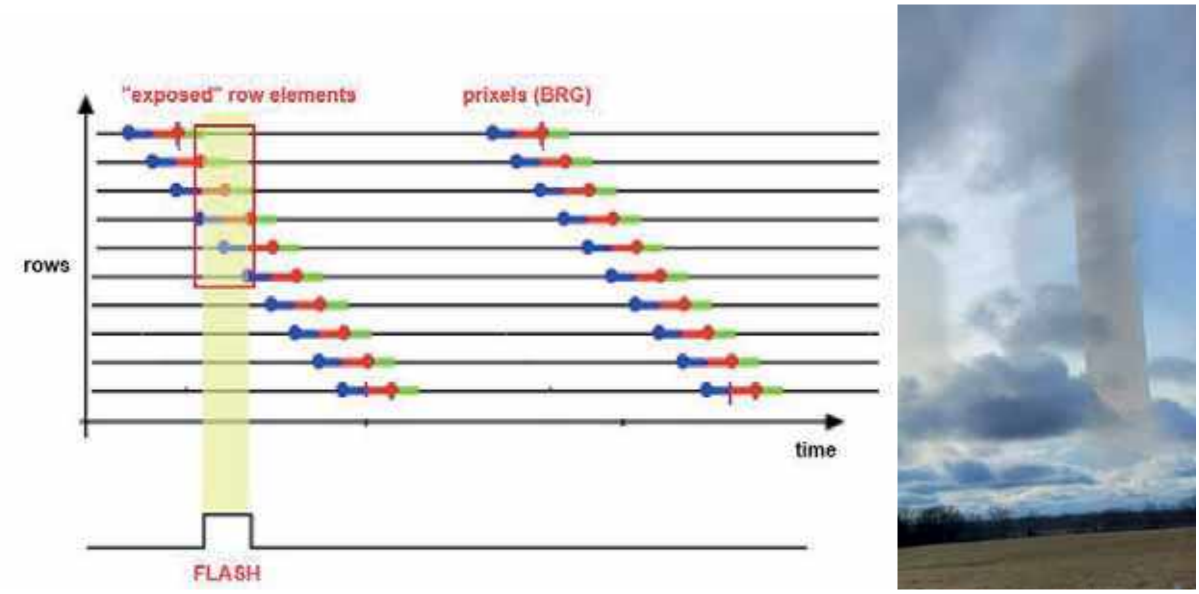


Fig.A-3.33 Exposure of pixel row elements (V. Guscha)

This defect occurs exclusively in digital cameras and mainly when shooting in vertical (portrait) frame orientation (with landscape orientation, horizontal stripes are observed). The effect is based on a short-term light pulse (flash) that occurs during exposure, i.e. sequential reading of data from matrix rows. At the same time, the pulse itself briefly overexposes pixels, creating the effect of "overexposure in a row". In other words, the longer the flash (and we are talking about milliseconds), the wider the overexposed element of the rows in the picture will be.

Purple sunset is the result of a defect in the camera's CCD sensor, which detects infrared radiation in the range of 750-1150nm (visible light is about 400-700nm). Cameras must therefore contain filters that block infrared radiation, but they usually let some residual rays through. Infrared sensitivity varies by camera; test yours by pointing it at a TV remote control from a distance of 6 inches or so.

Fig.A-3.34 Light Leakage (F. Azmani)

A-3.I.3. Foreign objects in the frame

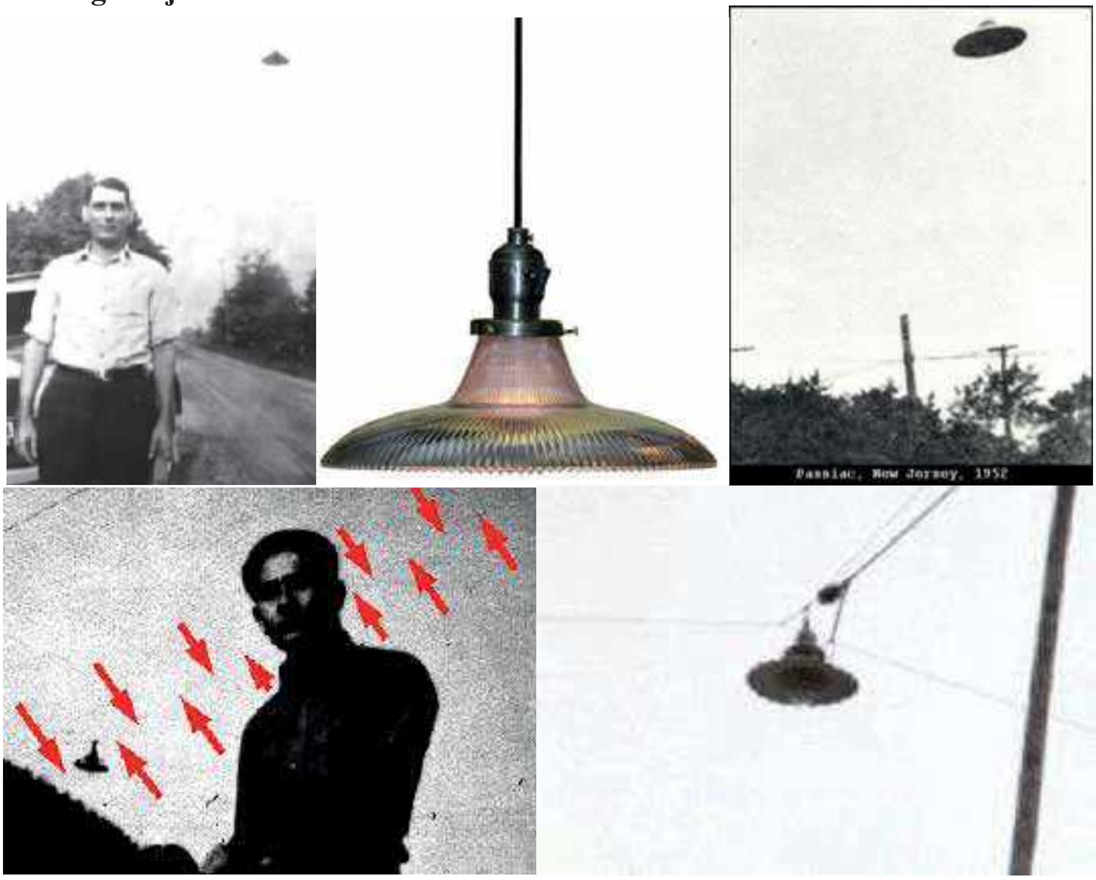


Fig.A-3.35 Lamps on the wire, under certain street lighting the cable is not visible (CC/GFDL)

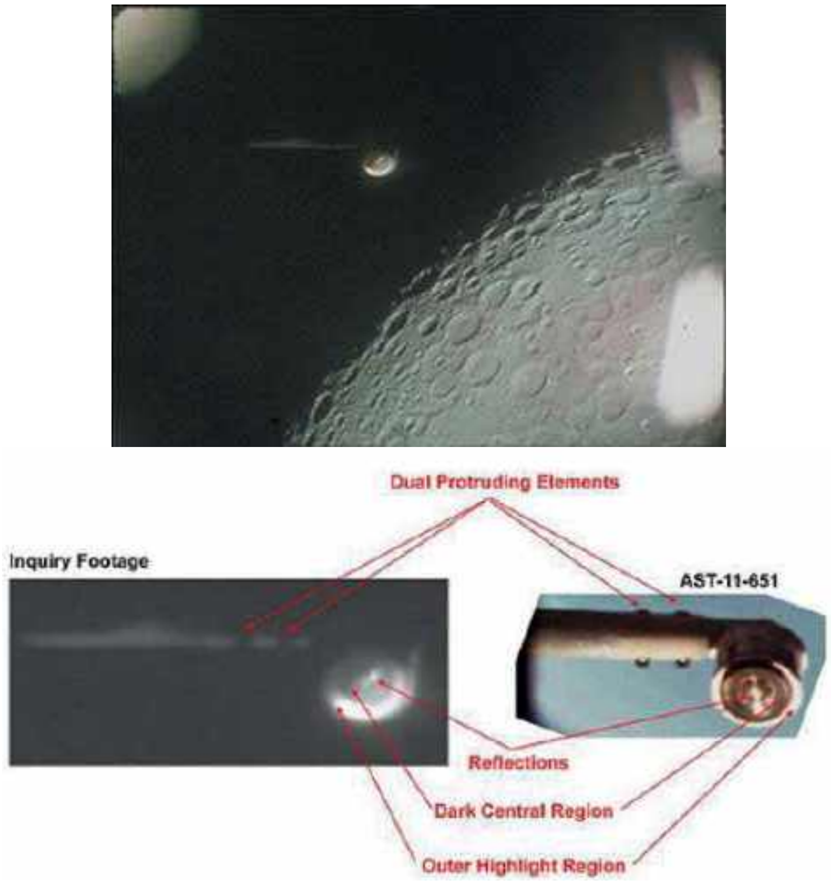


Fig.A-3.36 Elements of construction that become invisible when light and shadow are positioned in a certain way (NASA)

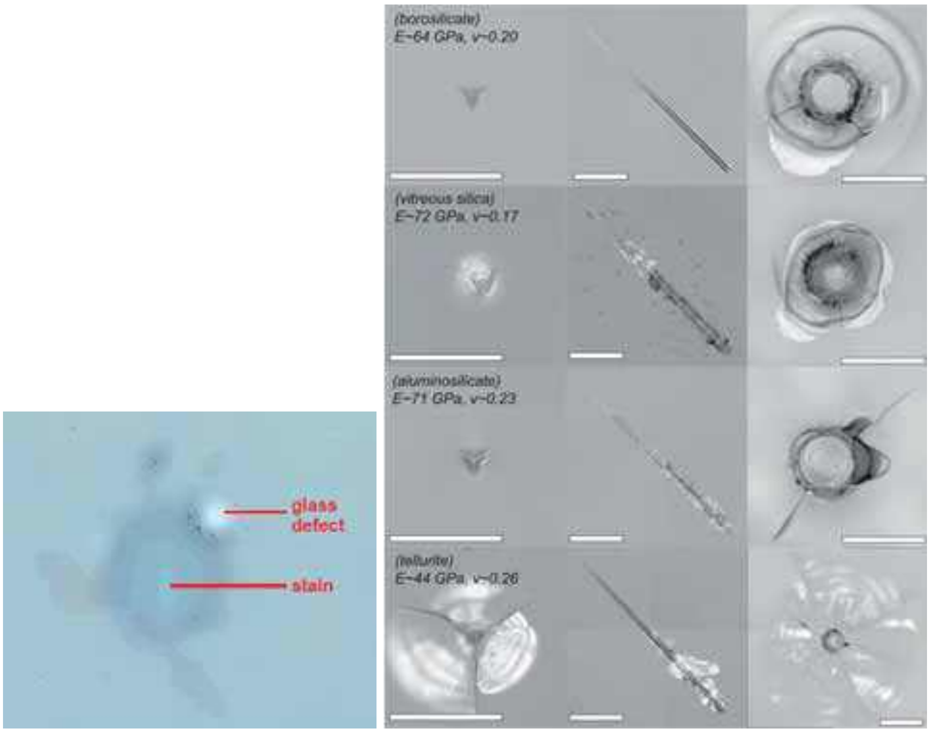


Fig.A-3.37 Glass defects (L. Wondraczek, E. Bouchbinder, A.J. Ehrlicher, M. Smedskjaer)

Fig.A-3.38 Smoke and steam (CC/GFDL)

Debris on the lens can be anything stuck to the surface where light is supposed to enter the camera. The term also includes grease, which is a common cause of distorted images. These phenomena can look a little different, but a dark spot or dot in severe blur is one variant that can occur.

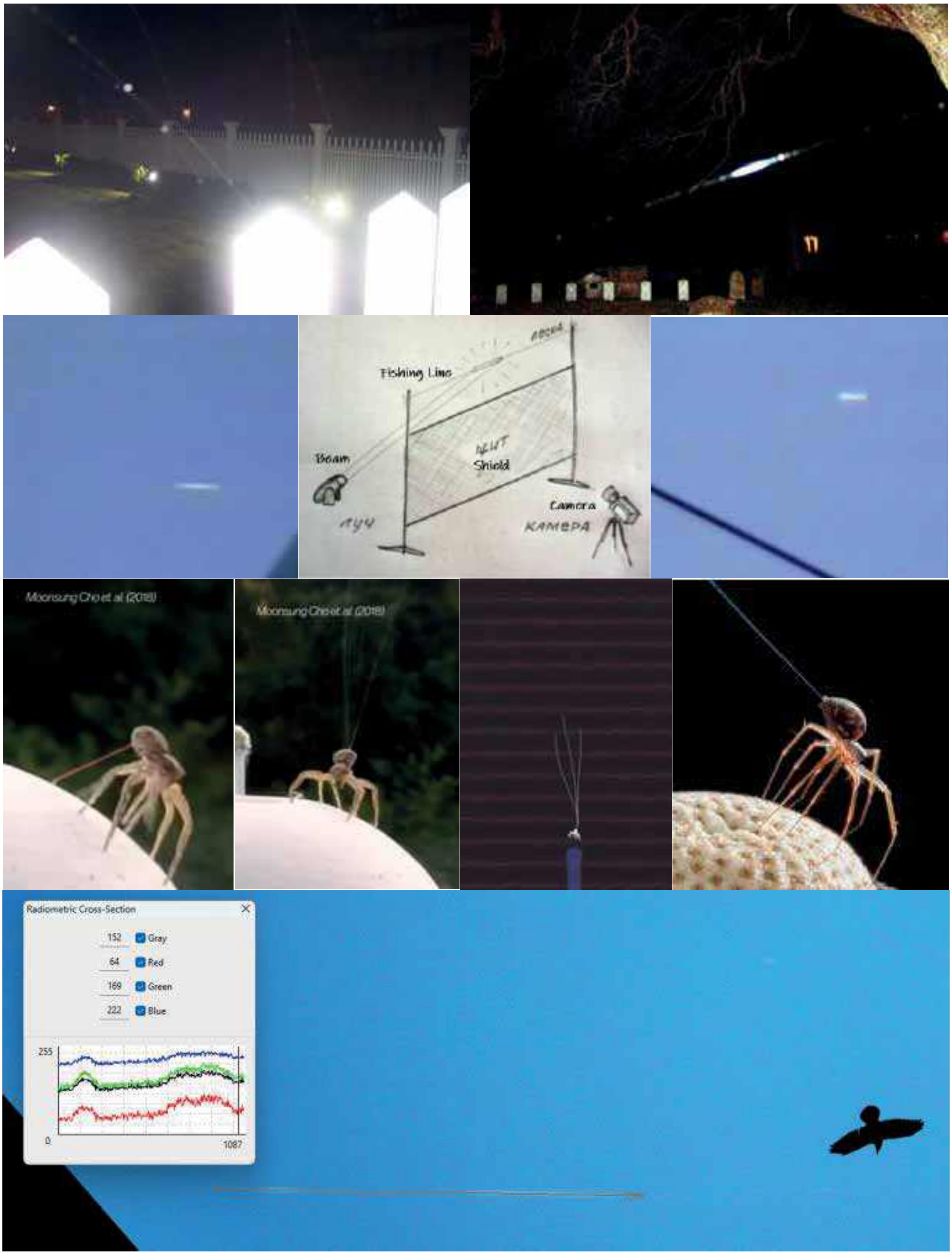


Fig.A-3.39 Web "Indian summer" and fishing line. (CC/GFDL, V. Belozerov, E. Morley, D. Robert, I. Kalytyuk, IPACO)

Torn webs, sometimes with raindrops on them, can move chaotically with gusts of wind. Some species of spiders are capable of lifting themselves into the air and "flying" on their webs, harnessing not the wind but the Earth's electrostatic forces and magnetic field. They release tiny threads that become charged and interact with atmospheric electricity, and this is enough to literally lift the spider into the sky. Scientists call this phenomenon "ballooning." Spiders can travel hundreds of kilometers, rising to altitudes of up to 2–3 kilometers, like tiny living gliders.

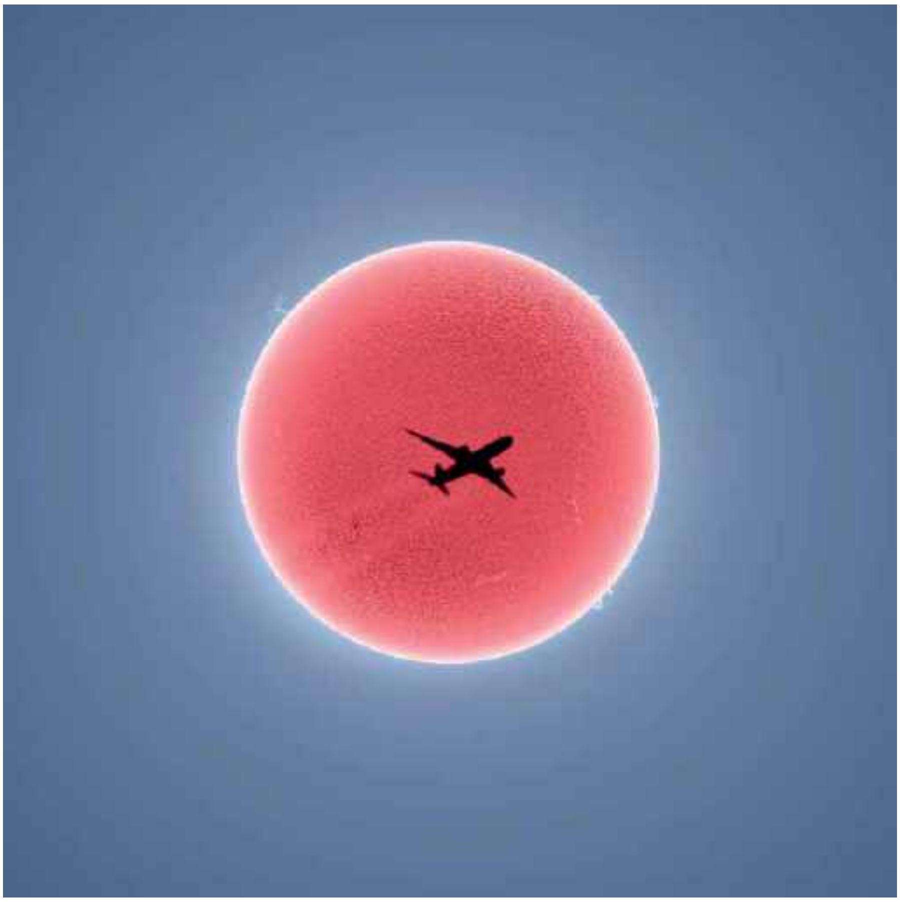


Fig.A-3.40 A stunning photo was taken in a split second when the plane flew in front of a Sun (CC/GFDL)

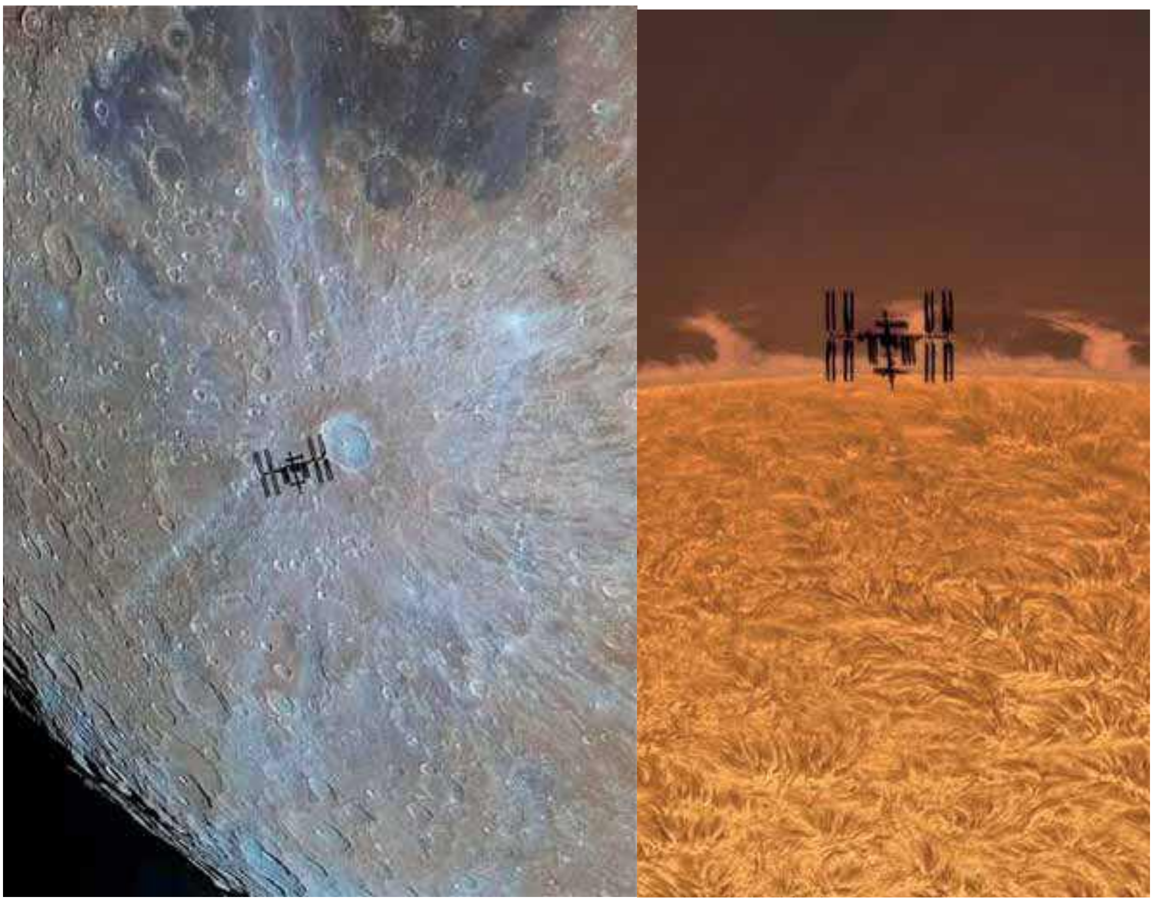


Fig.A-3.41 ISS and the Moon and the Sun (CC/GFDL)

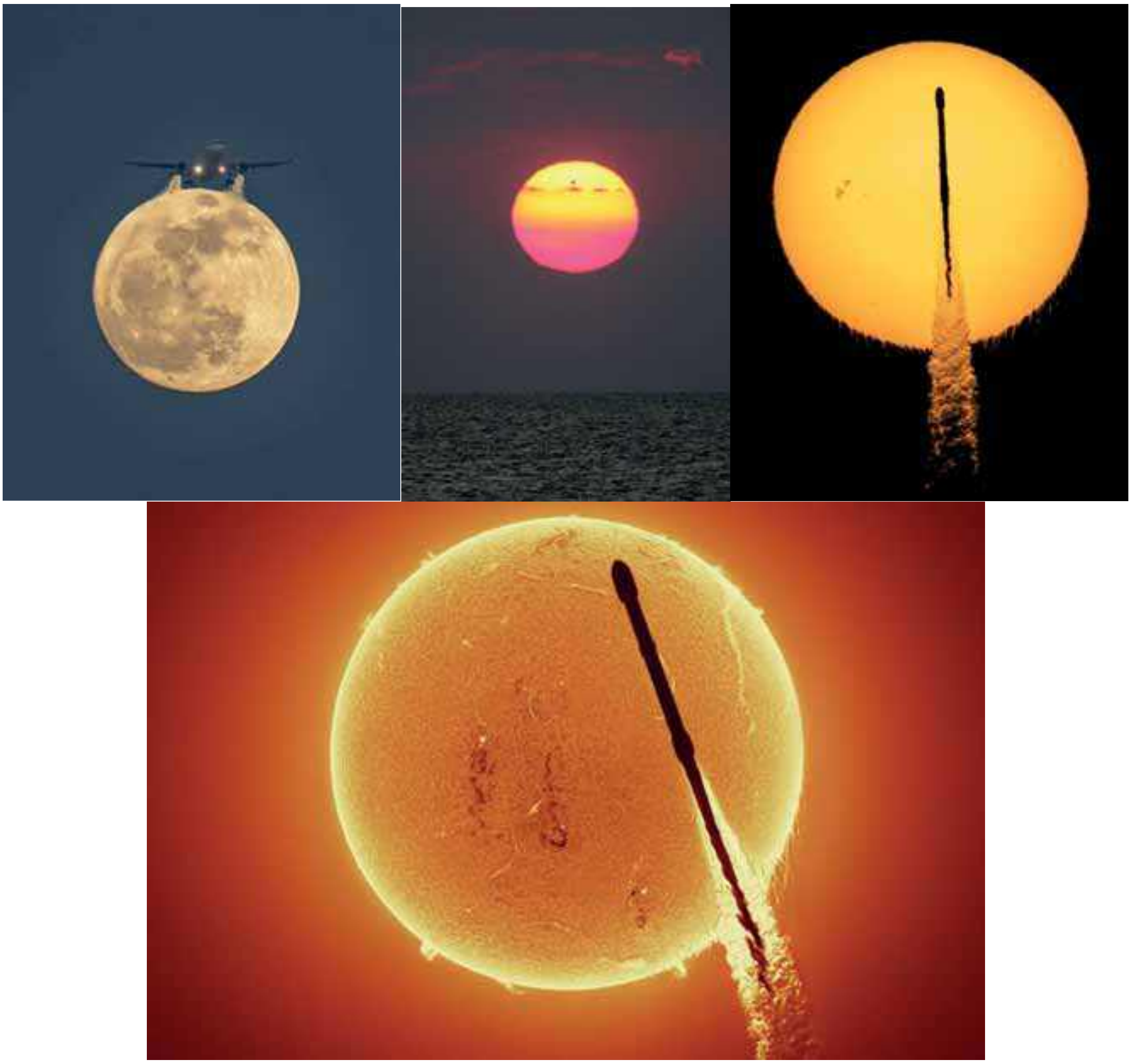


Fig.A-3.42 The plane appears to be taking off from the Moon. The rocket appears to be flying through the Sun. Venus rises with the Sun (CC/GFDL)

Fig.A-3.43 Butterfly in flight (A. Bilyk, SRCAA "Zond")

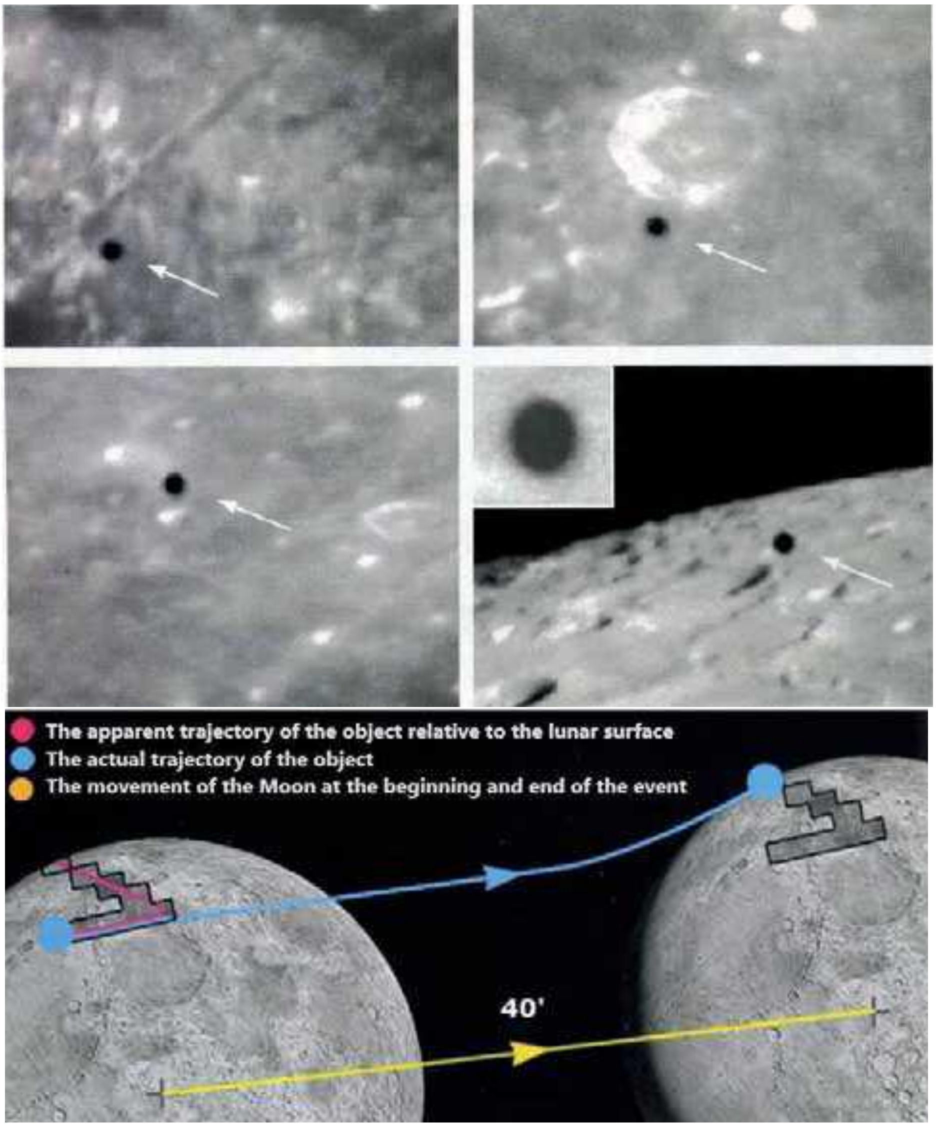


Fig. A-3.44 Balloon against the background of the lunar surface, visible through a telescope with a shifted lens (A. Chvartkovsky)

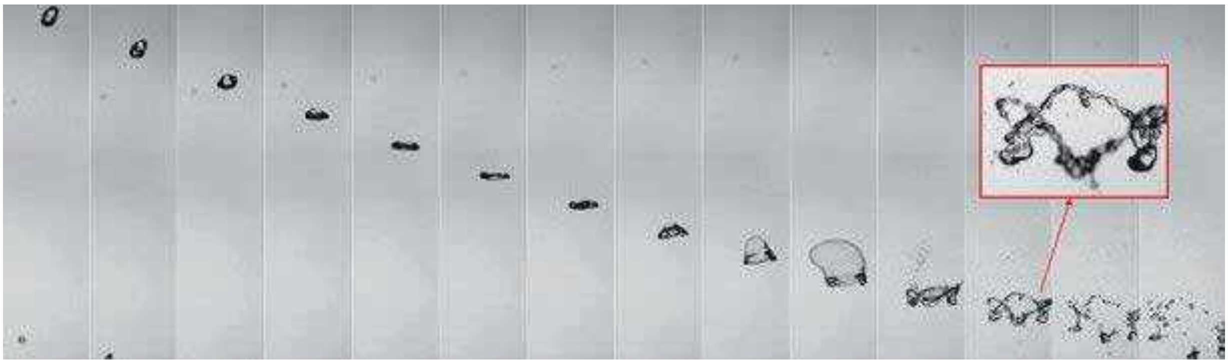


Fig.A-3.45 The figure shows the change in shape of a large drop of water falling down over time (from left to right, the entire process takes about 0.07 seconds) (E. Villermaux, B. Bossa)

Under the influence of air resistance, water splashes can take very bizarre shapes, especially large ones. The shape of drops has been studied best for atmospheric precipitation. Small raindrops (up to 2 mm) retain a spherical shape, larger ones become flattened, and starting from a diameter of about 5 mm, they acquire the shape of a pancake, an open parachute with subsequent fragmentation into small parts. Both the speed and the time course of shape changes during the flight of splashes, of course, differ from raindrops. Due to the balance of gravity and air resistance, raindrops fall at an almost constant speed (2-30 meters per second depending on size, large ones faster).

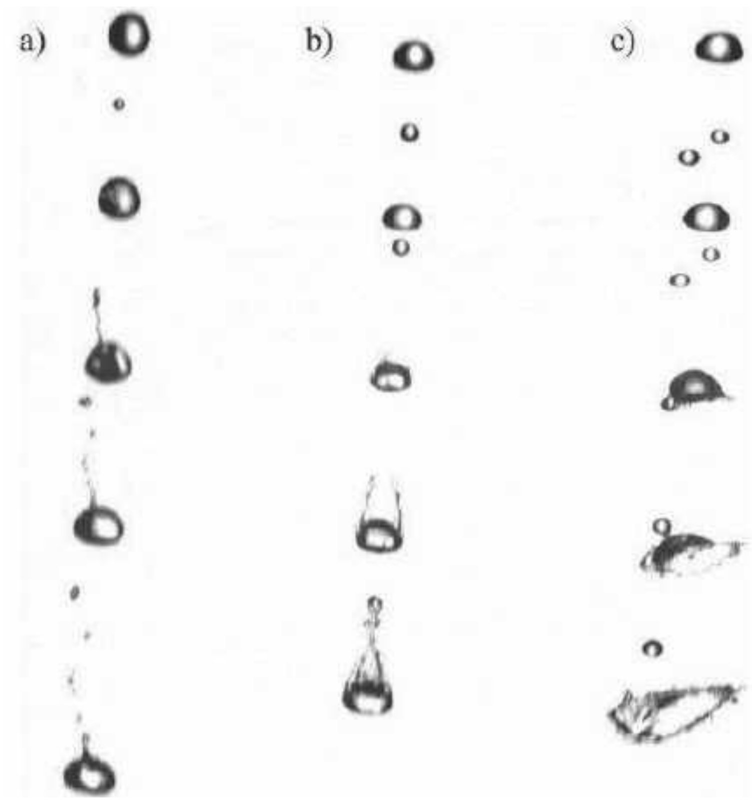


Fig.A-3.46 Drawing showing (a) filament, (b) sheet, and (c) disk droplet disintegration (cyclowiki.org)

The initial distribution of speeds and sizes of splashes depends on many factors (wind speed, wave height, weather conditions, and even small details of the surface of the rocks against which the waves break), and it is difficult to calculate it accurately. It is clear that the maximum speed is achieved at the beginning of the flight and at the end, and in the middle (at the top point of the trajectory) it is lower. However, the physics of interaction with air is the same, and as a result, similar shapes of objects should be formed. In surf conditions, the appearance of larger drops with relatively low initial speeds is not excluded, which will not quickly disintegrate, and can be observed at distances of 5 meters or more. The absence of noticeable blurring may indicate low speed. And if the objects are located almost on the same straight line, this may also indicate their common origin.

Fig.A-3.47 In low gravity, charged water droplets spin around a Teflon knitting needle (D. Pettit)

A-3.II. Light effects
A-3.II.1. Reflection of light rays

Fig.A-3.48 Reflection of light from snow during flash (CC/GFDL)

Reflection of light rays – is the process of interaction of light waves with a reflecting surface, change of direction of the wave front (with distortion) at the boundary of two media with different properties, sometimes with return of the wave front to the medium from which it came. Specular reflection of light is distinguished by a certain connection of positions of the incident and reflected rays: 1) the reflected ray lies in the plane passing through the incident ray and the normal to the reflecting surface, restored at the point of incidence; 2) the angle of reflection is equal to the angle of incidence. The intensity of light reflection depends on the angle of incidence and polarization of the incident beam of rays, as well as on the ratio of refractive indices n2 and n1 of the 2nd and 1st media. From them, in particular, it follows that when light falls along the normal to the surface, the reflection coefficient does not depend on the polarization of the incident beam and is equal to:

$$\frac{(n_2 - n_1)^2}{(n_2 + n_1)^2} \tag{A-3.3}$$

Quantitatively, the reflection coefficient is equal to the ratio of the radiation flux reflected by the body to the flux incident on the body

$$\rho = \frac{\Phi}{\Phi_0} \tag{A-3.4}$$

In the important special case of normal incidence from air or glass onto their interface (refractive index of air = 1.0; glass = 1.5) it is 4%.

Fig.A-3.49 Reflection of light from soap bubbles (CC/GFDL)

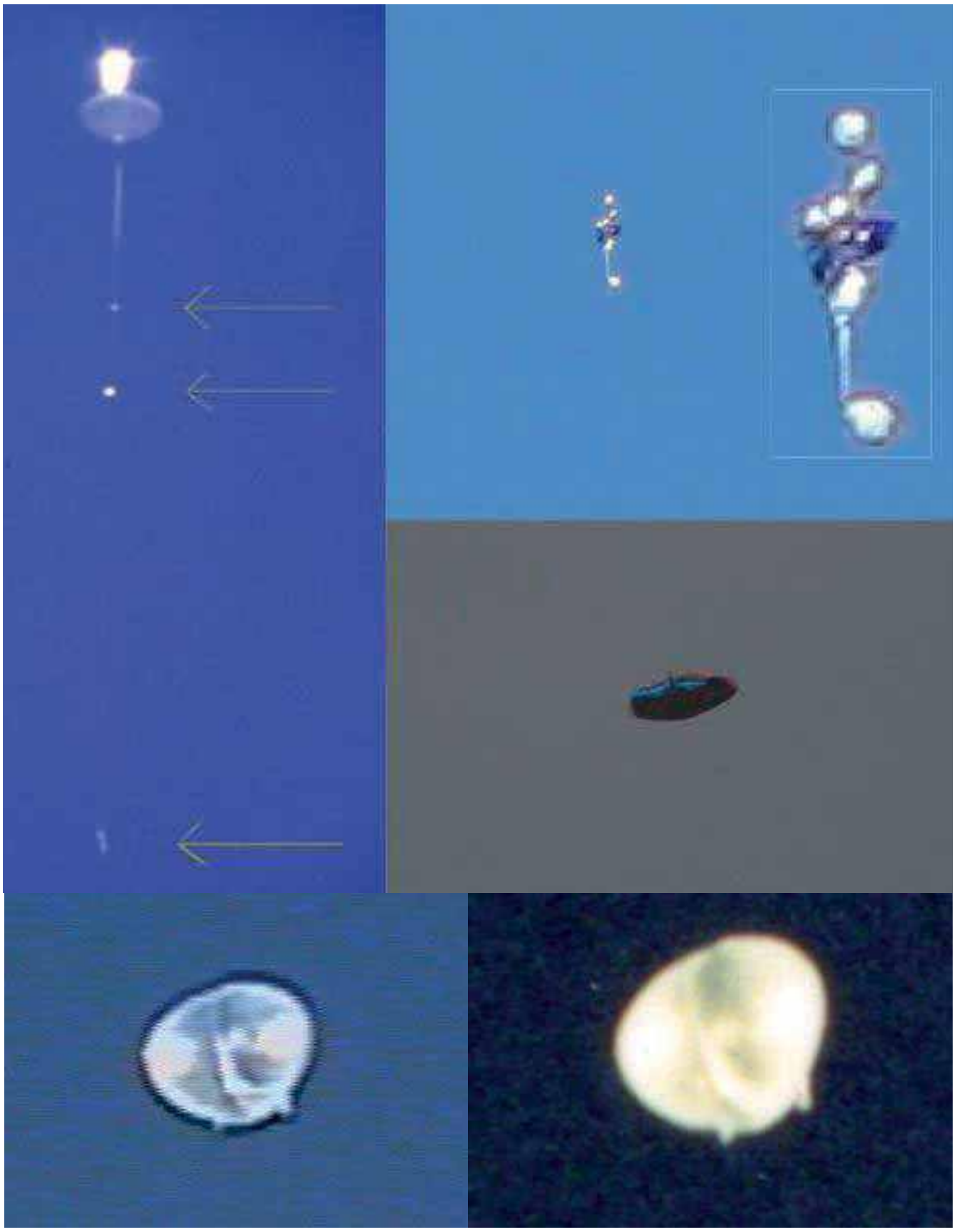


Fig. A-3.50 Reflection of light from weather balloons and helium balloons, with certain parts of the structure becoming invisible. Flight altitude of weather balloons is 30-40 km (maximum 53.7 km) (CC/GFDL)

Fig.A-3.51 Mylar balloon in the sky showing at higher altitude showing almost complete cold indication due to the surrounding cold atmosphere; thermal imager captures reflections from glass (CC/GFDL, I. Kalytyuk)

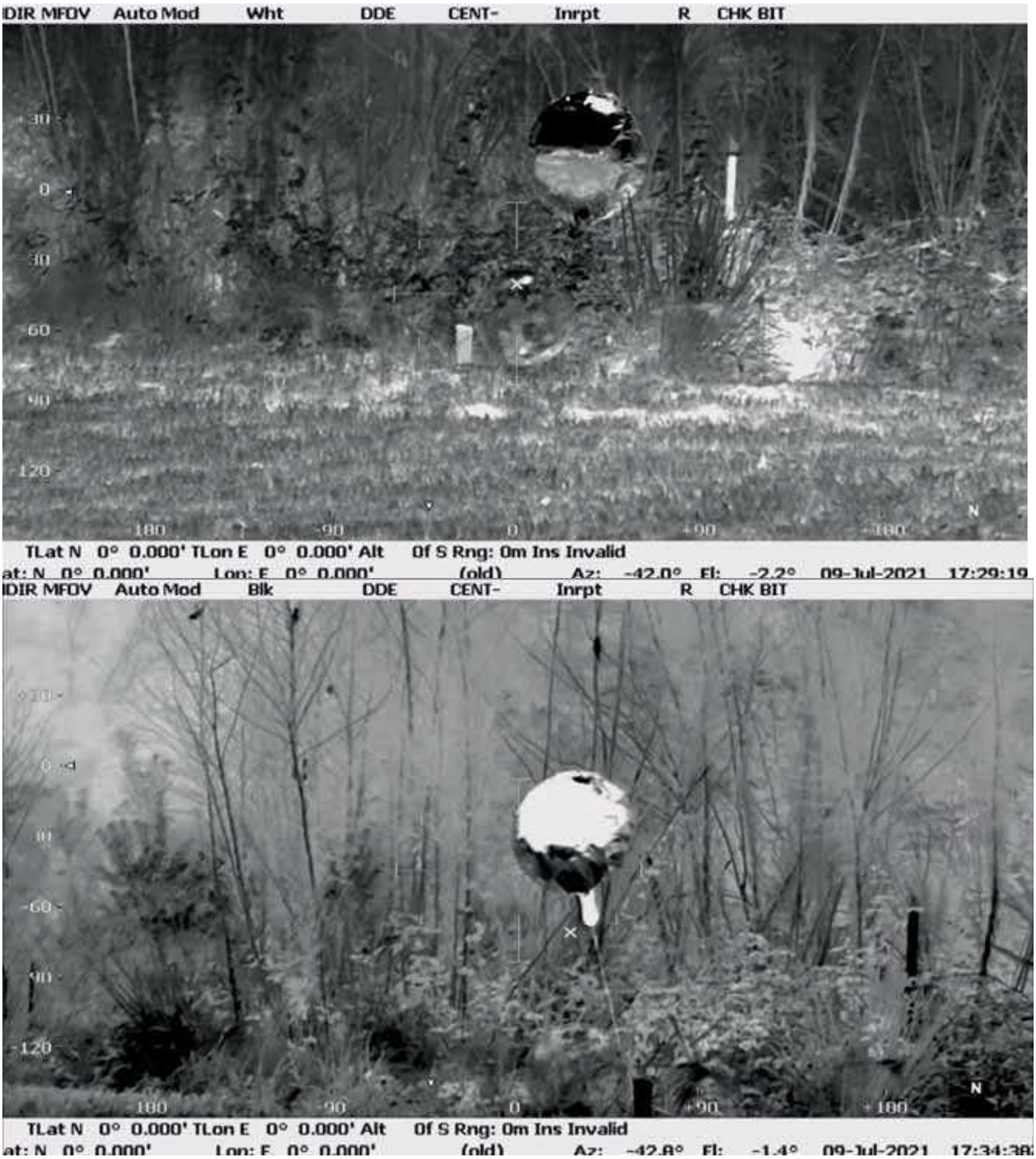


Fig.A-3.52 Shows the camera set as white hot and black as cold giving a false indication of cold due to reflecting the col sky above from the metallic coating on the mylar balloon (CC/GFDL)

Toy balloons are an unusual but common misinterpretation phenomenon. A toy balloon can be difficult to identify from a distance and today there are balloons in all kinds of shapes and colors. At festivals, colorful balloons of various kinds are sold and when these reflect sunlight and are observed from a distance they can look strange.

A type of balloon that has previously given rise to reports are so-called letter balloons. These are often silver-colored and have a highly reflective surface that from a distance can give them a slightly shiny shade. They are also available in other shades such as gold and the same models but with numbers are also available. Today there are also balloons equipped with LED lights on the market and these balloons can thus appear in different colors and resemble a regular UFO balloon from a distance. There are both constant and flashing lights in the balloons. If a balloon equipped with LED lights is inflated with helium, it can travel over large areas and give rise to observations at relatively large distances from the place where it was released.

Something to keep in mind when it comes to balloon flight behavior is that this can often be more irrational at lower altitudes where the winds are more turbulent and the balloons can then move in different directions laterally and both upwards and downwards. If a balloon reaches higher altitudes, however, the air layers are less turbulent and they often drift in a straighter path. Balloons can also have a wobbling or rotating movement pattern, which can give a balloon seen from a distance and illuminated by the sun a seemingly flashing or pulsating glow.

Another form of balloon is the so-called solar balloons. These also come in different shapes but to give an example of one of the variants, it is cylindrical, made of plastic and about 3 meters long when filled with air. The diameter of the balloon is then about 70 centimeters and the balloons are usually black. These balloons are placed outside in the sun and after the balloon has been heated by the sun, the balloon lifts and rises into the air with the help of the hot air. Size and shape can therefore vary and what mainly distinguishes solar balloons is that they are black in color and often, but not always, oblong sausages. These balloons can also be attached to a line on the ground and can then from a short distance resemble a dark cigar-shaped craft hanging still in the air.

Fig.A-3.53 Aluminum-colored balloons filled with helium and glare blimp airship (C.-J. Wall, UFO-Sverige)

Advertising balloons with motifs are not entirely uncommon and can literally occur in almost every conceivable shape. A recurring feature when it comes to advertising balloons is that they are shaped after the product being marketed. Many advertising balloons still look like the typical hot air balloon, but there are also many exceptions around the world. To name a few examples, they can be Coca-Cola bottles, a hot dog in a bun, a Panasonic battery, a power line tower, the Michelin Man, but also slightly more ordinary motifs such as a panda head or a snowman.

Fig.A-3.54 Here you can see the Jungheinrich balloon as it takes off. Note that the appearance of the balloon varies depending on the distance and angle of observation. (P. Sebestyén)

For a ground observer to be able to see a weather balloon, the person must be in the vicinity of one of the locations from which the balloons are released and be there at the time of the release. In other cases, only pilots have the opportunity to see the weather balloons, but since the balloons are equipped with transponders, it is easy for a pilot to identify a weather balloon and avoid it. However, the weather balloons are not equipped with any anti-collision lights or other light sources. Weather balloons can be checked through compilations made by the University of Wyoming (weather.uwyo.edu). Other types of research balloons are also released. The balloons can shine very brightly when illuminated by the sun.

Tow flights or target flights are sometimes used in exercises. This involves a shooting target that hangs on a line behind the aircraft and that can be fired at, for example, in air defense exercises. The target that is fired at can be oblong and is also called a target sausage. In target flights, the target aircraft can fly over large areas and move back and forth over several tens of kilometers. If you observe the flight under special conditions, you may be able to see the tow target but not the aircraft. A tow flight can of course also be perceived as an aircraft that is followed (or chased) by a cigar-shaped object as the line becomes more difficult to see from a distance.

Fig.A-3.55 Here the flight target has been winched out further during the same flight (G. Åkerberg)

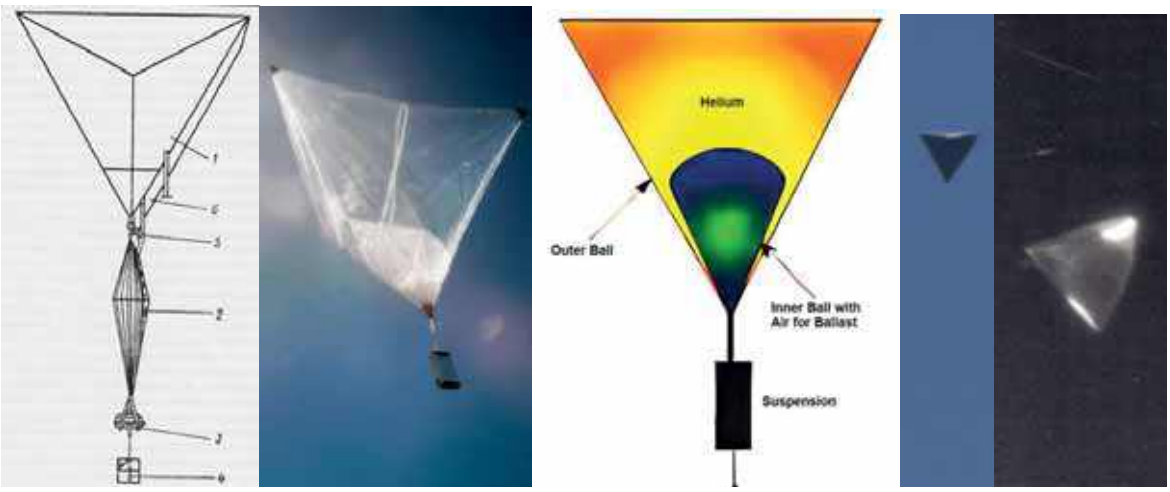


Fig.A-3.56 Tetrons – are tetrahedral balloons that have often been mistaken for UFOs. They are usually small, but sometimes have edges up to tens of meters long. 1 – shell, 2 – parachute, 3 – flight termination mechanism, 4 – radiosonde, 5 – pyrotechnic cutter, 6 – pyropatron (CC/GFDL)

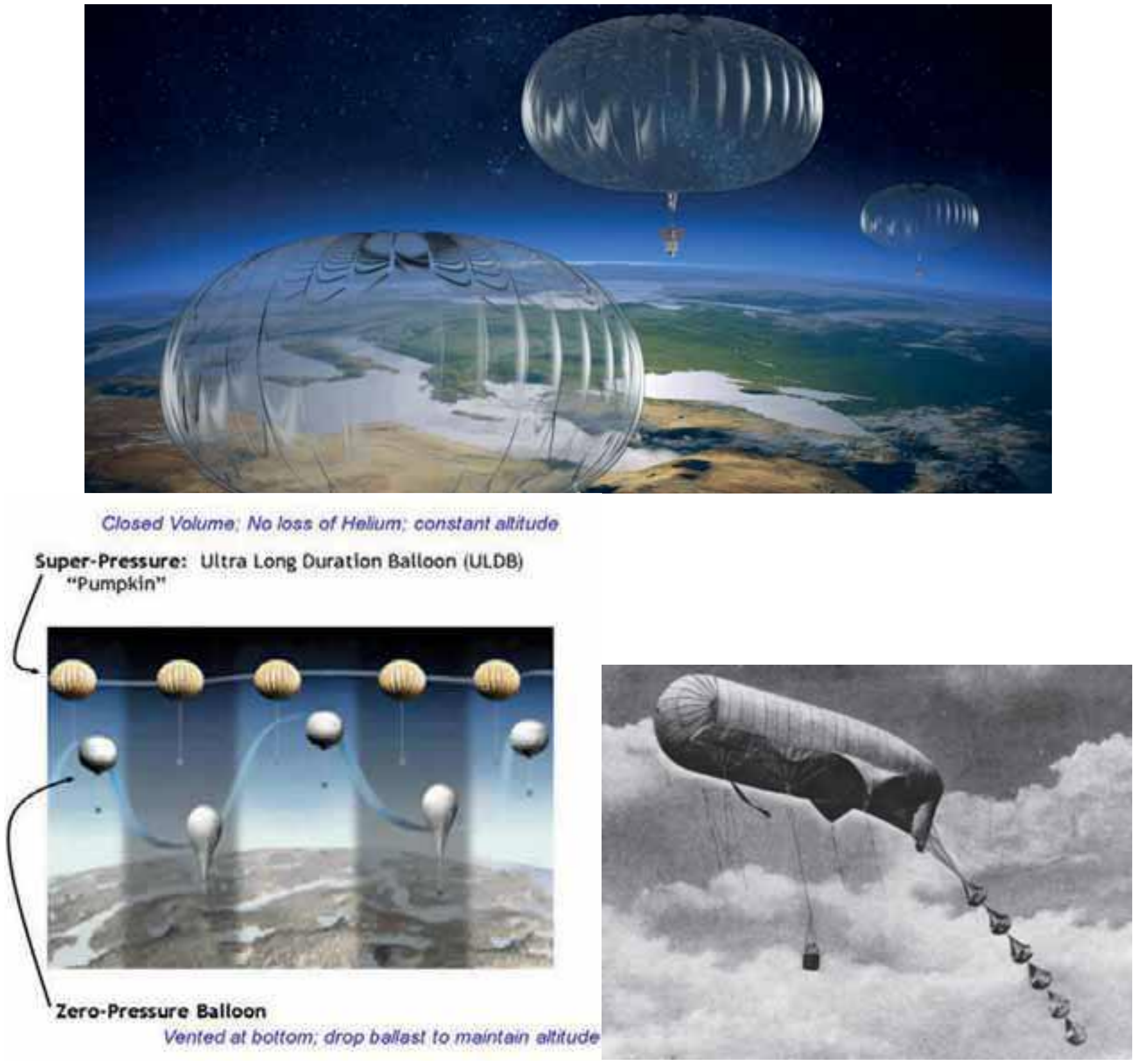


Fig.A-3.57 Weather balloon varieties and observation balloon (LTA, NHHC)

A large number of artificial objects orbit the Earth. These are not only satellites but also rocket parts from the launch of satellites. Satellites are visible from ground level because they reflect sunlight and usually look like small stars wandering across the sky.

Satellites move at a relatively slow speed across the sky and then disappear by fading away, which is because the satellite then enters the Earth's shadow, which can be perceived as leaving at right angles to the observer. Satellites usually shine with a white glow, but a red hue can also occur.

Many satellites also rotate around their own axis and can then shine with a significantly brighter glow for a few tens of seconds and then fade again, and some satellites can then also appear to blink or pulsate. A special type of satellite is called Iridium satellites and gives rise to so-called Iridium flashes (see more about Iridium satellites below). Most satellites orbit from west to east, but today it is possible to see satellites in all directions and moving in all directions. However, it is less common to see satellites moving in a westerly direction. On May 5, 1998, five satellites for advanced telecommunications were launched from the American Vandenberg Air Force Base. In 2017-2019, all operating first-generation Iridiums were deorbited.

Fig.A-3.58 Reflection of sunlight from passing artificial Earth satellites (AES) (CC/GFDL)

As for the Iridium satellites, it is a phenomenon that is being phased out. Instead, the previous generation of Iridium satellites has been replaced by a new constellation called "Iridium Next". However, this new generation of Iridium satellites does not generate the same kind of flashes of light as the previous generation. However, there are several other satellites that can produce similar satellite flashes and the phenomenon as such is therefore still present in the night sky.

Some satellites stand completely still in the sky and these are called geostationary or geosynchronous satellites and are visible at most as a faint or medium-bright star from Sweden. In reality, however, they do not stand still but move in an orbit that follows the Earth's rotation, which makes the satellites appear stationary when observed from Earth. They are often at an altitude of 36,000 kilometers and it is unusual for them to be visible to the naked eye. This should be compared with the ISS which moves 400 kilometers above the Earth's surface and many ordinary satellites which move at an altitude of between 180 kilometers and 2,000 kilometers. A large part of all geostationary satellites that are in operation are visible for only 4–15 minutes each night for 1–2 weeks before the spring equinox and after the autumn equinox.

Fig.A-3.59 "Star train" of the Starlink satellite (SpaceX, D. Lopez)

During certain periods, it is also possible to see the International Space Station ISS with the naked eye. It is then seen as a bright point moving from west to east relatively low in the southern sky. Usually, the space station can be seen for one or two minutes before it sinks towards the horizon and fades away. Since 2019, a new type of satellite has been orbiting the Earth and has become one of the most common causes of UFO reports. These satellites are called Starlink and appear as a "train" or "string of pearls" of small points of light that move in formation across the evening sky.

The Starlink satellites are launched in batches, and consist of a large number of small satellites that follow the same path across the sky. The satellites are very close together at the beginning and then it looks like an illuminated string of pearls. Over time, the satellites spread out, but still follow each other at slightly different intervals. Up to 60 points of light can then be seen passing across the sky in a few minutes!

Common illusions that can occur when observing a satellite are that it appears to be making a zigzag movement or that it moves with a somewhat jerky and irregular movement. It is not entirely clear what kind of illusion this is, but there is no doubt that it is an illusion in the eye, probably when the eye is looking for some point to relate the satellite's movement to. Given the great similarities that this illusion has with the previously mentioned autokinetic effect, there is good reason to assume that it is the same effect but against a moving object.

Another common illusion is that the satellite appears to stand still for a short time and then starts moving again, and the effect is then called autostasis. When a satellite enters the Earth's shadow or disappears behind a cloud, the previously mentioned illusion of the satellite appearing to accelerate away at a very high speed can also occur. If an observation has been made of an object that resembles a star that has moved slowly across the sky and then disappeared by accelerating away at a very high speed, it is likely that it is a satellite with elements of this illusion. There is also an illusion called the deflection effect. This illusion can occur when a moving object in the sky passes close to a bright point (star/planet). It can then look as if it is rotating or circling the star/planet. However, in reality it does not.

The phenomenon caused by the reflection of sunlight by the smooth surfaces of satellite antennas is very often observed in the Iridium satellite communications system, which is why it is called the Iridium flare. Reflecting sunlight with antennas measuring 0.9 by 1.8 meters, they occasionally "flare up" to -8..-9 magnitude. Such a flare is visible in a strip 5 kilometers wide, and at a distance of 15 km from the flare axis the brightness drops to -3..-4 magnitude. The Iridium flare lasts 20-30 seconds. More precisely, during this time its brightness exceeds +2 magnitude (usually satellites have a brightness of +6..+7m), and for about three seconds the satellite surpasses Venus in brightness (-4m).

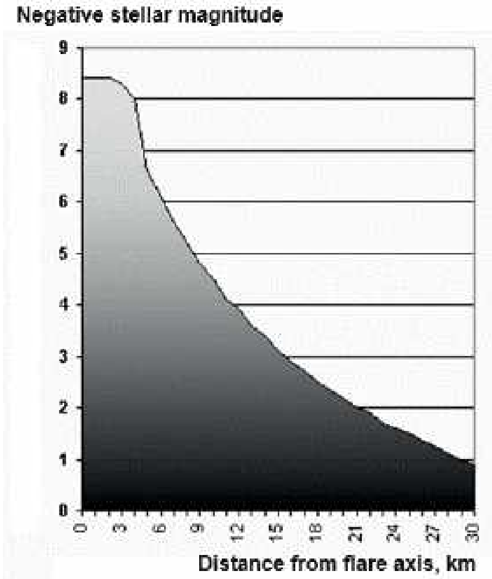


Fig.A-3.60 Ratio of negative stellar magnitude to distance from the “flare” axis in kilometers (CC/GFDL)

It is also worth mentioning that the satellites will not always fly in a straight formation, but sometimes they can fly in pairs or even in a group in the shape of a triangle.

As a rule, most observers can easily distinguish the movement of artificial Earth satellites from other moving vehicles in the sky. However, in some cases, when the satellites operate in non-standard modes, the latter can be mistaken for UFO.

Such modes can be:

1) Trajectory sections with periodic activation of motion correction engines, creating a short-term glow of ionizing gas jets;
2) Periodic changes in the brightness of the satellite due to the lack of stabilization of its position in orbit;
3) Accompanying satellites launched by ICBMs or artificial Earth satellites during technical observations.

However, satellite flights have a number of features that allow them to be almost unmistakably classified as man-made devices:

1) No noticeable acceleration, smooth movement.
2) Gradual changes in brightness and color at night when entering the Earth's shadow.
3) The practical constancy of azimuths and elevation angles when comparing observation data from different points, separated from each other by a few kilometers, which indicates a high altitude of the object.
4) The objects are not recorded on conventional airport radars

There are several programs today that locate satellites, but the most useful of these is Heavens Above, which can be reached using the following link: Heavens Above (www.heavens-above.com). Set your position with the link "Change your observation site" (don't forget to click on "Update" at the bottom of the page). Then use the link "Daily forecasts for bright satellites". There you set the date and the minimum magnitude (brightness) the satellite should have. A list of satellites that have been visible during the specified time is then displayed, and by clicking on the satellite, a star map with the satellite's orbit is displayed.

The map, which is shown in the form of a circle, should be read by assuming that the observer is in the center of the circle and the closer to the center of the circle the satellite's orbit is, the closer the satellite was to the zenith (directly above the observer's head) and the closer the orbit is to the outer edge of the circle the closer the satellite was to the horizon. The ISS can also be checked in the program by selecting ISS in the list on the front page.

The Starlink satellites can also be checked with Heavens Above. This is easiest done through the link "Starlink passages for all satellites in a given launch" and then adjusting the date intervals with the arrows in the image and selecting one of the launches in the adjustable list. It is important for the investigator to remember here that one must check all launches in order to make a complete check of all the Starlink satellites in orbit. The star program Starry Night has all satellites programmed in and shows their movements in real time. Orbitron and Stellarium also has relatively good coverage of visible satellite passages. (See Star and Planet Checks)

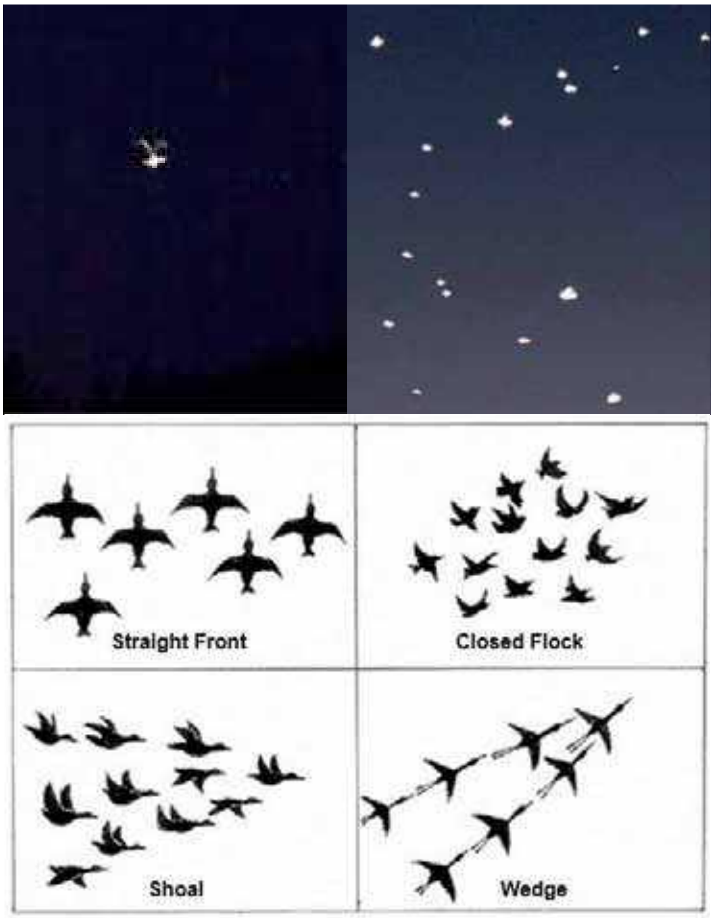


Fig.A-3.61 Reflection of light from birds with a flash or strong light source and shiny wings (CC/GFDL)

It is rare for people to mistake birds for something strange, but it does happen. This mainly happens when the birds are observed under unusual conditions. This mainly concerns birds that are sunlit or illuminated by street lights from below. Many birds have a bright and reflective surface and when these are observed from a distance at dusk or in the dark while being illuminated from below, they can easily look like a ball, point-shaped or diffuse light phenomenon. When the sun is low and has just dipped below the horizon, a bird that is a little higher in the air can still be reached by the sunlight, and especially bright birds like a seagull can then give a clear reflection that makes it look like a luminous object from a distance. Street lights can also have the same effect when a bird that is at a slightly greater distance reflects the underlying lighting.

When the sun is low, the bird is also hit by a more colorful glow towards yellow or red-orange, which is due to the sunlight being refracted in the atmosphere and the bird thus being given a more colorful reflection. The best way to try to determine whether an object may have been a bird is through the objects' behavior. Birds often move in circular movements and up and down and they often fly in flocks. They also fly in a smooth path in formations, while the light reflected from them can seem a little pulsating due to the wing movement that refracts the reflection. Here the observer should compare the flight behavior in the report with the behavior of the birds.

If the observation was made around sunset or sunrise, this increases the chance that the birds may have been illuminated in an unusual way. At night, bright birds can be illuminated by city lights and look very strange. If they are flying in formation, they can resemble discus that seem to shine of their own power.

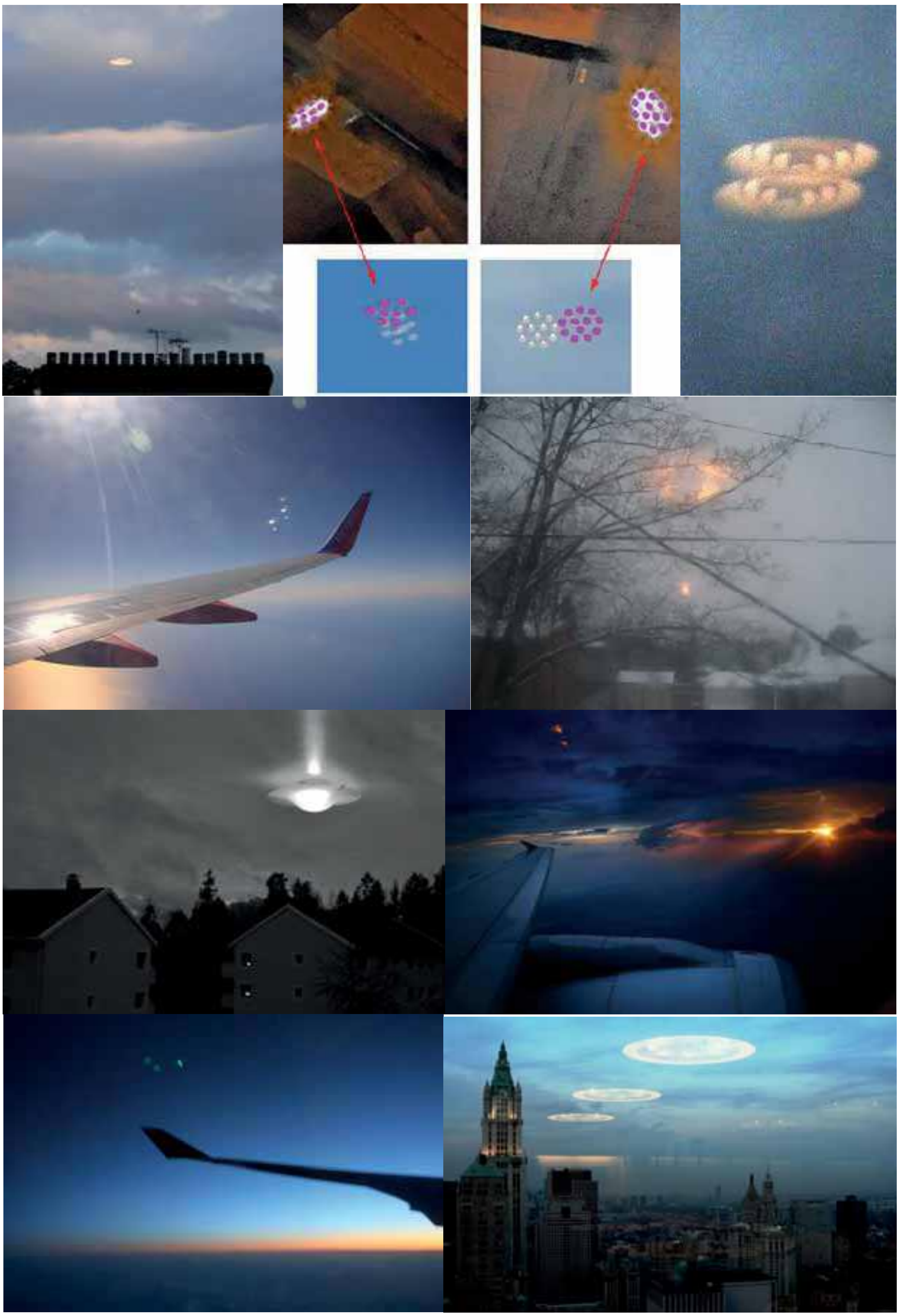


Fig.A-3.62 Reflections of light from lighting lamps from window glass (CC/GFDL)

Reflections of various kinds that occur in glass panes can also produce effects in an image that are discovered afterwards. The most common is a picture taken through a window pane with a lamp behind the photographer that is reflected in the window pane. When we look through a window pane, we usually do not react to the fact that an underlying light source is reflected in the window, but when the photographer looks at the image afterwards, the reflection from the lamp can look much more strange. It is often possible to see several signs that the image was taken through a window pane, as it is not uncommon for more than one object to be reflected in the window pane. A good rule of thumb is that if the object that is visible would be very difficult to miss with the naked eye if it were an external object, there is a good chance that it is something that was reflected through a window pane.

The reflections of a bright light source off the glass, depending on the curvature of the glass itself, can rotate around each other, creating a false "effect of movement" or displacement.

Spotlights shining from the ground are a relatively common misinterpretation phenomenon. A common description in these cases is that the observer sees one or more relatively diffuse lights in the sky that often resemble luminous spots dancing around in the sky. The lights are often round or oval and circle at a relatively slow pace, but since the movement depends on how fast the light source on the ground is moving, the speed can vary. Spotlights most often give rise to reports when the light from them is reflected in a cloud layer without the otherwise characteristic light pillar occurring. The light pillar occurs as a result of moist air layers in the lower atmosphere, but when there is drier air in the lower layers near ground level, the spotlight has nothing to reflect against and no light pillar occurs.

However, when the light source reaches a cloud base or a more diffuse layer of moisture or ice particles at higher altitudes where the air does not have to be as dry, the light source is reflected and is visible from the ground. Often there are multiple light sources as many searchlights (so-called skytrackers) are equipped with multiple lights and these can then move in formation and both appear to merge into each other and chase each other. Another characteristic feature of searchlights is that they are often visible over the same area for quite a long time and sometimes several days in a row.

Searchlights can be visible at a distance of up to 30 kilometers and therefore do not need to be placed in the immediate area. Sometimes the light source can disappear for short periods and then reappear, which is due to the reflection surfaces that the searchlight reflects against in the atmosphere being uneven and irregular or that gaps occur in the clouds. Searchlights are not infrequently linked to special events such as restaurant openings, concerts or as advertising at a shopping center.

Checking whether there has been a floodlight in the immediate area can be a laborious task considering that almost every outdoor venue in a city can use a floodlight. In addition to these, sporting events, cinemas, shops, festivals, concerts and similar events can use floodlights. Even private events at, for example, folk high schools can sometimes use light shows. The number of actors who can possibly use floodlights is consequently very large and it can be difficult to control all the possible possibilities.

Signs of operation of powerful laser systems:

1) A flash resembling intermittent lightning can occur strictly along the straight line of beam propagation
2) The impact on the environment can manifest itself at local points simultaneously with the flash
3) When working with relatively low-power lasers of the optical range, it is possible to observe small-area light spots (moving or not) on the surrounding area or clouds.

Fig.A-3.63 Reflection of city light on clouds (CC/GFDL)

Fig.A-3.64 Reflection of "invisible" beams of searchlights or lasers in clear air on clouds (CC/GFDL, K. Koutsouridakis)

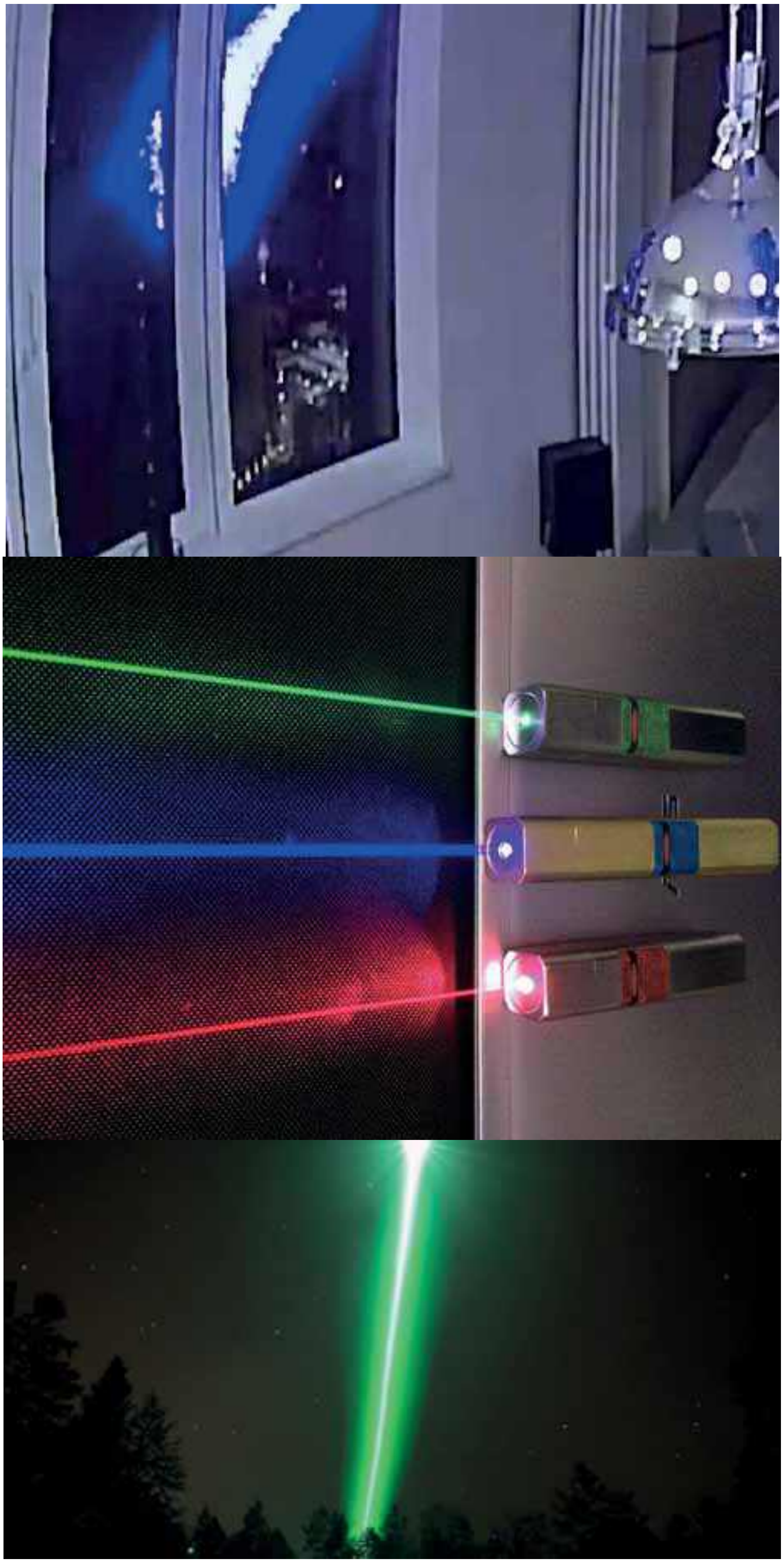


Fig.A-3.65 Lasers of different colors (I. Kalytyuk, CC/GFDL)

Fig.A-3.66 Laser on drone easily disables fiber optic FPV waiting in ambush (CC/GFDL)

Fig.A-3.67 Pink glow in the sky - cannabis grows in long days. The flowering zone is 12 hours of light and 12 hours of darkness, which usually occurs from 7am to 7pm, which is usually when the special lights are on over the cannabis growing area, darkening blinds are closed, but that night this did not happen, so the pink light was noticed by the city residents. (CC/GFDL)

Fig.A-3.68 Bending of light when the environment changes (CC/GFDL)

Fig.A-3.69 Spotlights on the ground and in the sky (CC/GFDL)

Fig.A-3.70 "Writings in the sky" using a convective smoke plume, as well as contrails illuminated by sunlight (CC/GFDL)

Fig.A-3.71 Wake trace (CC/GFDL, P. Carlsson)

Fig.A-3.72 Shadow of a contrail against the background of a solar halo (CC/GFDL)

A wake jet (wake trace) – is an air flow in the form of disturbed air masses (i.e. vortices) coming off the wing, stabilizer, other lifting and control surfaces, and the fuselage of an aircraft. Wake vortexes are formed due to the emergence of lift and, accordingly, when induced resistance is realized, are accompanied by the formation of two longitudinal vortices of opposite rotation (tip strands) at some distance (50-150 meters) behind the aircraft.

The total length of the wake vortex is 10-12 km, sometimes more, and depends on the state of the atmosphere, the aerodynamic configuration and flight configuration of the aircraft, flight mass, speed and flight altitude. Each type of aircraft has an individual wake vortex.

Getting into a wake vortex due to high turbulence of air masses causes strong turbulence, up to a complete loss of control. There are many known air crashes that occurred due to accidental entry into a wake and the inability to regain control of the aircraft. This is why military aircraft operating in pairs (groups) never fly one after another, but only in a bearing. On the other hand, when performing a coordinated (i.e. geometrically correct) 360-degree turn, with a precise turn, the aircraft should "shake" upon completion, which indicates entry into its own wake. Strong air disturbances also occur during takeoff and landing. Air traffic controllers take this into account and, taking into account the actual weather conditions, maintain intervals sufficient for the dispersal or wind blowing of disturbed air from the glide path zone. Recently, lidars have begun to be used to monitor wake jets in the glide path zone. To reduce energy loss, special wingtips are installed on the wingtips of some aircraft, which look like small "wings" - aerodynamic ridges or winglets (from the English winglets), located vertically or at an angle. The installation of these elements allows for a reduction in fuel consumption. The disadvantages include reduced resistance to crosswind.

Fig.A-3.73 Setting up a smoke screen (CC/GFDL)

The smoke screen contains titanium tetrachloride, and it takes about a minute to spray such a huge curtain.

Fig.A-3.74 Excessive discharge of a foaming substance (for example, washing powder) into the sewer system causes foam to be released through cracks in sewer manholes (CC/GFDL)

Fig.A-3.75 Colored clouds – as a result of man-made disasters, for example, an orange cloud may be a release of nitric acid (CC/GFDL)

Fig.A-3.76 Blue snow from ultramarine pigment, which is used in the manufacture of paints (CC/GFDL)

Fig.A-3.77 Scattering of solar light and rocket engine plume in a gas-aerosol cloud (A. Yakovlev, CC/GFDL)

Depending on the launch site, flight path, and lighting conditions, launch effects can be seen over a million square kilometers and can also cause interference in radio communications. The spiral shape of the "flying whirlpool" is seen when the rocket releases its fuel.

The launches often took place early in the morning when it was bright at high altitude but still dark on the ground. When the barium emissions were exposed to sunlight (which they do at high altitude even though it is dark on the ground), they ionized and could be seen over very large distances.

Fig.A-3.78 Rocket trail (CC/GFDL)

The observations of these launches often involved spectacular light phenomena that hung in the air for a relatively long time and were described, for example, as white or greenish balls of light that took up a significant part of the sky and were therefore often perceived as very extensive and tangible. This led many to believe that the light phenomena that were observed were at a significantly closer distance than they were.

What you see from the launch is also not caused on these occasions by the rocket itself, but by its exhaust gases that are illuminated by the sun at high altitude while it is dark on the ground. Often the exhaust develops in long bands or streaks behind the rocket and this can give rise to quite spectacular light phenomena. The rockets have also been described as somewhat funnel-shaped light phenomena where the light radiates from the luminous object in the middle and it is then the illuminated exhaust that is seen radiating from the rocket. They have also been described as luminous spirals.

Signs of launch of ballistic missiles or artificial satellites:

1) Presence (under cloudless skies) usually in the evening and at night, in the first minutes of observation of a contrail near the horizon (angular height usually 3~30°) behind a moving bright luminous point (visually at the speed of a passenger jet at a distance of several kilometers). In the first minute of observation, the contrail resembles a contrail from a high-altitude aircraft, and then it becomes much more powerful, begins to expand and gradually bend under the influence of atmospheric flows.

2) The front part of the contrail behind the moving point undergoes a noticeable expansion. This widening of the contrail is not symmetrical (convex upwards - due to lower atmospheric pressure). Streams of escaping gases are visible in it in the form of "rays". The bright luminosity of the contrail and gases is caused partly by self-illumination, and to a large extent due to their illumination by the Sun due to the high altitude above the Earth's surface (50~200 km) and the refraction of solar rays. When observed along the trajectory of the glow, the area usually has a drop-shaped form. The observed phenomena are caused by the operation of the 1st stage of the launch vehicle.

3) Observation of the moment of the flash at the location of the bright point and the formation of a usually motionless area with increased or high brightness of the glow, which temporarily masks the continuing movement of the bright point (luminous gases in the nozzles) and creates the impression of "hovering" of some luminous object. At the moment of the flash, diverging concentric circles (shock waves) can be observed. The described picture corresponds to the moment of separation (ejection) of the launch vehicle stage.

4) Further movement of the 2nd stage is also observed as a movement of a bright point or a dash with a cone of gas jets diverging behind it (at an angle of 70~100°), resembling "rays". The speed of the "point" during this period usually increases, and its trajectory of movement changes. At the moment of ejection of the stage, another more powerful flash with diverging circles in the area of the rays can be observed here. At this time, a rapid expansion of gases in the form of a sphere is often observed, with its lower edge reaching the horizon line (it seems to the observer that he is already inside the sphere). Vortices are often observed - streams with rotation. The reason for this phenomenon is the burning of the remaining fuel in the separated stage. This causes a feeling of fear in many observers.

5) After the end of the observation of the movement of a bright point (up to 10 minutes), a fairly rapid (5~15 minutes) dispersion of gases occurs with their intense glow, which gradually (after 1~3 hours) weakens and disappears.

6) In cloudy weather, only fragments of the phenomena described above can be observed, since any type of cloud is located much lower than the trajectory of intercontinental ballistic missiles (ICBMs) or artificial satellites. 7) A sign of a significant range (100~1000 km) and altitude (100~500 kmμm) of the processes taking place is the fixation of the same azimuth for the selected fragment of observation (by compass or by changing the observation point by several kilometers or during observations with a base of tens of kilometers). During simultaneous observations at a base of tens of kilometers, the azimuth change is no more than a few degrees. Comparison of the azimuths of observations with a large base (hundreds of km) allows us to determine the area of the phenomenon.

8) During the launches of ICBMs and artificial satellites, as a rule, there is no radar fixation of visual phenomena and objects, or this fixation indicates the movement of a high-speed target such as an ICBM.

9) The launches of ICBMs and artificial satellites lead, as a rule, to changes in the conditions for the propagation of HF and VHF radio waves, as well as radio communications due to the imbalance of the ionospheric ionized layers reflecting the radio waves.

Signs of injection of plasma (ion-electron) plasma beams into the ionosphere:

1) As a rule, with the simultaneous observation of the rocket launch, it is possible to record phenomena similar to the polar lights (due to the plasma entering the ionosphere at altitudes of 100~200 km).

2) The duration of the "polar lights" does not exceed several minutes.

When checking reports, there is a comprehensive compilation made by the American astronomer Jonathan McDowell. The compilation is called "launchlog" and can be accessed with the following link: Launchlog (www.planet4589.org) On that page there is a link to the "master orbital list", a somewhat difficult-to-read text file that lists a number of rocket launches that have been carried out since 1957 in chronological order with the date and time of the launch in UTC time. The column "Launch_S" shows where the launch was carried out in the form of a specific designation. You can usually see what location the designation refers to by copying the designation and searching for it in the "Sites file", a list of launch sites that is also linked to on the page.

However, the launch site that is mainly relevant to us when checking against older dates is the Plesetsk Cosmodrome in Russia and it is usually designated NIIP-53 or GIK-1 in the chronological list of launches.

Fig.A-3.79 The second stage of the Chinese CZ-8A dumped fuel; rocket trail intersects with Starlink "space train" (CC/GFDL, I. Bortnevsky)

Fig.A-3.80 Inversion trail of a rocket; application of air defense systems; shooting heat traps; offshore drilling platform fire over the horizon (CC/GFDL)

A-3.II.2. Night lights

Examples of "steady" and "flashing" lights in the home environment, as seen in frames from a moving video (LED indicator on a television and neon pilot on a mains switch):

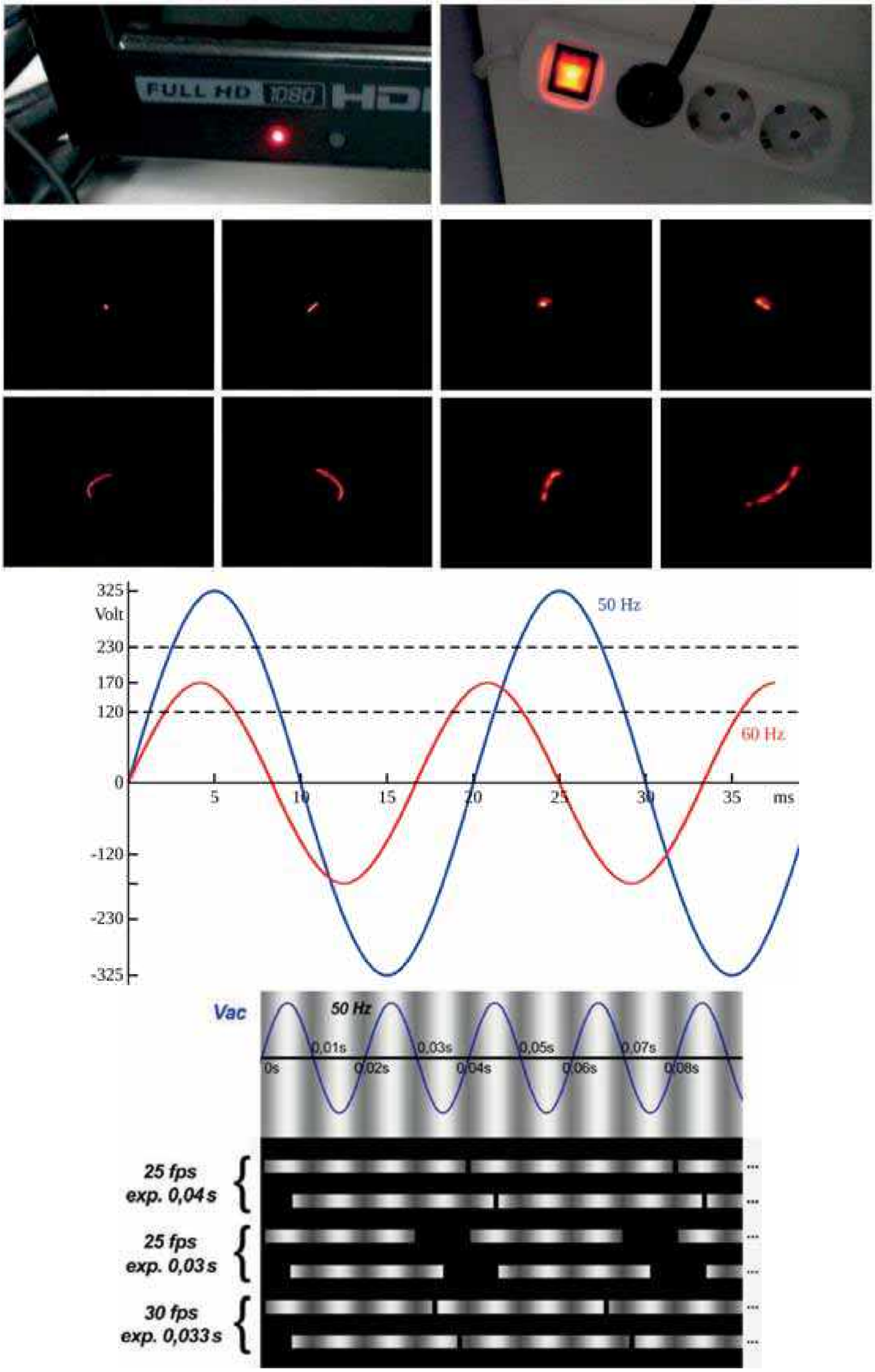


Fig.A-3.81 Shaken shot detect any unnoticed intensity fluctuation from a luminous object, for example, the frequency of periodic processes (synchrophasor), i.e. the number of oscillations, cycles, or repetitions of an event in one second (M. Borraz Aymerich, CC/GFDL)

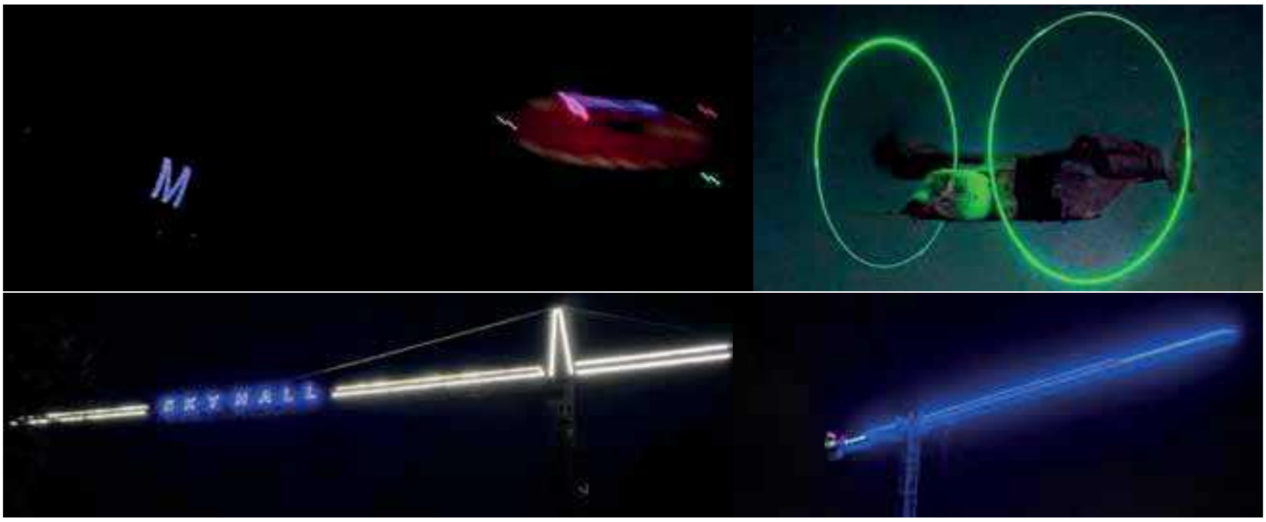


Fig.A-3.82 Neon lights on airships and cranes (CC/GFDL)

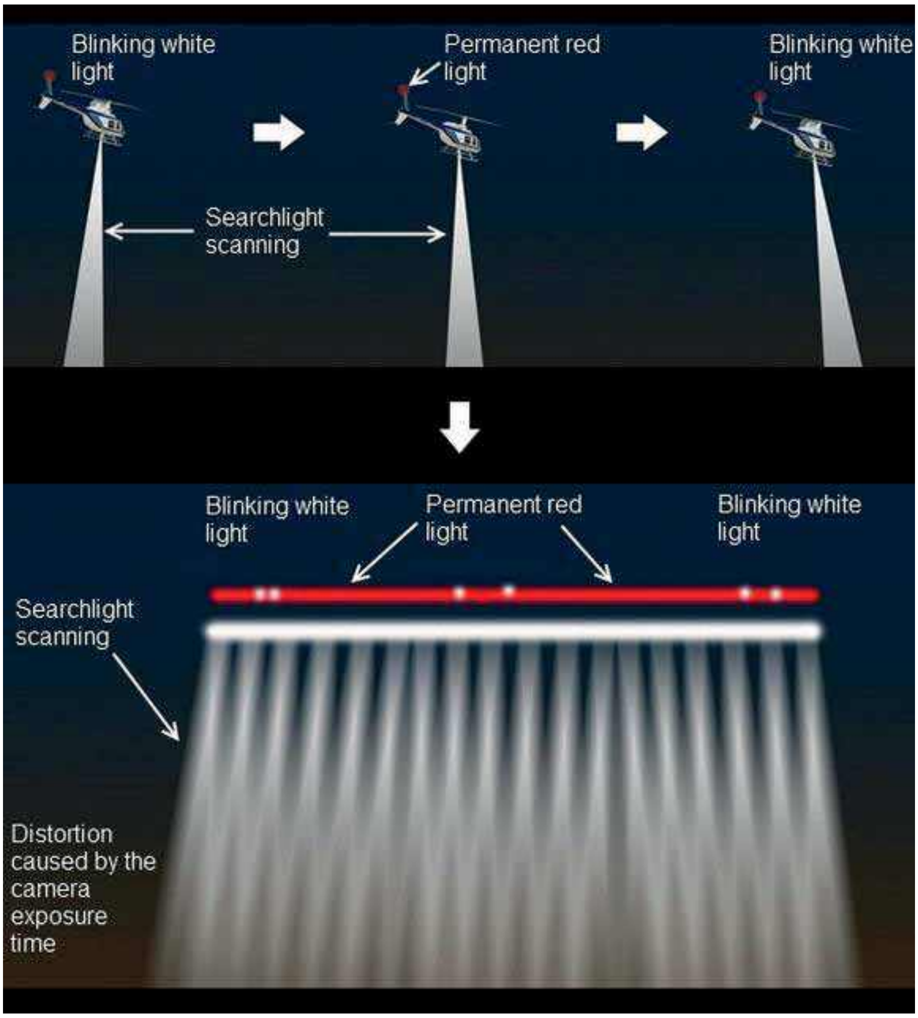


Fig.A-3.83 Identification of objects at long exposure (CC/GFDL)

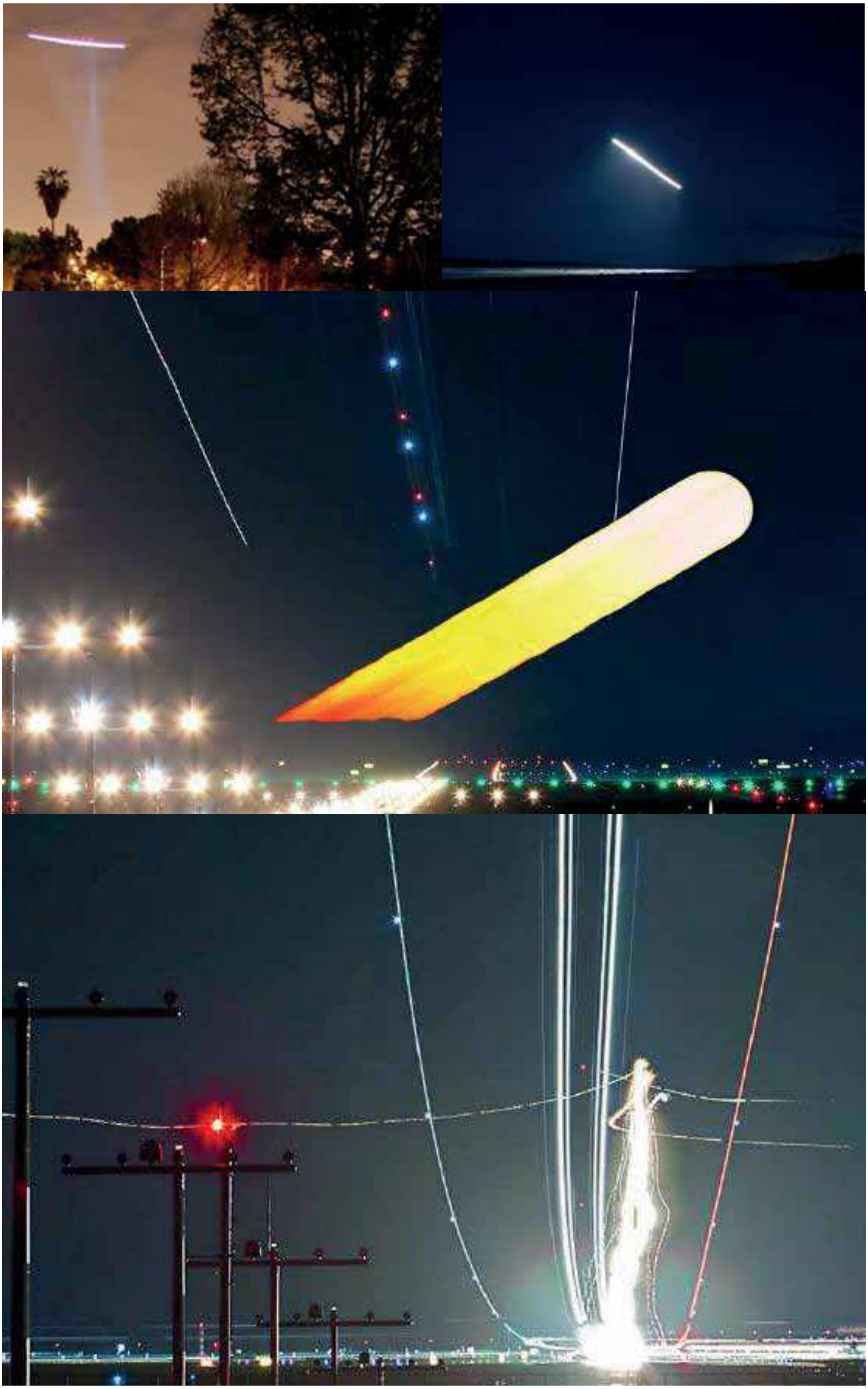
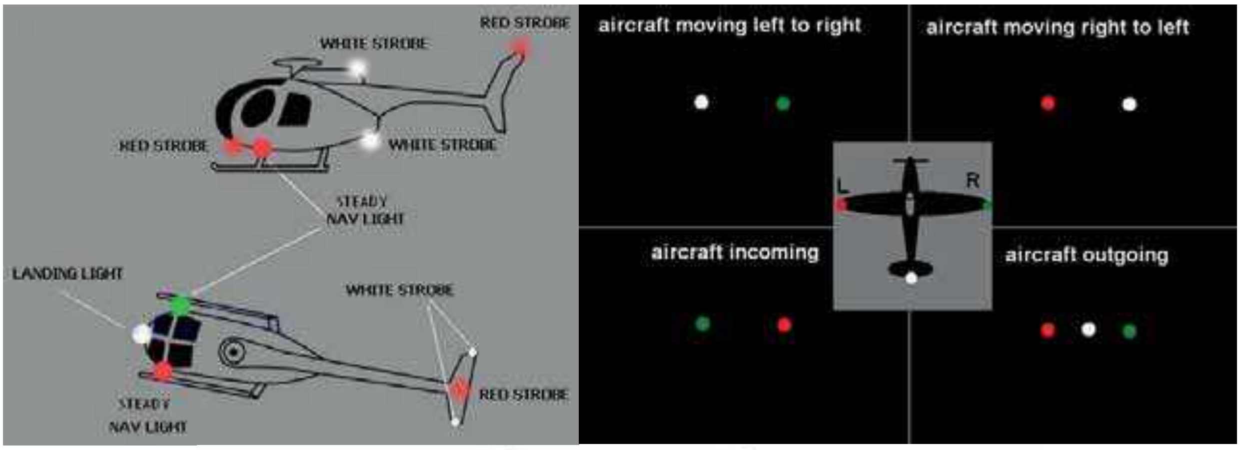


Fig.A-3.84 Shooting with a long exposure time (CC/GFDL, B. Mellmann)

Fig.A-3.85 Shooting with a long exposure time (CC/GFDL)



Aircraft in Normal status	Descriptions
	Power On Self-Test
	Warming Up & Aircraft cannot take off during warming up
	Ready to Fly
	Ready to Fly (non-GPS)
Aircraft in abnormal status	Warnings and errors
	Remote Controller Signal Lost
	1st Level Low Battery Capacity Warning
	2nd Level Low Battery Capacity Warning
	Not Stationary or Sensor Bias is too big
	Errors & Aircraft cannot fly.
	Compass data abnormal because of ferro-magnetic interference or

Fig.A-3.86 Location of airborne navigation lights (ANL) (CC/GFDL)

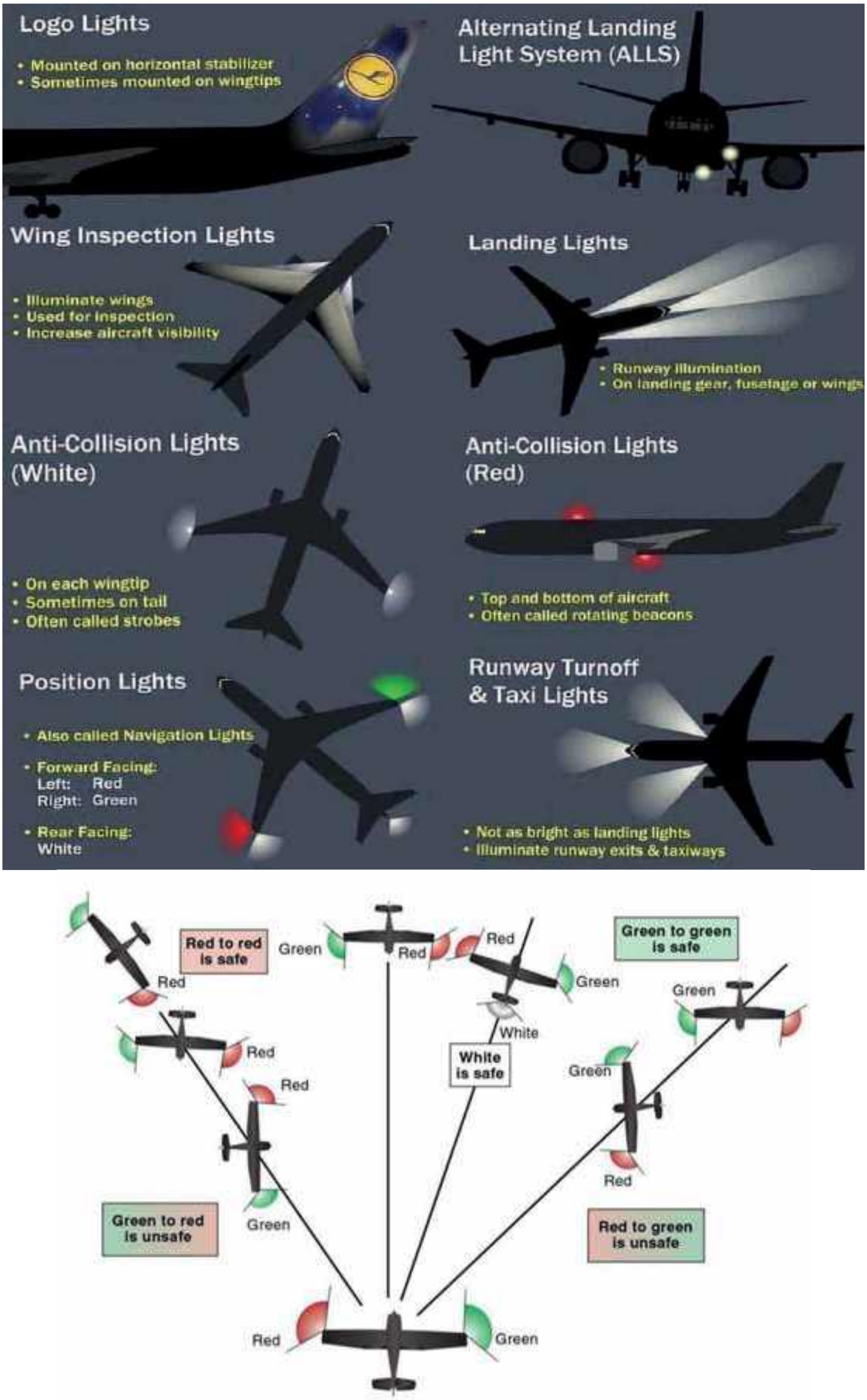


Fig.A-3.87 Location of airborne navigation lights (ANL) (CC/GFDL)

External lighting equipment provides:
1) illumination of the runway and taxiways;
2) illumination of the leading edges of the wing and air intakes;
3) illumination of the emblem on the vertical stabilizer of the aircraft;
4) light designation of the aircraft in the air;
5) light signaling over long distances to prevent collisions.

At the same time, pulse lights are placed on passenger aircraft in such a way as to reduce the reflection from flashes of light on the wings, which create the impression of a fire in passengers.
1) to illuminate the runway during takeoff and landing, two retractable runway lights are installed in the front part of the fuselage and two fixed landing lights on the nose landing gear and two lights for illuminating the turn from the runway (in the wing fairings with the fuselage).
2) two lights are installed in the fuselage to illuminate the leading edges of the wing and air intakes, and two lights are installed on the stabilizer to illuminate the emblem.
3) wing flashing beacons and dual ANL-11 air navigation lights are installed. White tail air navigation lights are installed on the trailing edges of the right and left wingtips. In flight, the lights operate in the nominal mode, and on the ground, with the landing gear down, the lights automatically switch to a reduced light intensity mode.
4) in ground conditions, the lights from the airfield power source operate as parking lights.
5) the aircraft is equipped with light beacons located in the upper and lower parts of the fuselage, and have colorless light filters and stepped (100% and 10%) light intensity adjustment.

Fig.A-3.88 Example of the location of the ANL (CC/GFDL)

A typical observation of an airplane at night can be a bright light moving across the sky in combination with a flashing light. This is the combination of landing lights and position lights. All airplanes are equipped with red, green and white light sources, while the green and white light together can be perceived as a bluish light. Usually, airplanes are perceived as silent. Depending on the observation angle, it may be possible to see only the fixed position lights without perceiving the flashing lights. An airplane with switched on landing lights observed in the oncoming direction then looks like a brightly shining and stationary point that may then gradually grow in brightness. If you also watch the landing itself, the illusion that the object is descending straight down in a vertical movement can arise due to the observation angle.

Military jet aircraft can cause reports, but these are less common than civilian air traffic (probably because there are significantly more civilian flights). They are equipped with a large number of different lights, all of which are adjustable in strength. Single-flight aircraft usually have full power on the lights, while aircraft in formation have dim lighting. However, the last plane in a formation always has full power on all lights. The lighting can sometimes be turned off during various exercises, giving the impression of a sudden disappearance. Fighter aircraft are propelled forward by a powerful jet. The exhaust is adjustable in several different stages. A JAS Gripen aircraft with its afterburner lit shines with a bright orange-yellow fireball from the stern. Most often, no other lights can be seen, which can be misinterpreted as a fireball flying forward at high speed.

Like civilian aircraft, military aircraft have powerful landing lights. They are located on the landing gear or the nose wheel and are automatically turned on when these are folded down. However, they can also be lit during flight. Military planes do not follow any set routes and can in principle be seen anywhere in our country. However, most often they practice in areas free from civil air traffic. In terms of practice, there are some scenarios that are followed, which are hunting other planes, attacking ground targets or ships, and reconnaissance missions. Many times the planes suddenly change direction and altitude, which can look as if an object suddenly appears or changes its location in the sky in a way that civilian planes cannot handle.

These missions can be carried out with individual planes or in formation. These formations can be seen as one object when they fly close to each other which then breaks up into several different objects when the combat planes change formation, direction or altitude. This can also cause strange light phenomena in the distance, lights that suddenly appear or disappear.

- Attack missions often begin with a collective approach at low altitude to climb to a higher altitude at the last moment to see the targets, which they then dive towards, drop their cargo or rockets and then disappear at low altitude, sometimes in a spread formation. Sometimes the aircraft's searchlights can be used to simulate firing at targets on the ground. The aircraft then flashes the searchlights so that it looks like flames.
- Hunting other aircraft can be done individually or in formation, where they fly in formation towards the aircraft they are hunting and then break up individually in a so-called "dog fight", usually in graceful and winding movements both high and low.
- Reconnaissance missions are usually done individually where the approach is carried out very low and the reconnaissance aircraft takes off quickly before reaching their destination where they go up and take pictures of the target, and then turn down and disappear low in another direction. Other missions are done very high so that air defenses do not reach the aircraft. Many times these exercises are repeated with the same scenario and in approximately the same way.

Each flotilla has its own exercise plan, with times for flying. It may look like this.

- Monday: Review with the pilots about the exercise plan and regulations and what you want to achieve with the exercise. Some parts can be practiced in a flight simulator.
- Tuesday: The flight mission is carried out.
- Wednesday: Review of what was good and what needs to be improved.
- Thursday: The flight is carried out again and you then try to fix the things that could be improved.
- Friday: Reviews of the latest missions.

This is a schematic picture of the exercise rhythm but is not set in stone. However, it is important to keep in mind that a military flight exercise can continue with the same plan over the same area for several days during the same week. In addition to established exercise series, rolling readiness at different times has been spread across all flotillas, in order to be able to meet other planes that violate Swedish territory, which gives completely different flight times. They often fly two by two (rotating pairs), or in other formations that can look very strange from a distance. The sound of jet planes is usually heard from afar but can of course be drowned out by disturbing background noise, for example if the observer is in a vehicle. When a jet plane is approaching the base, it is also common for them to run at low engine speed and then emit a weaker sound than they do when flying at higher speeds.

Towing flight. This involves a shooting target that hangs on a line behind the aircraft and that can be fired at, for example, during air defense exercises. The target that is fired at can be oblong and is also called a target sausage. However, smaller coil-shaped towing targets have also been used, and in previous years a target called a wing target was used, which was more like an aircraft in shape. During target flights, the target aircraft can fly over large areas and move back and forth over several tens of kilometers. If you observe the flight under special conditions, you may be able to see the towing target but not the aircraft. A towing flight can of course also be perceived as an aircraft that is followed (or chased) by a cigar-shaped object, as the line becomes more difficult to see from a distance.

Fig.A-3.89 Corona discharge from an exploding generator (CC/GFDL)

Fig.A-3.90 Cars driving on a mountain road (O. Obyedkov)

Car lights are generally uncommon as misinterpretation phenomena but have occurred under special circumstances. Around the world there are several places where people have seen recurring light phenomena for many years. The Marfa lights in Texas, the Min Min lights in Australia and not least the Marteboljuset on Gotland are some examples.

Now it should be emphasized that there have also been elements of strong expectation effects and a tendency towards what can most closely be described as hysteria among some of those who have made observations at Martebo. It is probably not likely that they would have mistaken the car lights for something strange if they had been in a place where they did not expect to see an unusual light phenomenon.

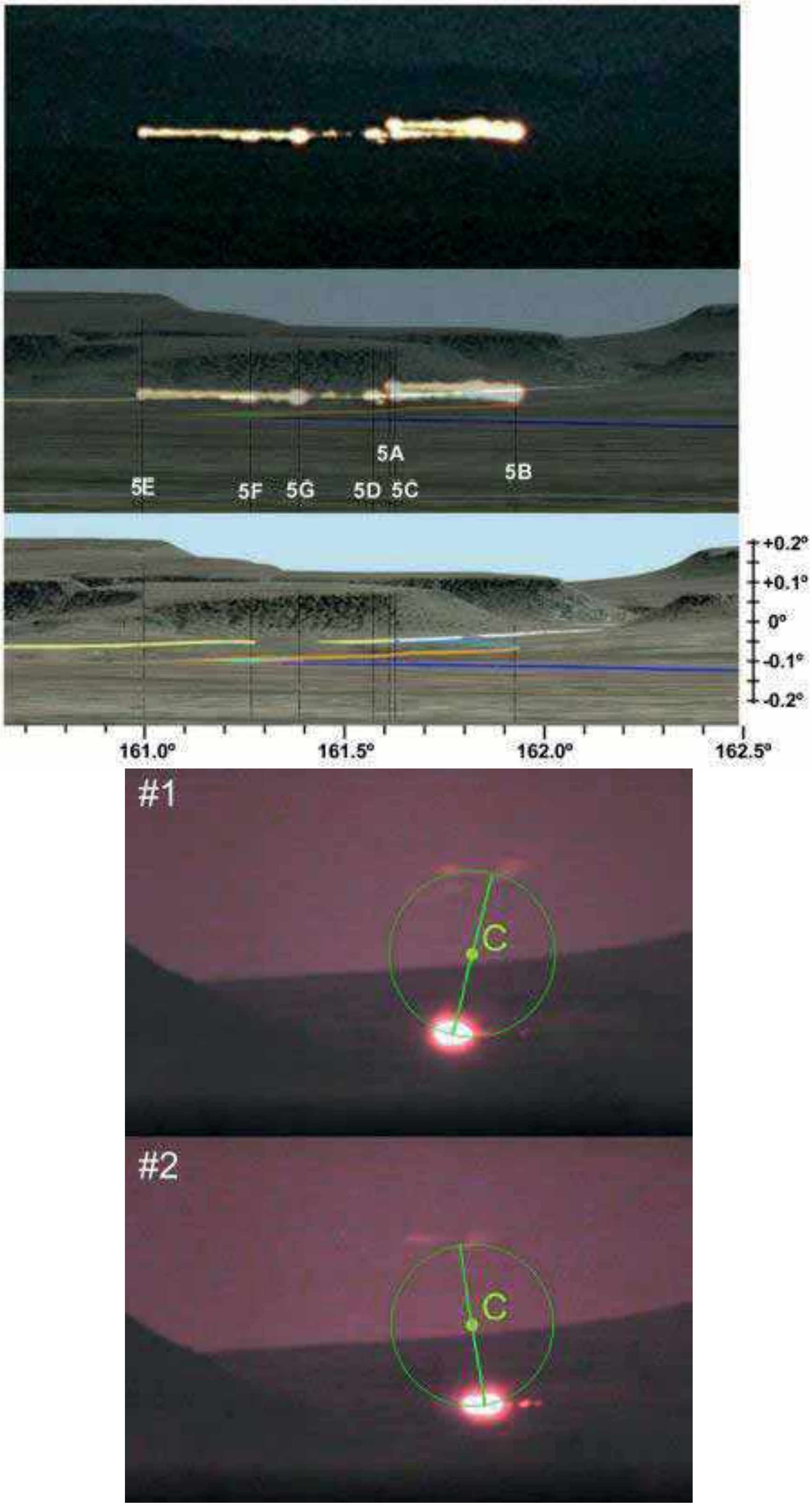


Fig.A-3.91 Glare and photographic artifacts when shooting car headlights with high probability (V.J. Ballester Olmos, M. Borraz Aymerich)

While a normal mirage occurs when light is reflected in a warm layer of air near the ground, such as when you see the blue sky reflected off a hot asphalt road, the Fata Morgana phenomenon occurs when light is reflected in a cold layer of air near the ground that will guide the light beam over the horizon. In this way, a light beam can not only be guided over long distances but also be amplified.

One way to check the probability that a Fata Morgana phenomenon has occurred and thus suitable conditions for a car light to be able to travel over greater distances is to check the temperature conditions during the current day. In cases where it concerns a light phenomenon near the ground, the investigator should always check whether there are roads in the immediate area and in the current direction and whether the conditions were such that a Fata Morgana phenomenon could have occurred. However, it is also important to remember that objects such as trees and buildings can make it more difficult to see the car lights even if they travel over longer distances as a result of the Fata Morgana phenomenon. The more open the landscape, the better the conditions for the car light theory.

The most typical signs for identifying moving man-made phenomena are the following:

1) No noticeable acceleration, relative smoothness of movement.
2) The presence, as a rule, of side marker and warning lights (including flashing lights) on air and water vehicles.
3) The presence of characteristic engine noise at fairly close distances.
4) Clear fixation on local airport (port) radars, including in auto-response mode (for aircraft).
5) Change in azimuth for different observation points, spaced from each other by fractions of a kilometer or kilometers

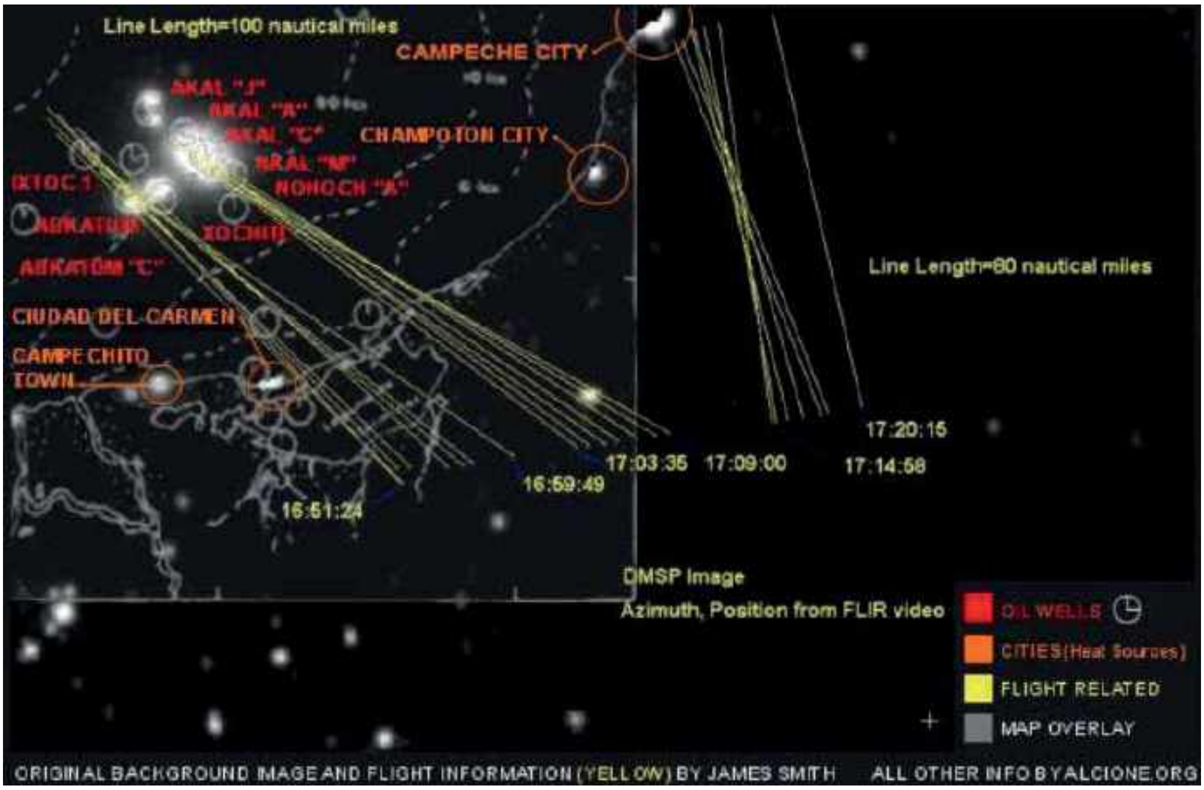


Fig.A-3.92 Oil platforms at night and out of focus were reported as unidentified flying objects (UFOs) observed from an airplane (F.-A Navarrete)

Fig.A-3.93 According to one logical explanation, the mysterious red spots on Atlantic Ocean were most likely caused by a fishing fleet using red led lights to draw schools of saury fish. Fishing boats often use large panels of LED lights to attract saury fish (CC/GFDL)

Fig.A-3.94 The process of identifying an object that turned out to be a reflector lamp with a bixenon in the center (S. Minkov)

These floating hot air balloons have many names – rice lanterns, UFO balloons, Khom loy, Thai lanterns, are just a few examples we have heard. The lanterns are particularly popular to send up around New Year but are now seen all year round, although to a lesser extent than around the turn of the year. The balloons are often seen in formation and sometimes large mass releases are made of balloons that usually glow in a red/orange light but can also occur in other colours. A UFO balloon consists of a thin, transparent plastic bag (about 60 litres), steel wires and a lump of paraffin or a piece of cardboard. After inserting the two wires crosswise through the lump of paraffin or piece of cardboard, the ends are attached to the bottom edge of the plastic bag. Then you hold the top of the bag and ignite the paraffin/cardboard. Once the bag is filled with hot air, it is released. The balloon then rises quickly and the burning paraffin/cardboard lights up the inside of the plastic bag, making the balloon visible from a very long distance.

A normal flight time before the balloon burns out is 8–10 minutes. Sometimes several balloons can sail away together while others "get stuck" in a layer of air further down and appear to be hanging. UFO balloons have been very common among sightings reported to the association over the years, but in recent years the reports have decreased significantly.

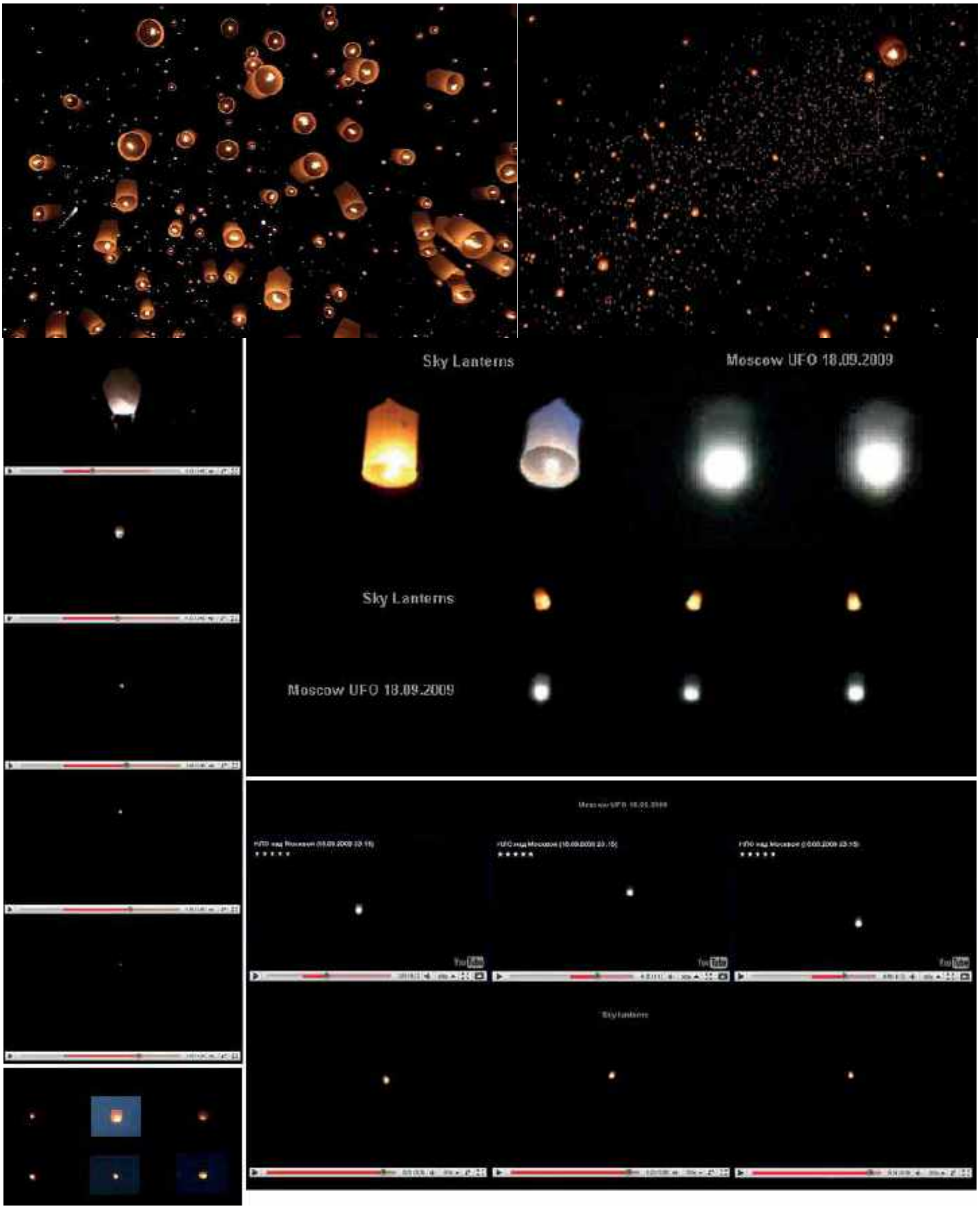


Fig.A-3.95 Air lanterns. Flight altitude 200 m, flight at wind speed, flight duration 20 min (CC/GFDL). Wind speed in the sky and at the ground may differ.

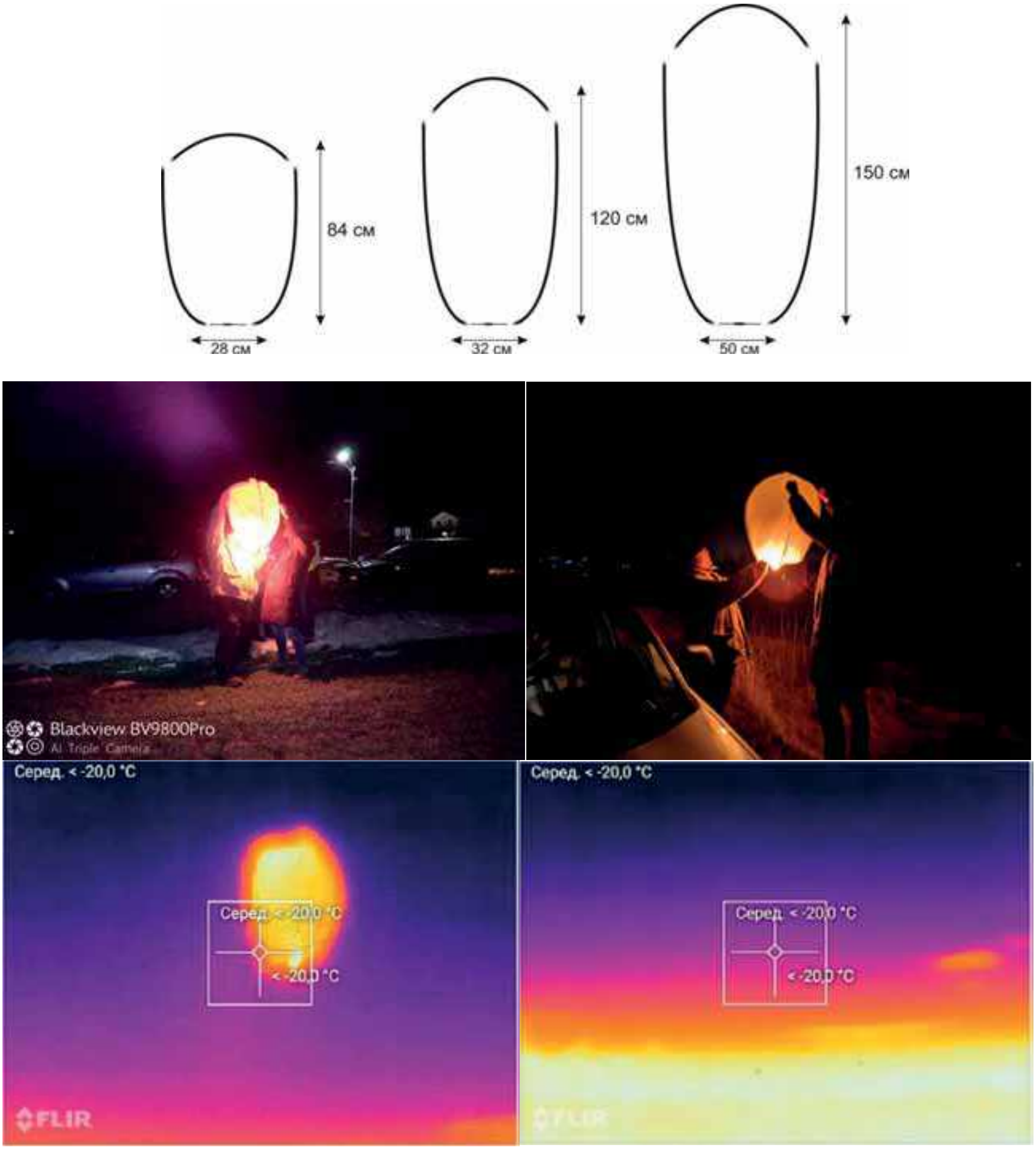


Fig.A-3.96 Sizes of small, medium and large air lantern. And thermography of the "Chinese lantern" in flight at short and long distances (CC/GFDL, SRCAA "Zond")

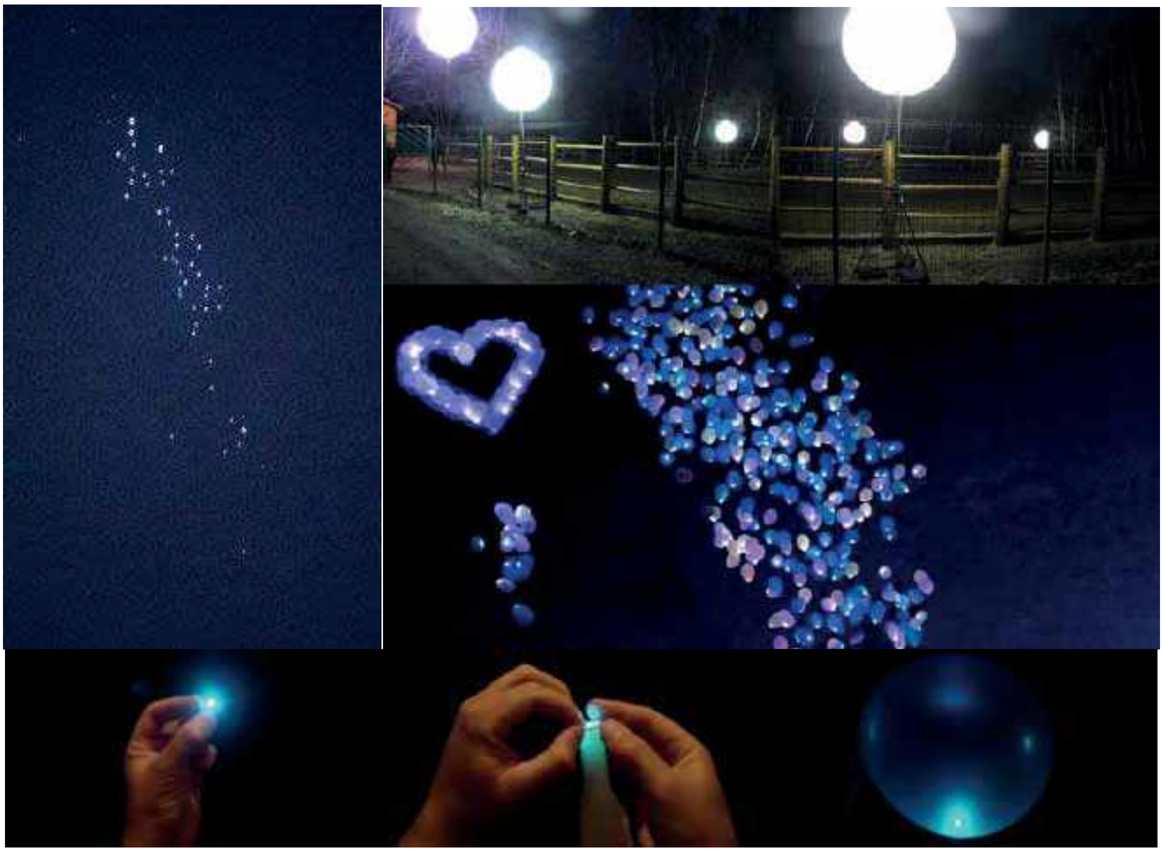


Fig.A-3.97 Luminous helium balloons with LEDs inside (CC/GFDL, S. Petrov)

Fig.A-3.98 Signal lights and illuminating ammunition (CC/GFDL)

There are also signals that change the color of the flame when burning (the signal cap is pressed sequentially with two compounds). There are military flares and cartridges that provide illumination in the infrared (invisible) spectrum. It is used for illumination when observing with night vision devices - so as not to unmask your troops in the visible range. If the visibility of the signal in the air is more than a minute (according to the stopwatch), then it is not a hand-held rocket cartridge.

<u>"Chandeliers" and "Balls" from a group of lights </u>– multi-torch illumination bombs (SAB-250, SAB-500), Soviet contain seven torches on parachutes. Duration of action from 5 to 8.5 minutes. Luminous aviation bombs are dropped from a height of 9 kilometers, at a distance of 70-75 km from the coast, and at an altitude of 6 kilometers they begin to glow. Missiles are launched from aircraft at them, which react to thermal radiation.

Only illumination ammunition of artillery (illumination shells and mines) and aviation (SAB light bombs) can provide a duration of action in the air for 2-8.5 minutes. At the same time, their visibility can reach (taking into account the absorption of light in the atmosphere and the closed horizon) more than 200 km (as bright point lights).

<u>Groups of many lights hanging high in the sky </u>– the result of an aircraft firing heat traps (IR cartridges of the PPI-26 type, Chaff Cartridges, Decoy Flares, etc.). This is a means of protecting aircraft and helicopters from missiles with heat-seeking heads. Cassettes with jamming cartridges are attached to the fuselage of an aircraft/helicopter; in flight, upon a signal from the pilot, the jamming is fired in groups to the sides of the fuselage. Widely used in exercises. From a distance, it looks like a "bouquet" of red lights appearing in the sky - a single group or appearing one after another at short intervals. Along with IR cartridges, anti-radar reflectors PRL are also used (a cloud of small particles reflecting a radio signal, cartridges of the PPR-26 type).

<u>Single flashes </u>– distress sound rockets, photo cartridges and photographic aerial bombs.

Luminous lights on the ground - can be created by ground pyrotechnic signals. If the duration is up to 2 minutes - signal grenades, hand torches (false flares). If the duration is several minutes - orientation-signal aerial bombs (like NOSAB) and practice (for training bombing) blank aerial bombs.

Fig.A-3.99 Air bomb FOTAB-100-80 (CC/GFDL)

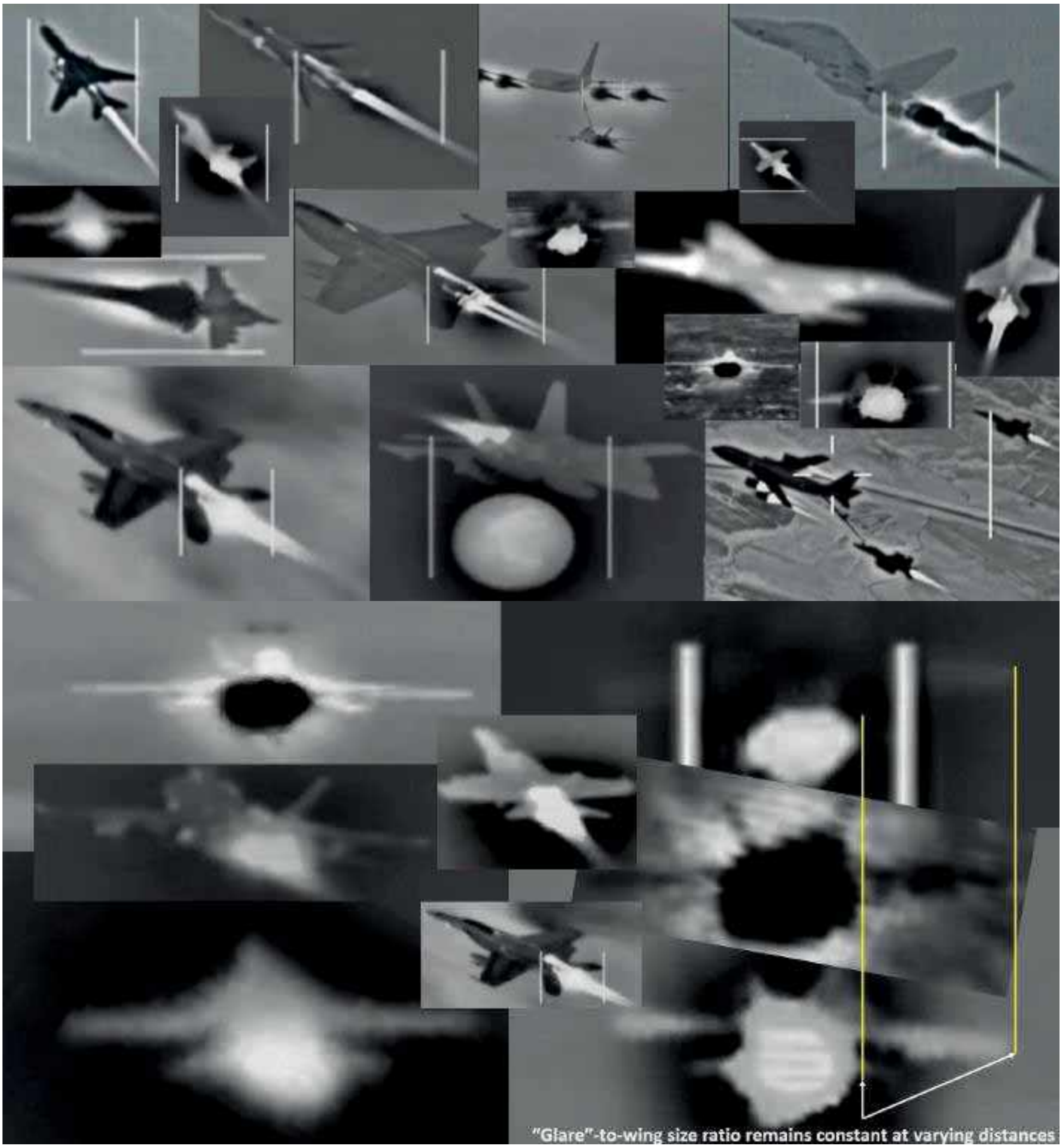


Fig.A-3.100 Publicly available AN/ASQ-228 ATFLIR imagery of jet engine exhaust. In the available ATFLIR footage, exhaust viewed approximately tail-on never obscures the entire aircraft by several factors, as required by the "distant jet" theory (Y. Peings, M. von Rennenkampff, US Air Force)

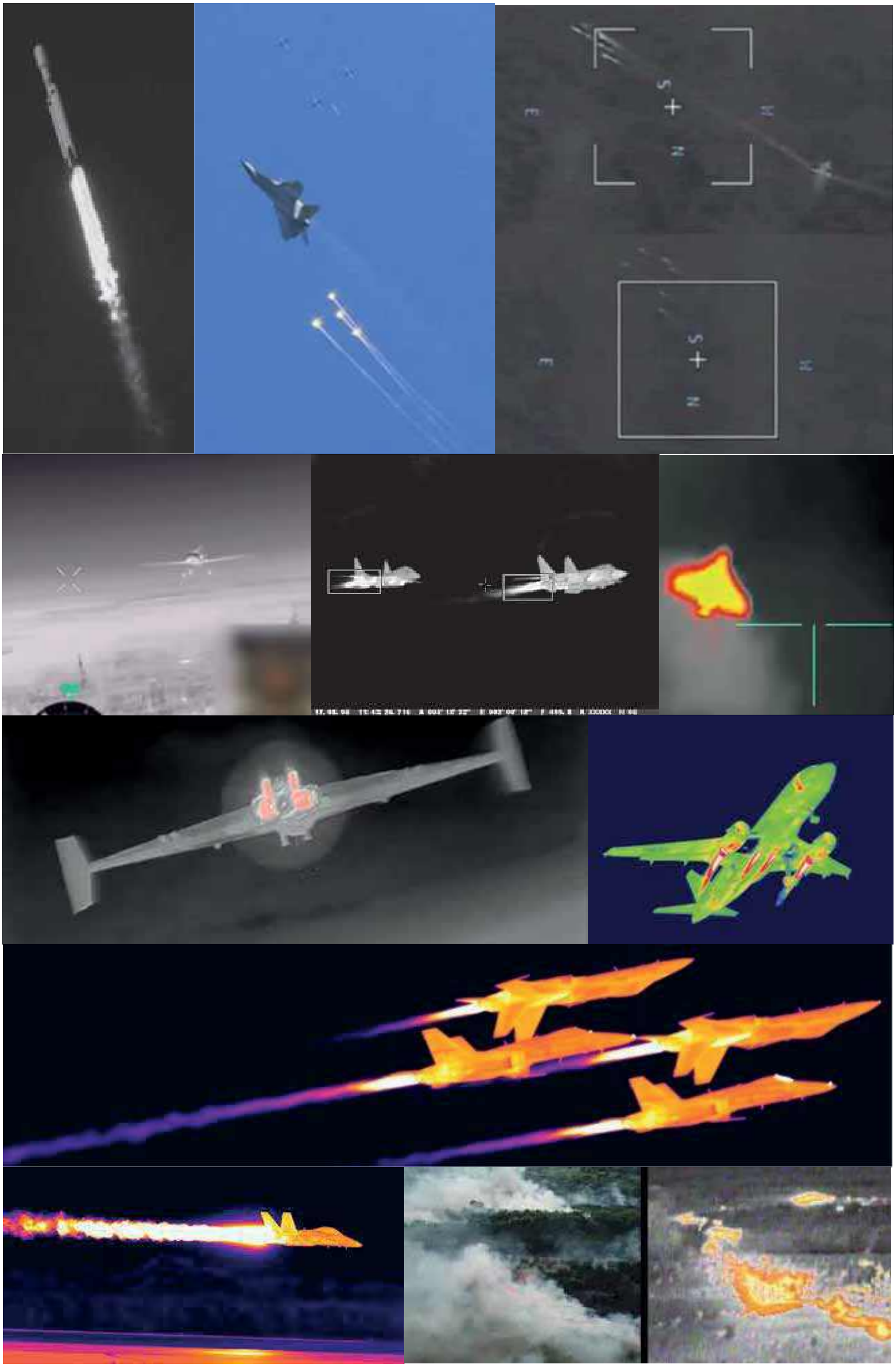


Fig.A-3.101 Examples of characteristic video of airplanes, drones, boats, missile launches and fire filmed with a drone with and without a thermal imager (CC/GFDL, Ukrainian Air Force, US Air Force)

Table A-3.3. Nature of signals and compliance with cartridge samples

SINGLE FIRE	"slow", "frozen", "floating"	Parachute cartridge	Color – white or white-yellow. Luminous intensity – 200,000 – 400,000 candelas. Burning time 20-35 sec Descent speed – 3-5 m/sec Signal height – 200-600 m	Illuminating 40-mm ROPUD 50-mm ROPDD
			Color – red, yellow, green. Luminous intensity 30,000 – 50,000 cd Burning time 35-60 sec Signal height 200-400 m	Signal 40-mm RPSP, RB-40SH, PRB-40 50-mm RB-50S KSP (launched from a submerged submarine) Comet, LeSea, PainsWessex, Ikaros distress missiles
	moving relatively quickly	Single star without parachute cartridge	Color white or white-yellow. Luminous intensity – 100,000 cd Burning time 8-10 sec. Vertical descent speed 30-40 m (free falling) Signal height – 150-350 m	Illuminating 30mm ROPUD
			Colors: red, yellow, green. Burning time 9-12 sec. Speed of descent – up to 30-40 m/sec. (free falling) Signal height 150-350 m	Signal 30-mm RSP, ROK-30, ROZ-30
GROUPS OF LIGHTS one color	TWO FIRES		White or white-yellow shade Burning time 8-10 sec Signal height 150-350 m	Illuminating two-star 30-mm old model
			White, red, green, yellow Burning time 10-12sec Signal height up to 350-400m	Signal two-star 40-mm RDSP 2 Star Red Rocket Mk3
	THREE FIRES		Red, green Burning time 6-8 sec Signal height – 200-250 m	Signal multi-star 30-mm RSP
	FIVE FIRES		Red (with whistling sound in the sky) 5-6sec (whistle 8-10sec) Signal height 200-250m	40mm chemical alarm signal SHT-40
			Red, green, yellow Signal height – 200-250m	Signal Rocket Cluster Signal M125, T133, T137
	SIX FIRES		Red, lights flash in the air one after another, at short intervals. Total duration 18-20 sec Signal height – 350 m	Ship distress rocket RB-40S
SINGLE FLASH			A bright flash, accompanied by a loud sound. Audibility range – 10 km The sound reaches the observer after a few seconds (at a large distance – 20-30 sec)	Sound rocket
The visibility range of signals at night is 10-15 km or more. Illuminating lights of 40-50 mm cartridges, launched vertically upwards, can be seen at a much greater distance.				

Photo-illuminating aerial bomb - an aerial bomb that creates a powerful short-term light flash. The main charge of FOTAB is made of powdered aluminum-magnesium alloy, called a photo mixture. An incendiary-explosive charge (IEC) consisting of a mixture of an oxidizer and aluminum powder with magnesium is installed along the axis of the aerial bomb. It is activated by a remote fuse. When it is triggered, the explosive impulse is transmitted to the IEC, the explosion of which destroys the body of the aerial bomb. The photo mixture is scattered, ignites and burns using oxygen in the air. A 100 kg FOTAB creates a flash with a luminous intensity of more than 2 billion candles lasting about 0.2 sec. The FOTAB-100-80 aerial bomb is designed to illuminate the area during night aerial photography from an aircraft from altitudes of up to 10,000 m, at flight speeds of up to 1000 km/h.

Signs of the launch of signal and illumination flares (depending on the distance from which they are observed):

1) The presence of rocket movement during the vertical ascent and initial descent (before the braking parachutes open) along a parabolic trajectory.
2) Relatively short rocket burning time (units of seconds for signal flares and tens of seconds for illumination flares).
3) Characteristic shape of the combustion source with spontaneous rapid brightness fluctuations.
4) Traces of smoke during combustion and after it has ceased, clearly visible in the daytime.
5) Slow drift of a group of illumination flares "suspended" on parachutes and burning out signal flares in the direction of the wind.
6) Observation of the above phenomena in cloudy weather, i.e. at a relatively low altitude (100~200 m), excluding launches of signal flares from airplanes and helicopters.
7) Difference in azimuth to the location of the phenomenon when observed from different points (locality of the phenomenon).
8) The presence of low-level radio emissions in a wide frequency range in the form of radio interference, which can be recorded using radars or highly sensitive radiometric receivers in the VHF and microwave ranges.

All pyrotechnic signals move along a steep parabola, at a low speed of 50-150 m/s. The combination of factors of acceleration of fall for parachuteless, and the nature of parachute opening under the influence of wind for parachute, can give subjectively bizarre effects. The fire in the sky can move unevenly (accelerating or decelerating), be visible in a halo due to clouds or flicker, the group of lights can change in number (due to the reorganization of the group at a great distance, fading of signals or separation of parts from the light).

Incendiary ammunition

Unfortunately, the massive use of incendiary munitions, not only against the military but also against civilians, has become a reality today, and no international bodies, due to their weakness, can prevent this in any way.

Fig.A-3.102 9M22C (CC/GFDL)

A similar effect is provided by the 9M22S rockets used by the BM-21 Grad multiple launch rocket systems. Replacing the standard high-explosive fragmentation warhead of the 9M22 missile, the 9M22S missile carries the 9N510 warhead. The warhead of this missile consists of 180 incendiary warheads made of ML5 magnesium alloy and filled with a pyrotechnic composition similar to thermite.

Fig.A-3.103 White phosphorus (CC/GFDL)

When burning, white phosphorus develops a temperature of up to 1300°C. The combustion temperature of phosphorus ammunition depends on a number of conditions (the type of ammunition used, air temperature and humidity, etc.) and is 900-1200°C. The combustion temperature of incendiary ammunition with a charge of white phosphorus and a combustible substance is 800-900°C. Combustion is accompanied by abundant release of thick, acrid white smoke and continues until oxygen access ceases or all the substance burns out.

Artificial glowing clouds (AGC) are used to observe optical effects that occur when certain chemical substances are ejected into the atmosphere by rockets. Thus, when alkali metal vapors and some other substances are ejected into the sunlit layers of the atmosphere, resonant radiation occurs, the intensity of which at each point in space is associated with the local concentration of the substance's atoms, which allows one to visualize the spatiotemporal structure of the formed AGC. By photographic and spectral observations of such clouds, one can obtain information about the parameters of the atmosphere - wind speed and direction, parameters of molecular and turbulent diffusion, temperature, electric field, etc. Observations of artificial aerosol clouds glowing due to scattered solar radiation allow one to study the patterns of scattering and transport of fine dust particles. The relevance of such studies is due to the increasing anthropogenic pollution of the upper atmosphere due to the intensive use of rocket and space technology. When using various compositions to create AGC, the method of artificial formations can be used in a very wide range of altitudes - practically from the Earth's surface (smoke clouds) and up to several hundred and even thousands of kilometers (barium, lithium and other artificial luminous clouds). Nitrates of alkali metals are used to create ALC ($NaNO_3$, KNO_3, $CsNO_3$), azides (eg - LiN_3, BaN_6), peroxides (eg - BaO_2), aluminum oxide (AlO). In addition to gases, AGC can also be in the form of sprayed, tiny foil that reflects sunlight at high altitudes, moving across the sky with the wind for several days, changing its shape from a sphere to a disk, and is used to test radar defense systems.

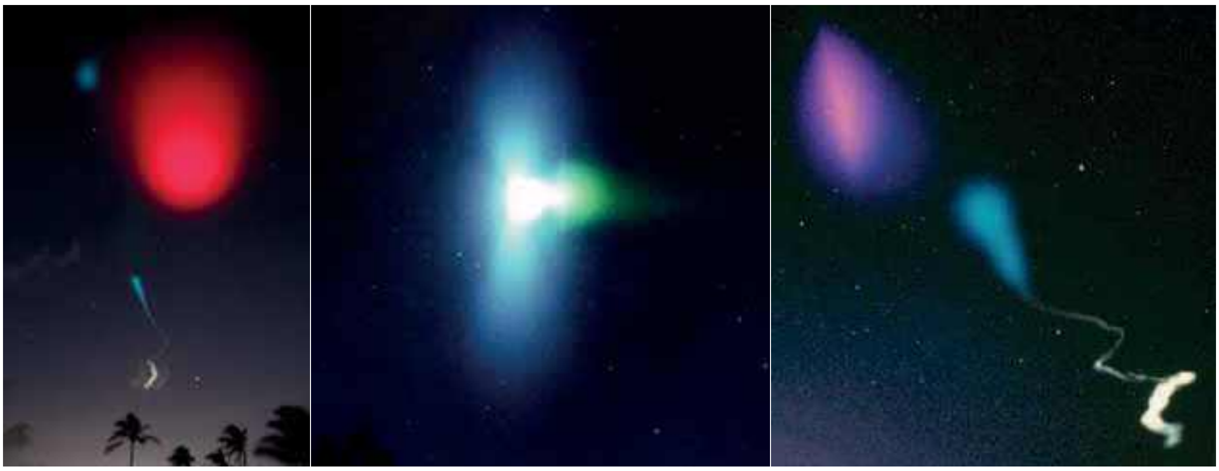


Fig.A-3.104 Artificial luminous clouds (CC/GFDL)

Signs of observation of the launch of a system by a rocket with subsequent dispersion of vapors of alkaline Earth and other metals:

1) The movement of a bright point (usually in the evening or early morning hours), leaving a contrail, and then, in the upper layers of the ionosphere - short "rays" (jet gases of the launch vehicle).
2) The formation of a luminous area (approximately corresponding to the brightness of the glow of the Moon), quickly (within several tens of seconds) expanding to a size of several diameters of the lunar disk.
3) Gradual weakening of the glow of ionized metal vapors, a decrease in density with observation of stars through the "veil" of the luminous area (within 10~30 minutes).
4) In cloudy weather, individual fragments of the above-described phenomena can be observed.
5) The practical constancy of the azimuth of the observation area of this phenomenon when the observation point changes by several kilometers indicates a large range and altitude of the phenomena.
6) This type of phenomenon is usually not recorded by airport surveillance radars (it can be recorded only if the phenomenon is close enough and at a relatively low altitude). It can also lead to a change in conditions in the launch area on HF and VHF.

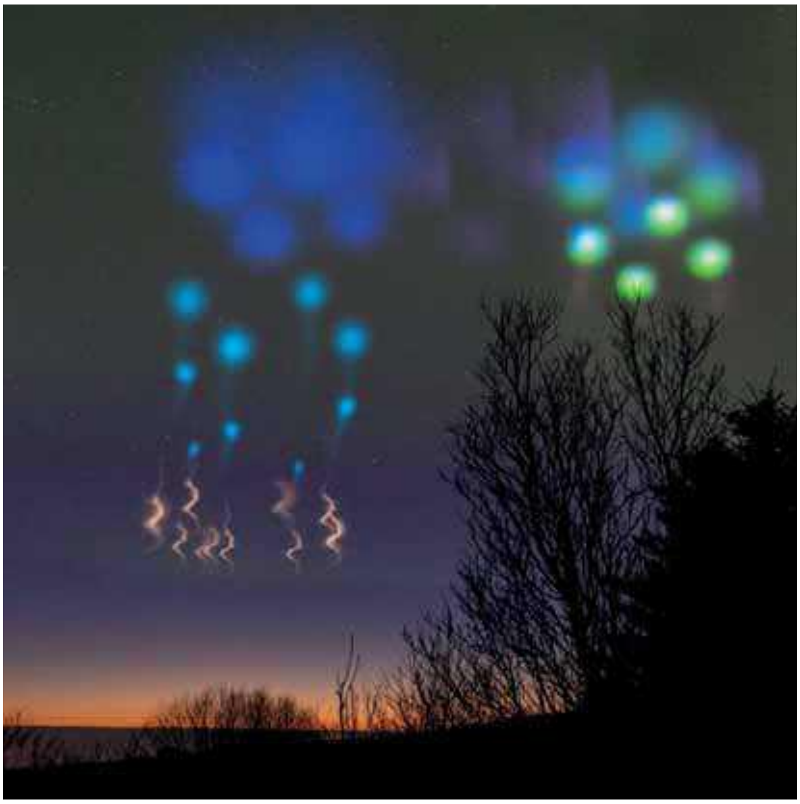


Fig.A-3.105 Auroral Zone Upwelling Rocket Experiment (NASA)

Example: A mixture of trimethylaluminum, barium and strontium particles was sprayed at altitudes of 115 to 250 km. As a result of interaction with the Earth's atmosphere, these substances formed luminous multi-colored clouds in order to study the behavior of charged particles in the ionosphere during the polar lights.

Disused satellites, launch vehicles and the like will sooner or later be pulled towards the Earth where they crash and burn up through friction with the atmosphere. Crashing satellites and launch vehicles resemble meteors and can shine in different colours. Unlike meteors, however, they are usually seen for a much longer period of time and can be observed for 30 seconds or more. However, it can take up to two minutes before the remains have completely burned up. Space debris often enters a flat horizontal orbit and then moves parallel to the Earth's surface. It is common for the space debris to break into a number of pieces that form a string of flaming light sources. Occasionally, crashing space debris can be seen during the day, leaving smoke trails in the sky.

Most launch vehicles are launched in an easterly direction, which allows them to gain additional speed due to the axial rotation of the Earth.

Signs of sinking of spent satellites or combustion of parts of launch vehicles in the atmosphere:

1) Movement (during combustion in the atmosphere) of a group of multi-colored luminous bodies in the form of a swarm, as a rule, without a noticeable change in mutual distances during the observation period (1~3 min).
2) Burning bodies are stretched in the direction of movement (due to differences in the drag of individual parts of the satellite) by units or more angular degrees.
3) The trajectory of the burning satellite is close to horizontal.
4) The movement of the group of bodies occurs without acceleration, smoothly.
5) The movement of the burning satellite, as a rule, is not recorded on surveillance radars.
6) The initial and final azimuth of the trajectory of movement and the angular altitude hardly change when comparing observations from different points located at a distance of several kilometers or more, which indicates a significant altitude (range) of the trajectory of the object's movement.
7) In cloudy weather, fragments of the picture of the movement of bodies can be observed.
8) During movement, various types of sounds can be recorded, mainly low-frequency (including infrasound), caused by the formation of shock waves when burning parts of the satellite or launch vehicle move faster than the speed of sound in air.
9) Sometimes there is a sensation of sound effects before the luminous bodies approach the observation area
10) Can cause short-term changes in the conditions of radio communication and radio reception on HF and VHF.

When checking re-entries that are several years old, the compilation made by Ted Molczan, which is in the link below, can also be useful. However, that compilation only refers to observed re-entries and is not a compilation of all re-entries. • Current re-entries (aerospace.org) • Older re-entries (www.satobs.org)

Fig.A-3.106 Reentry – phase of entry of space technology into the dense layers of the atmosphere (CC/GFDL)

Fig.A-3.107 High-altitude interception of a ballistic missile in the sky (Israeli Air Force)

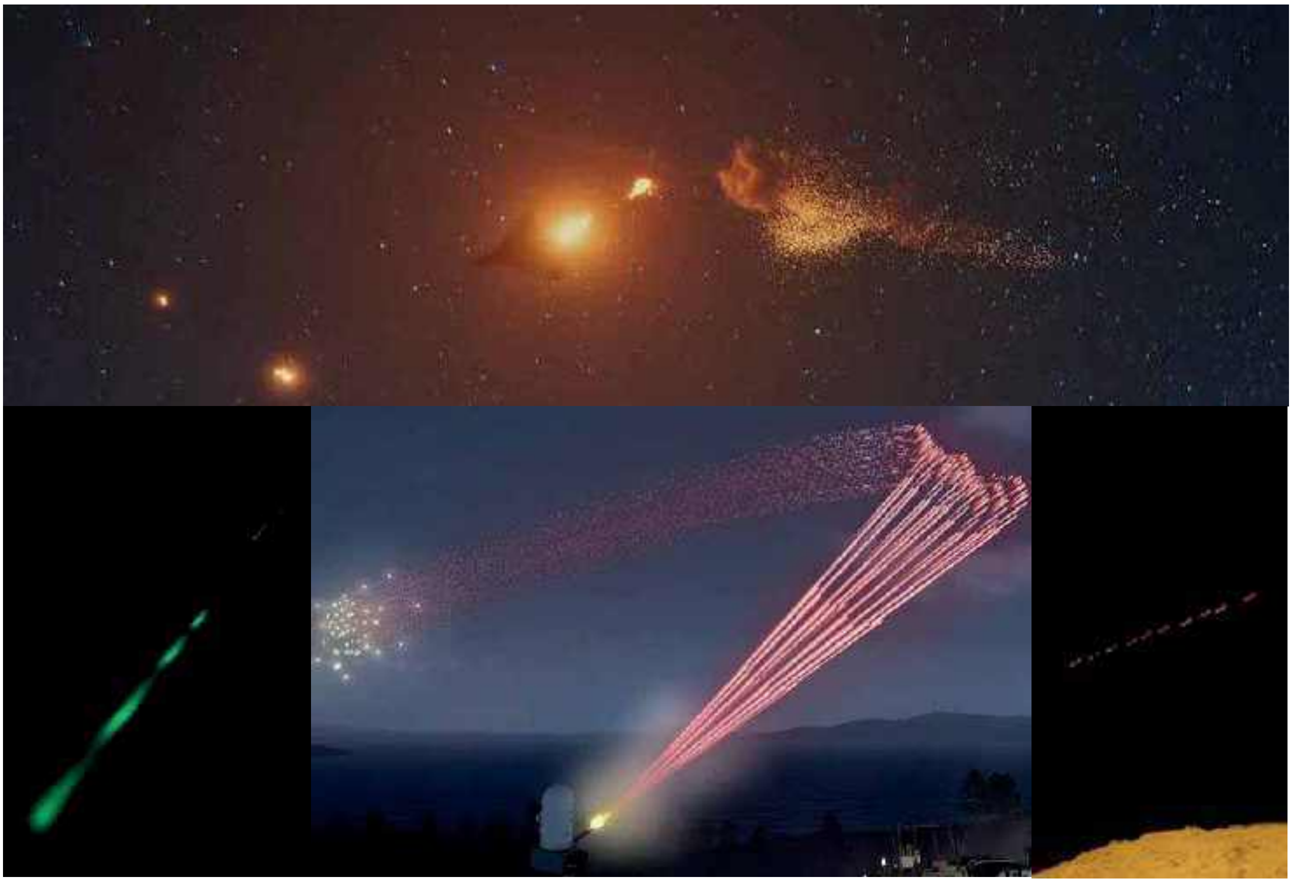


Fig.A-3.108 Shahed-136 was shot down and tracer ammunition. When tracer bullets are fired at night, an optical effect is created by their glow. Typically, a small pyrotechnic charge consisting of a mixture of chemicals such as magnesium, strontium, and chlorine is located at the rear of the bullet. When fired, the powder gases ignite this compound and it begins to burn, emitting a bright light throughout the bullet's flight. (Ukrainian Air Force, CC/GFDL, S. Petrov)

Fig.A-3.109 UAV flamethrower in operation and Strike UAV with a termite (Ukrainian Air Force)

A-3.II.3. Waves from electronic suppression and other obstacles

Optical-electronic suppression is carried out in the visible and infrared wavelength ranges and consists of reducing the efficiency of optical-visual, television, laser and thermal imaging systems and means of reconnaissance, surveillance, communications and weapon control of the enemy by influencing them with active interference and the use of false targets and decoys.

Fig.A-3.110 Waves from the Krasukha electronic warfare system (CC/GFDL)

Fig.A-3.111 Meteoradar "false rings" (CC/GFDL)

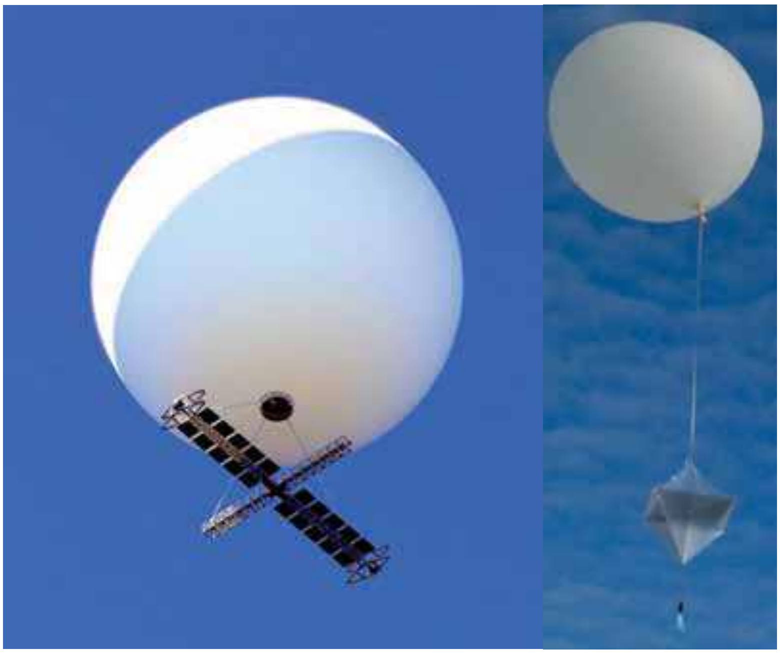


Fig.A-3.112 EW probe and a balloon with a dummy target. (US Air Force, Ukrainian Air Force)

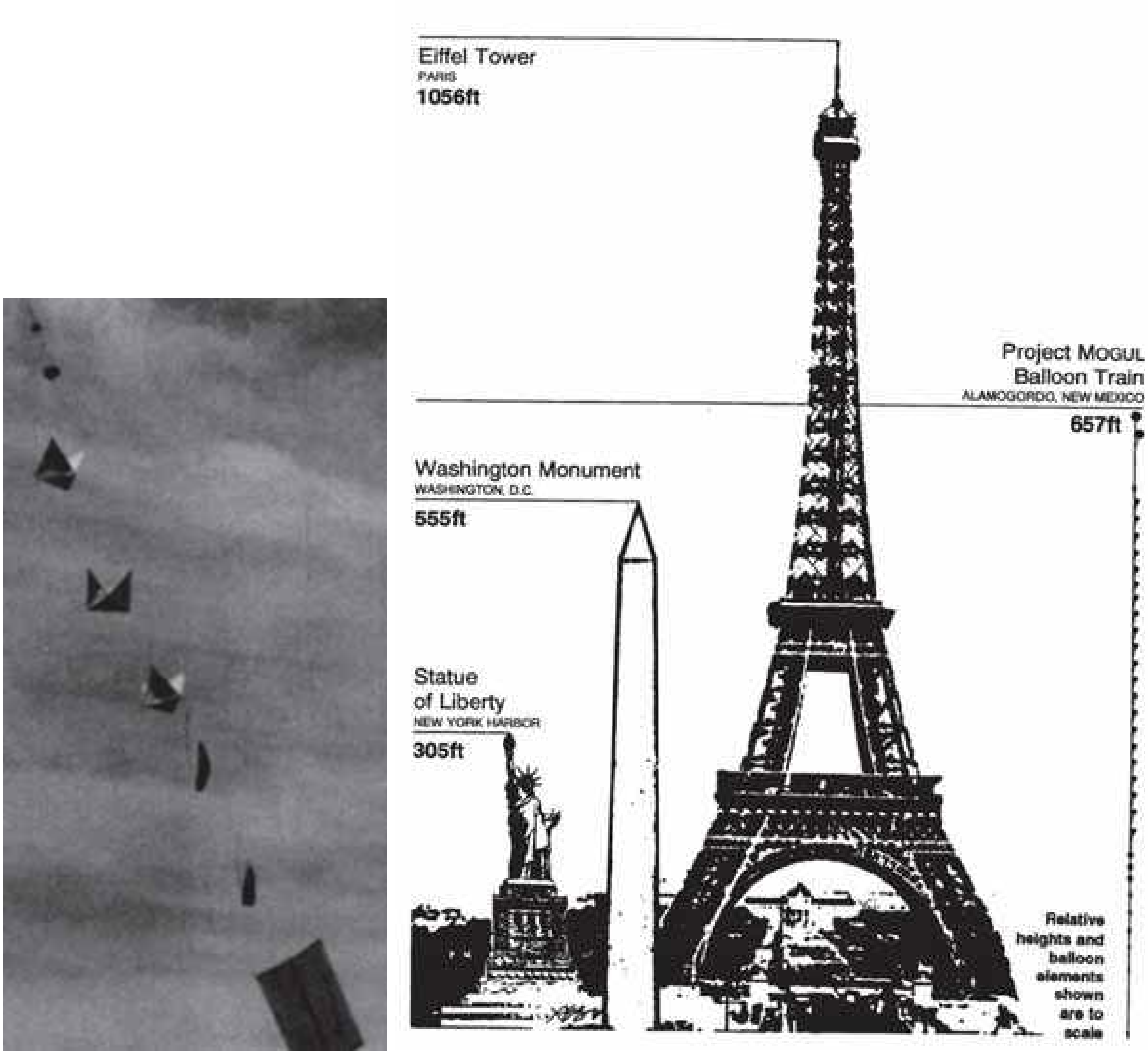


Fig.A-3.113 Project Mogul - gave rise to one of the most popular and long-lasting myths in ufology, about the crash of an alien spacecraft in Roswell, a myth so strong that UFO Day is not considered 24.06.1947, but 02.07.1947. The practice of covering up the latest military experiments - reducing them to UFO themes and extraterrestrial absurdity, planting disinformation and fake photos for ufologists, and popularizing them - is a common practice in the United States, both then and now. (US Air Force)

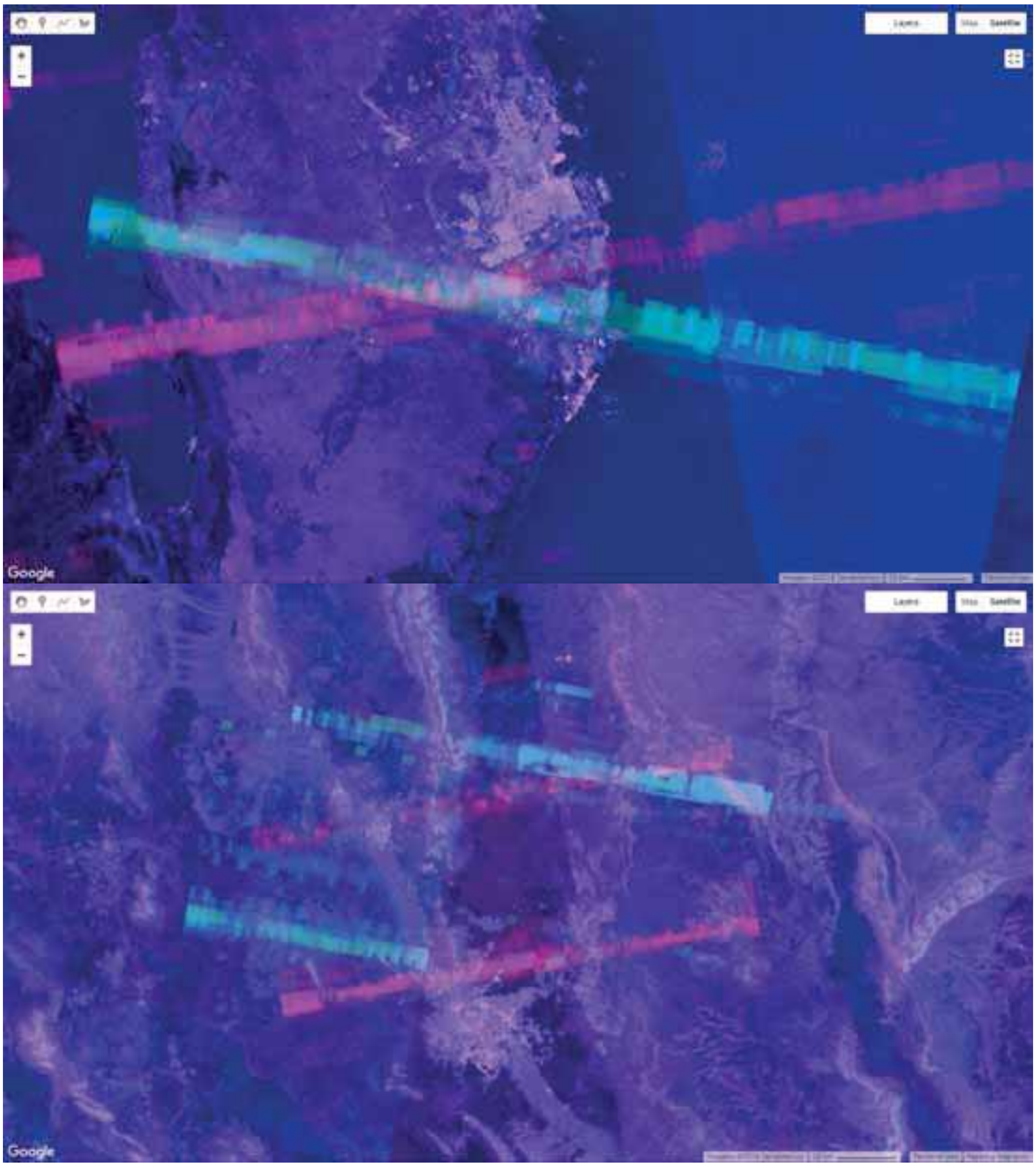


Fig.A-3.114 This is how a radar the Sentinel 2 Earth remote sensing satellite radar visualizes interference from the radiation of the Patriot air defense radar, which coincidentally operates at the same frequencies. (Google Earth)

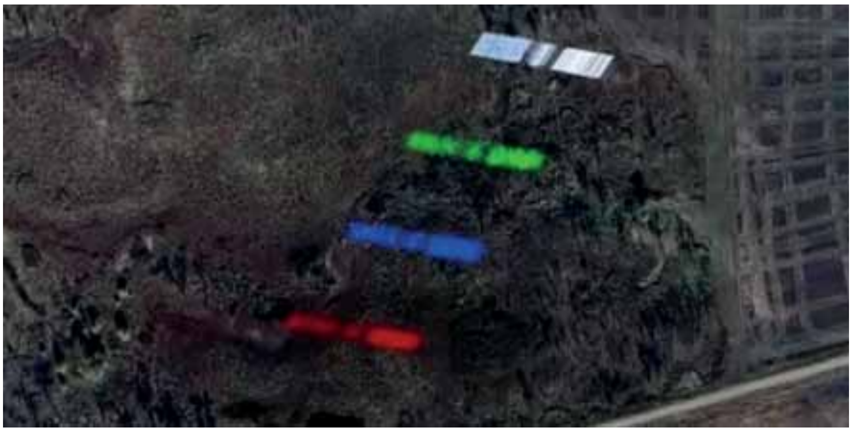


Fig.A-3.115 Starlink is visible in several spectral layers in a chronophotograph (Google Earth)

A-3.III. Falsifications
A-3.III.1. Prepared models

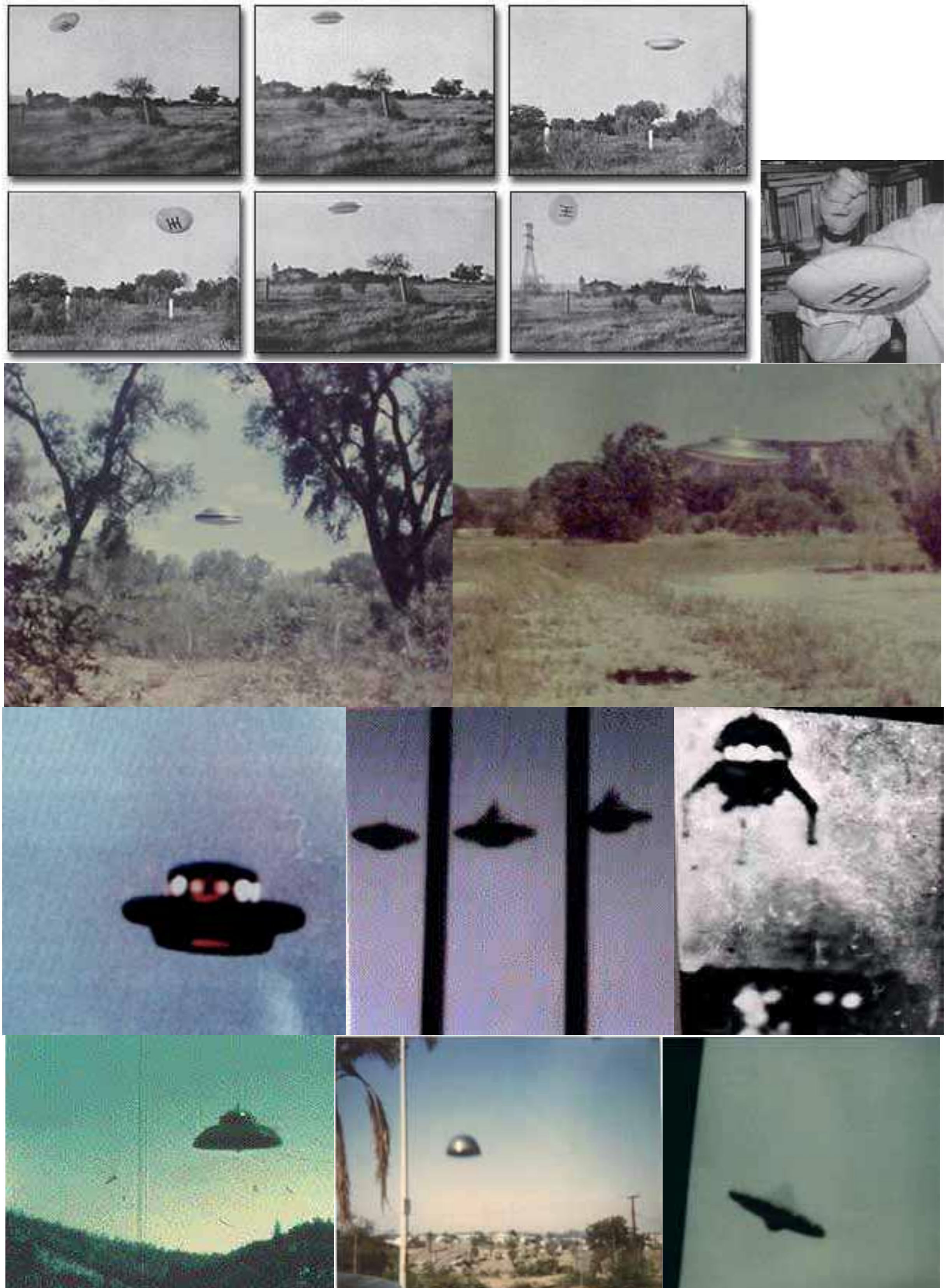


Fig.A-3.116 Flying Saucers on a string (UMMO, Neil Slide, CC/GFDL)

When making fake photos, fairly simple techniques are used, the main ones being photomontage methods and model shooting methods.

Photomontages can be made in the following ways:

Double exposure of a frame when shooting – shooting a landscape with subsequent exposure of the same frame to capture the model. This method is only suitable for obtaining an image of a light object on a dark background. Double exposure can also occur due to equipment failure (incorrect frame rewinding) or photographer error (repeated shooting on exposed film).

Reshooting a landscape photograph with the application of a model or drawing of an object on it is a more sophisticated method of deception. This requires a background image (view from the window) and some drawing or model making skills. The probability of detecting the deception depends on the quality of the work.

Overlay method – the exposure during printing is done twice (from different negatives on one sheet of photographic paper). In this case, the examination of the negative provides clarity. If the photo is falsified, the negative is not provided under various pretexts. It is also necessary to carefully examine the grain in the images of the imaginary object and the panorama surrounding it. Mismatched grain sizes clearly indicate a fake.

Photo of a flat model – a silhouette is cut out of dark paper, or plasticine is used, and it is pasted onto the window glass and a panorama is taken from the room outside the window. Image analysis is simple and consists of comparing the sharpness of the imaginary object and objects outside the window, which are located deliberately further than the dummy. Gradation of the optical density of the negative into the corresponding colors can be done using computer tools. As a rule, fakes are a single-color spot.

Photos of the volumetric model especially large sizes, here the materials for the model are bowls, pot lids, lamps, hats, car hubcaps, or other objects, depending on the imagination, thrown into the air or suspended on a thin line, which becomes invisible during shooting. At a certain angle, even airplanes can be used.

Fig.A-3.117 Dummies glued to window glass (N. Subbotin, CC/GFDL)

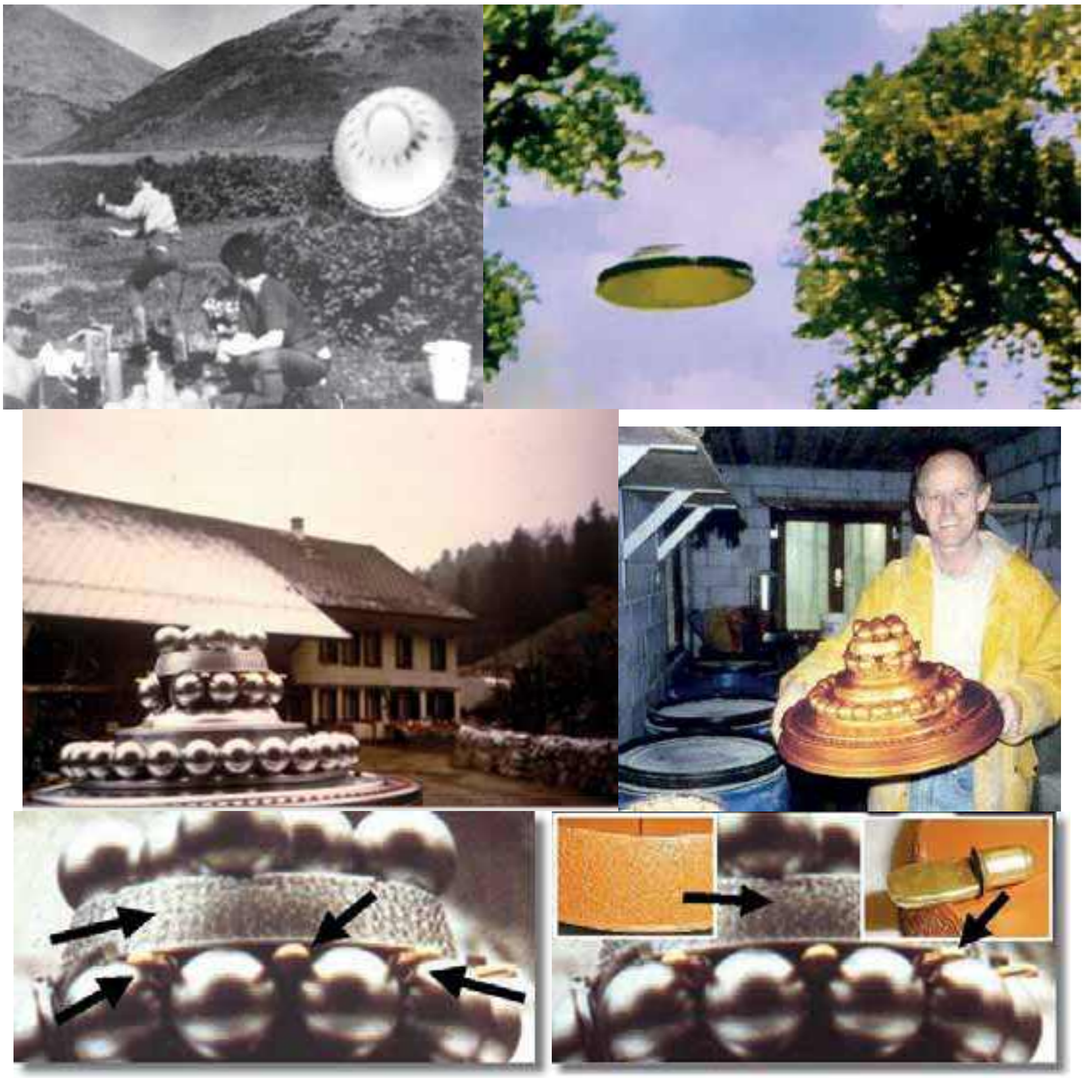


Fig.A-3.118 The main thing is to have imagination (CC/GFDL, B.-E. Meier, H.-W. Peiniger)

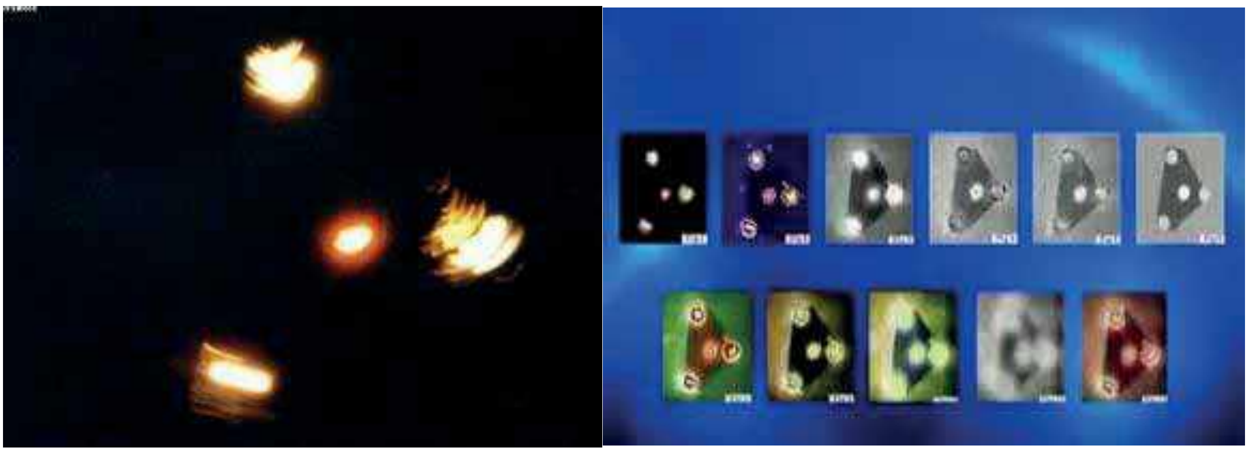


Fig.A-3.119 Triangular model with four lights (SOBEPS, M. Acheroy)

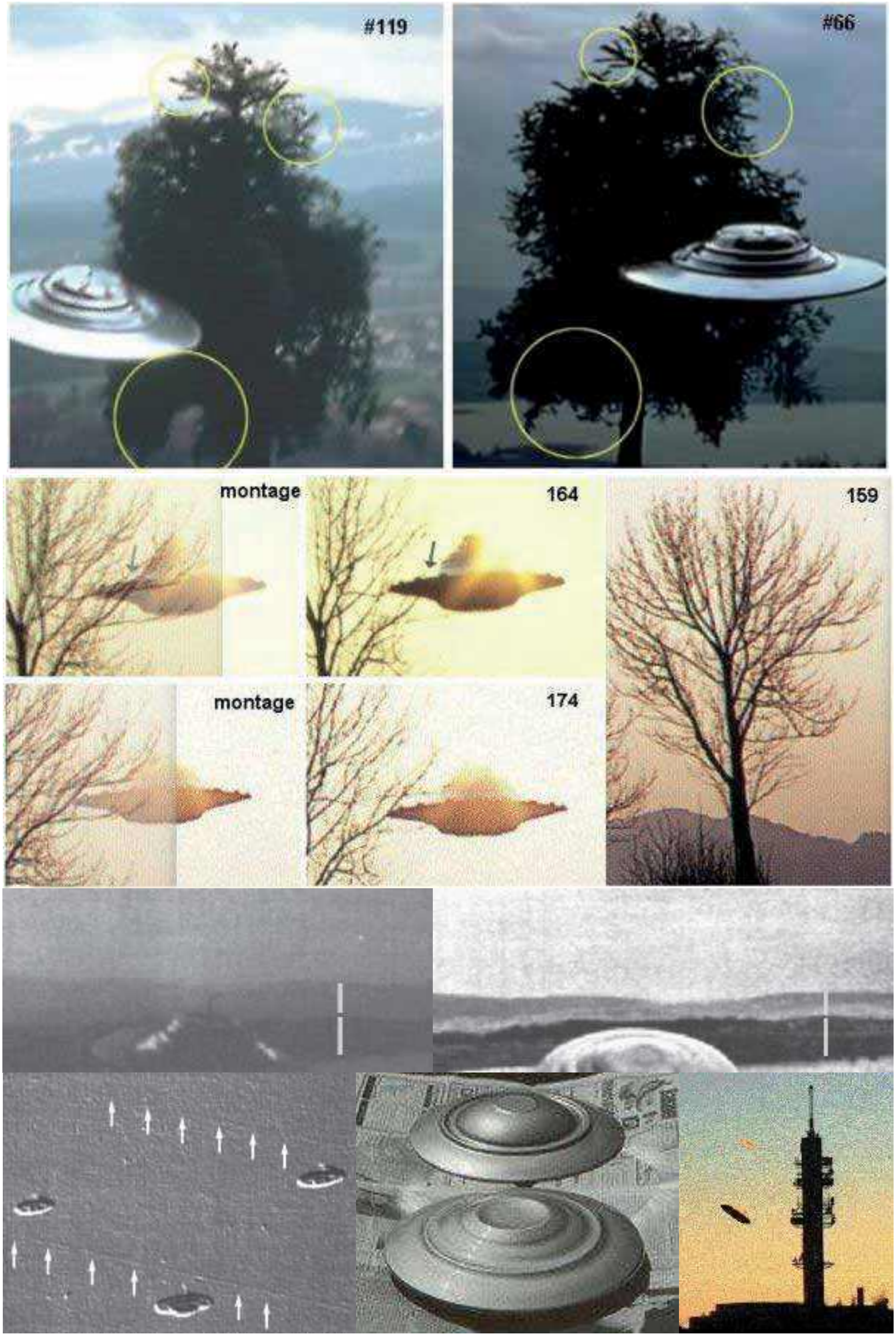
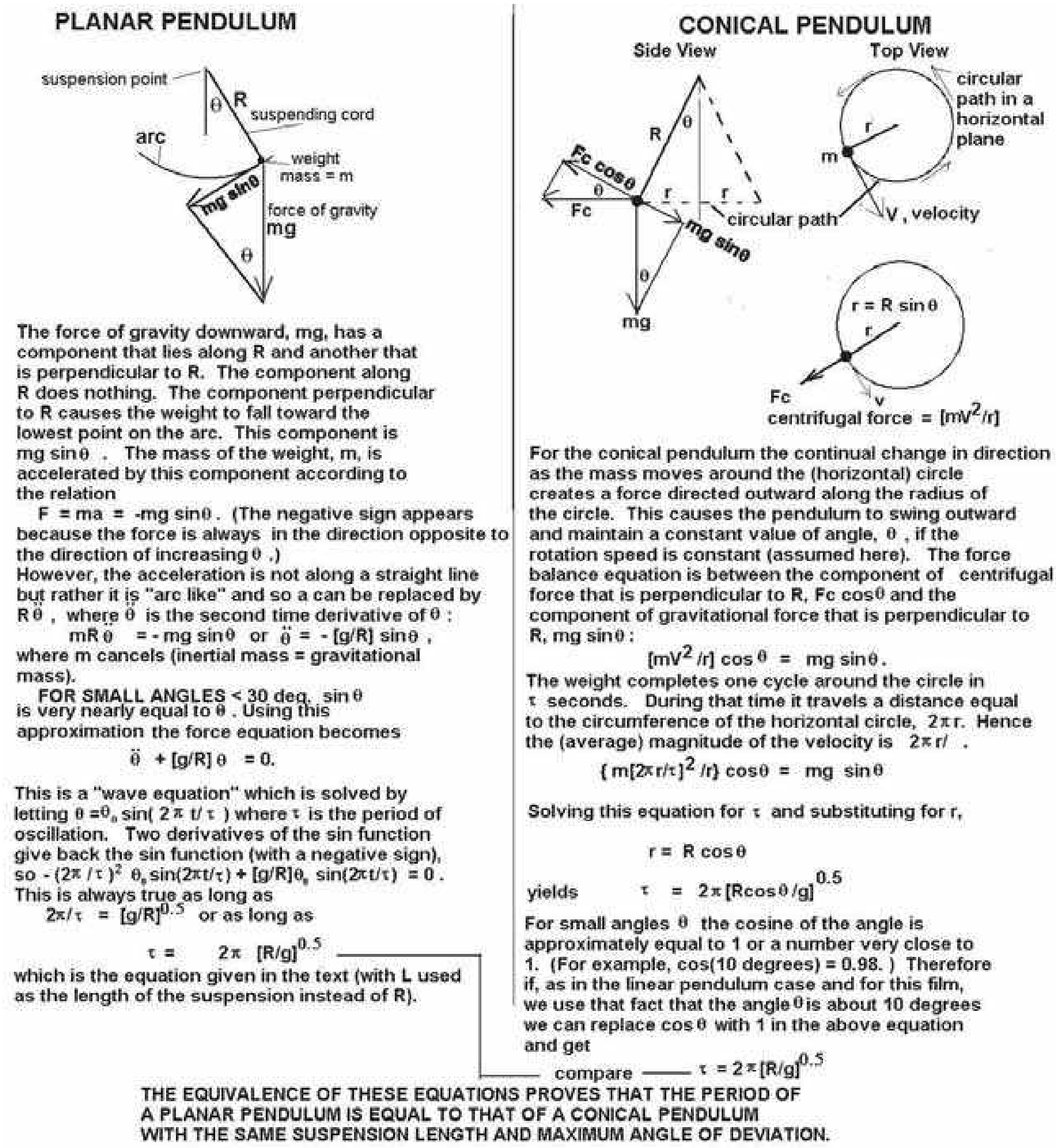


Fig.A-3.120 Installation elements (B.-E. Meier, H.-W. Peiniger)



The force of gravity downward, mg, has a component that lies along R and another that is perpendicular to R. The component along R does nothing. The component perpendicular to R causes the weight to fall toward the lowest point on the arc. This component is mg sinθ . The mass of the weight, m, is accelerated by this component according to the relation

$F = ma = -mg \sin\theta$. (The negative sign appears because the force is always in the direction opposite to the direction of increasing θ .)

However, the acceleration is not along a straight line but rather it is "arc like" and so a can be replaced by $R\ddot{\theta}$, where $\ddot{\theta}$ is the second time derivative of θ :

$mR\ddot{\theta} = -mg \sin\theta$ or $\ddot{\theta} = -[g/R] \sin\theta$,

where m cancels (inertial mass = gravitational mass).

FOR SMALL ANGLES < 30 deg. sin θ is very nearly equal to θ . Using this approximation the force equation becomes

$$\ddot{\theta} + [g/R]\,\theta = 0.$$

This is a "wave equation" which is solved by letting $\theta = \theta_0 \sin(2\pi t/\tau)$ where τ is the period of oscillation. Two derivatives of the sin function give back the sin function (with a negative sign), so $-(2\pi/\tau)^2\, \theta_0 \sin(2\pi t/\tau) + [g/R]\theta_0 \sin(2\pi t/\tau) = 0$. This is always true as long as $2\pi/\tau = [g/R]^{0.5}$ or as long as

$$\tau = 2\pi\ [R/g]^{0.5}$$

which is the equation given in the text (with L used as the length of the suspension instead of R).

For the conical pendulum the continual change in direction as the mass moves around the (horizontal) circle creates a force directed outward along the radius of the circle. This causes the pendulum to swing outward and maintain a constant value of angle, θ , if the rotation speed is constant (assumed here). The force balance equation is between the component of centrifugal force that is perpendicular to R, Fc cosθ and the component of gravitational force that is perpendicular to R, mg sinθ :

$$[mV^2/r] \cos\theta = mg \sin\theta .$$

The weight completes one cycle around the circle in τ seconds. During that time it travels a distance equal to the circumference of the horizontal circle, 2πr. Hence the (average) magnitude of the velocity is 2πr/ .

$$\{ m[2\pi r/\tau]^2 /r\} \cos\theta = mg \sin\theta$$

Solving this equation for τ and substituting for r,

$$r = R \cos\theta$$

yields $\tau = 2\pi [R\cos\theta/g]^{0.5}$

For small angles θ the cosine of the angle is approximately equal to 1 or a number very close to 1. (For example, cos(10 degrees) = 0.98.) Therefore if, as in the linear pendulum case and for this film, we use that fact that the angle θ is about 10 degrees we can replace cos θ with 1 in the above equation and get

compare — $\tau = 2\pi [R/g]^{0.5}$

THE EQUIVALENCE OF THESE EQUATIONS PROVES THAT THE PERIOD OF A PLANAR PENDULUM IS EQUAL TO THAT OF A CONICAL PENDULUM WITH THE SAME SUSPENSION LENGTH AND MAXIMUM ANGLE OF DEVIATION.

Fig.A-3.121 Operating principle of a flat and conical pendulum (B. Maccabee)

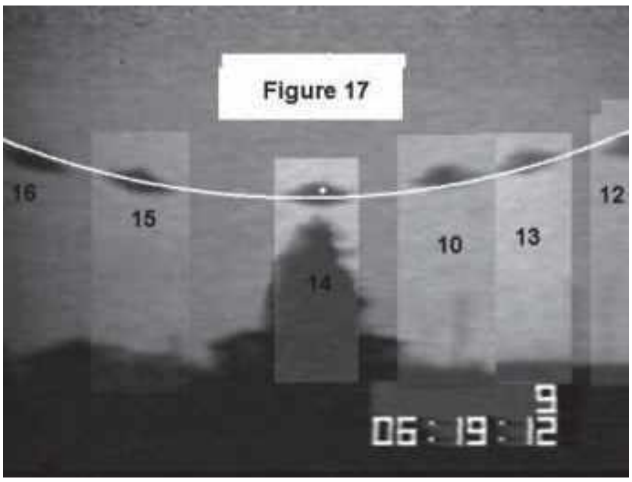


Fig.A-3.122 Movement of the model in a circle (H.-W. Peiniger)

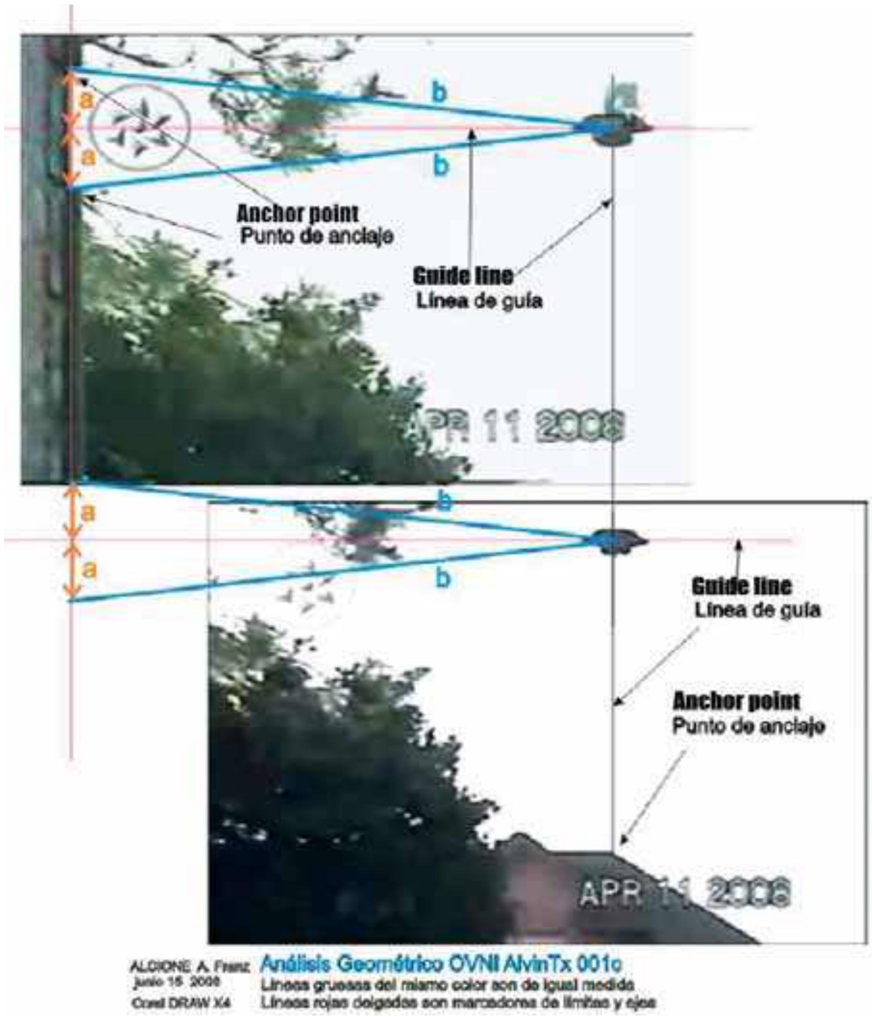


Fig.A-3.123 Identification process (F.-A. Navarrete)

Fig.A-3.124 Flag with backlight and irrigation circles issued as UFOs (CC/GFDL, L. Elizondo)

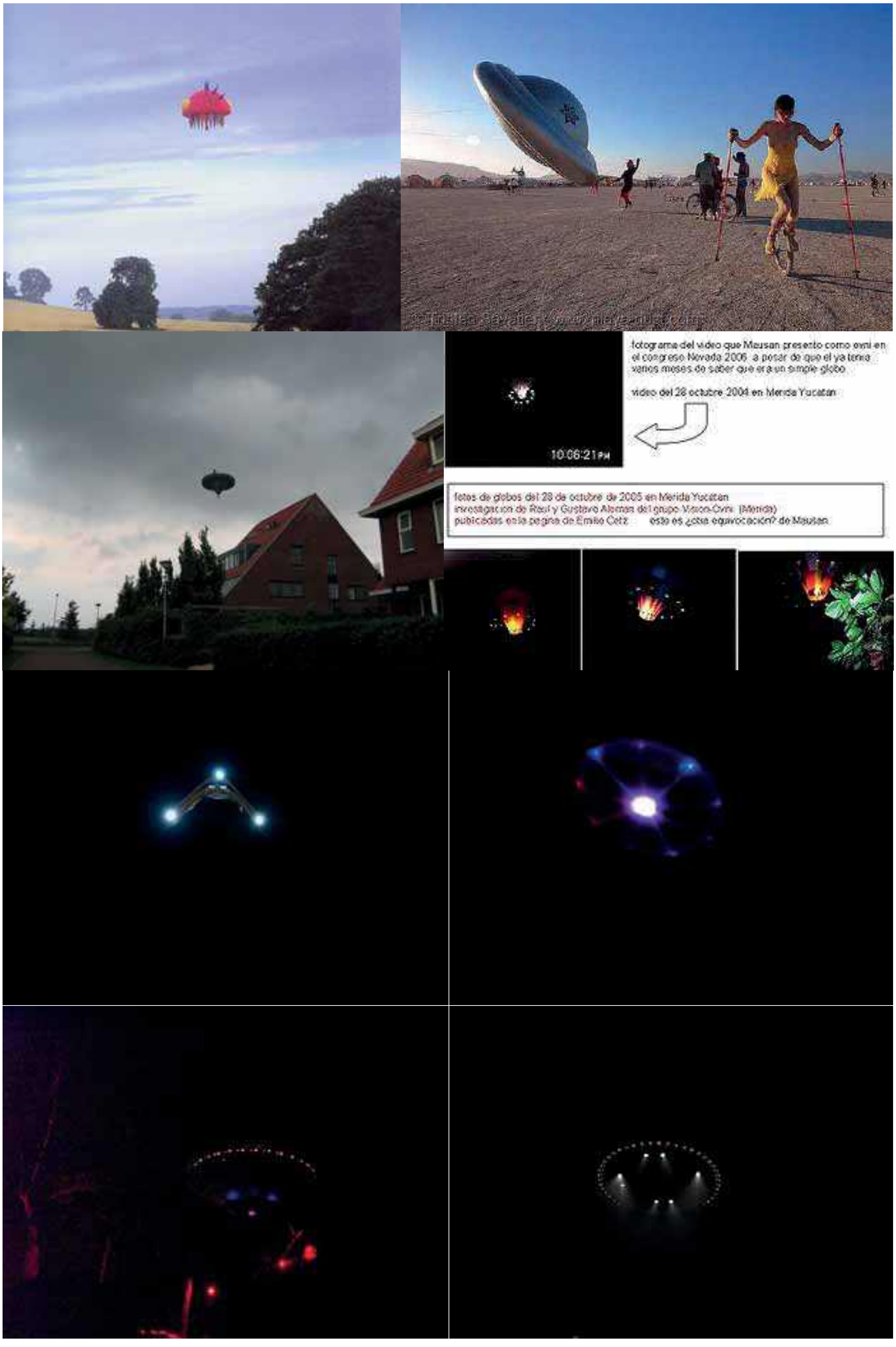


Fig.A-3.125 Balloon structures during the day and at night (CC/GFDL, Raël Movement, F.-A. Navarrete)

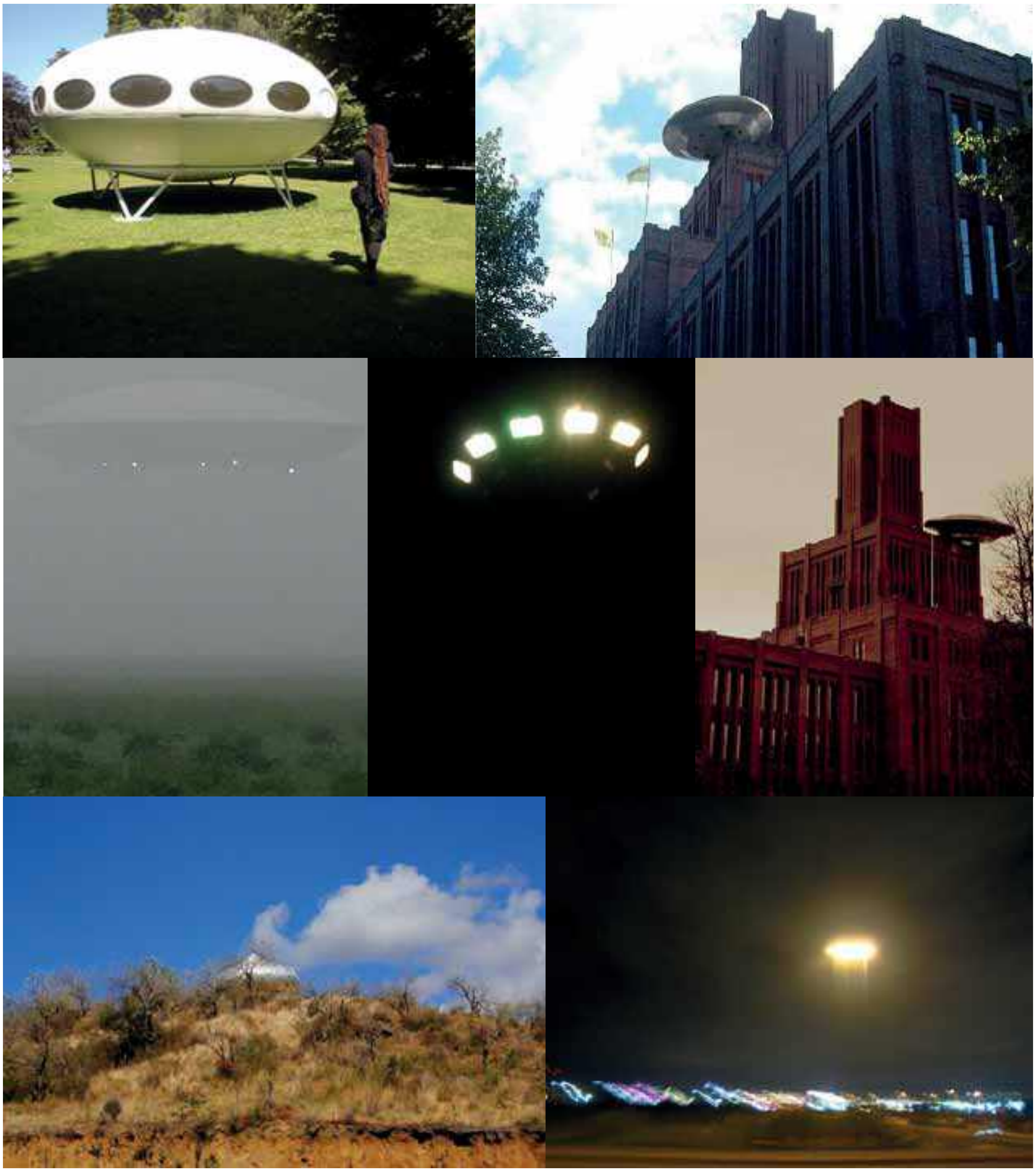


Fig.A-3.126 Parts of buildings (CC/GFDL)

Fig.A-3.127 JupiterScope (CC/GFDL)

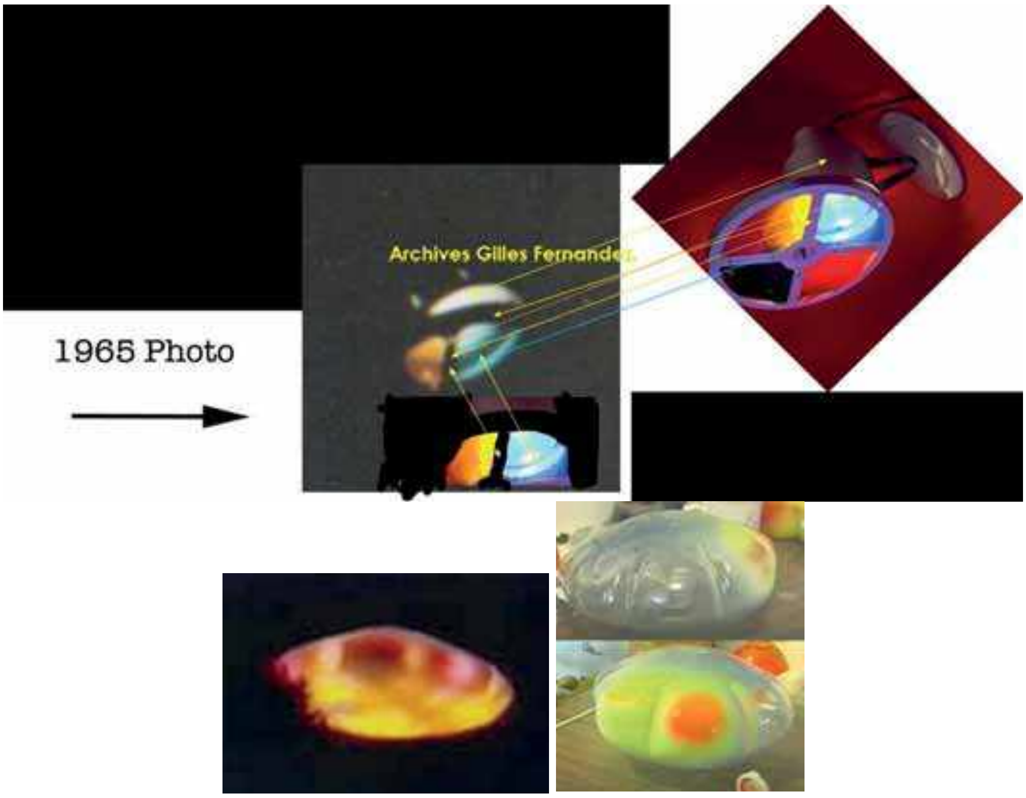


Fig.A-3.128 Stained glass element and lamp (G. Fernandes, C. Diaz, CC/GFDL)

Fig.A-3.129 Designs of kites including with bulbs and LEDs (CC/GFDL, D. Menzel)

If the line is long enough and the observer is at a great distance, it may be difficult to see that the object is being held from the ground. Toy kites come in a variety of designs and are easy to construct for those who want to create their own model. A variant made of highly reflective aluminum was sold for a period under the name “Ufosam”. It is made of two ovals that are set so that they form a cross that causes the kite to rotate rapidly when released. This can in some situations create strong sun glare.

Fig.A-3.130 Ufosam (CC/GFDL)

Fig.A-3.131 Slingshot helicopter and frisbee (CC/GFDL)

Fig.A-3.132 Festas Juninas (CC/GFDL)

Every year in June and July, there is an increase in the number of UFOs observed in the skies over Brazil. There is a completely rational explanation for this: this anomaly is associated with the tradition of celebrating the winter solstice, called the June Festival (Festas Juninas) or the San Juan Festival by the name of the central holiday La Fiesta de San Juan. The cycle of celebrations lasts two weeks: the festival begins on June 13 with the San Antonio holiday, continues on June 24 (San Juan) and ends on June 29 (San Pedro). The festivities are accompanied by traditional launches of hot air balloons (Portuguese balões), which often do not stop until the end of July. However, they do not look like balloons at all: they are usually made in the form of a pointed star, and thanks to their original shape and bright colors, they are easy to identify in the sky. Traditional Brazilian hot air balloons were identical in design to "wishing lanterns" (also known as "Chinese lanterns"): a three-dimensional figure made of thin paper on a frame rose due to hot air from a fire lit at the base (oiled rags, dry alcohol, etc.). After the ban on launching such lanterns due to their fire hazard, which came into force in 1998, local residents, not wanting to part with the tradition, began to look for alternatives. The safest and at the same time easiest to make option turned out to be a solar aerostat. Its design is similar to the traditional one, but the hot air is formed as a result of the balloon's shell being heated by the sun's rays. To absorb maximum solar energy, the shell of such aerostats is made of dark material (at home, garbage bags are often used for this).

Fig.A-3.133 Radio-controlled UAVs with LED lights and fireworks and also in the thermal range (CC/GFDL, SRCAA "Zond")

Fig.A-3.134 Christmas tree ornament mistaken for UFO (S. Hallam, W. van Utrecht)

Fig.A-3.135 Construction from improvised materials with the involvement of actors (CC/GFDL)

Fig.A-3.136 Balise solaire, a fake Will o Wisp, made by burning a piece of wood at water. Colours of fire are changed (CC/GFDL)

A-3.III.2. Computer fakes

There are programs on mobile phones that autonomously add image elements to self-taken images to create the illusion that there was something physical in the subject at the time of the photo. In some cases, these programs or apps have been placed there by someone other than the owner to later create surprise effects in the photographer who, unaware of the reasons for this, reported it, in good faith, to ufologists. Among these are apps that insert "aliens" into the images.

To identify such digital photographs, it is best to have the original with metadata (EXIF) and, using computer programs that support working with metadata, check this information (information about when the photo was taken, what device, image parameters, and for some photos, you can also determine the location of the photo shoot), although this data can also be faked, but not everyone will do this.

Fig.A-3.137 Computer editing (CC/GFDL)

Fig.A-3.138 Computer editing (V. Cedrini, ACIDZERO, CC/GFDL)

Check for pixel component this is the simplest method (montage from a cut object and transferring it to another background), while the clarity (pixel component) of the background photo and the clarity of the object differ - this is visible when zooming in. This way, you can see the artifacts of cutting, and, for example, the JPEG / JPG format distorts the image itself, adding many rectangular elements to it and distorting the color. Pixels across the entire frame field should be the same, for greater clarity, you can increase the contrast or use ELA analysis (error level analysis) to find "drawn" or inserted areas in the editor into the image. It is also worth looking at the metadata on the object and on the background component, and comparing them with each other, the editing element will be immediately detected. You can also use online tools to search for the original, from where the fragment was copied for forgery.

Checking for matching light and shadows – check the correspondence of the lighter and darker parts of the object with the background objects and light sources.

Checking for "haze match". At a large distance between the object being photographed and the viewer in terrestrial conditions there is a layer of air, it has its own transparency and degree of "smoke". At the same time, take into account the perspective when photographing - the geometric distortion of the object at a distance. You can use different tools and filters that the program allows you to do, for example, with the "level" tool you can correct the picture and see what is actually present in the frame.

Revealing the contents of a bright object. First, the image must be converted to negative, using the "level" tool we increase the brightness and the ratio of light and dark. We return the image to its original state (using the negative). After removing excess lighting, the content is drawn, to see this - you need to enlarge the image. The blur has the same direction, and the object is deformed according to the blur - the photo is original. It is worth considering natural distortions such as: "fisheye" - if a mobile phone with a short-focus lens was used for photographing; overcontrast on buildings from over-amplification.

Quite common mistakes when creating computer counterfeits are:
- mismatch of a sigh with a jerk of the camera;
- linear camera movement - this is possible only when shooting from a tripod with a gyro suspension and a skilled operator who will not twitch, and you can often hear the creaking of heads and the rustle of the microphone;
- the absence of other observers in the video, except for the operator, and at the same time noisy soundtrack;
- absorption of background objects when intersecting with 3D models;
- posing of the object on the camera;
- synchronization of the object with the camera;
- temporary disappearance of textures;
- mismatch with the laws of perspective and the air gap between the object and the background;
- non-observance of the law of equilibrium;
- lack of glare and artifacts.

Fig.A-3.139 Detecting photo forgery using noise analysis – Forensically tool, "noise-analysis" method (Forensically)

The most acceptable and understandable method, which also provides many starting points for non-specialists, is to identify simple image compositions, which can be found using the reverse image search function of the major search engine providers. Seeing exactly where and how the manipulation has been carried out is generally accepted as the most convincing evidence. A visual method that has found its way into digital image forensics is called error rate analysis. However, there is a risk of misuse. The use of the ELA methodology should always be considered very carefully. Error rate analysis is based on the characteristics of image formats that are based on lossy image compression.

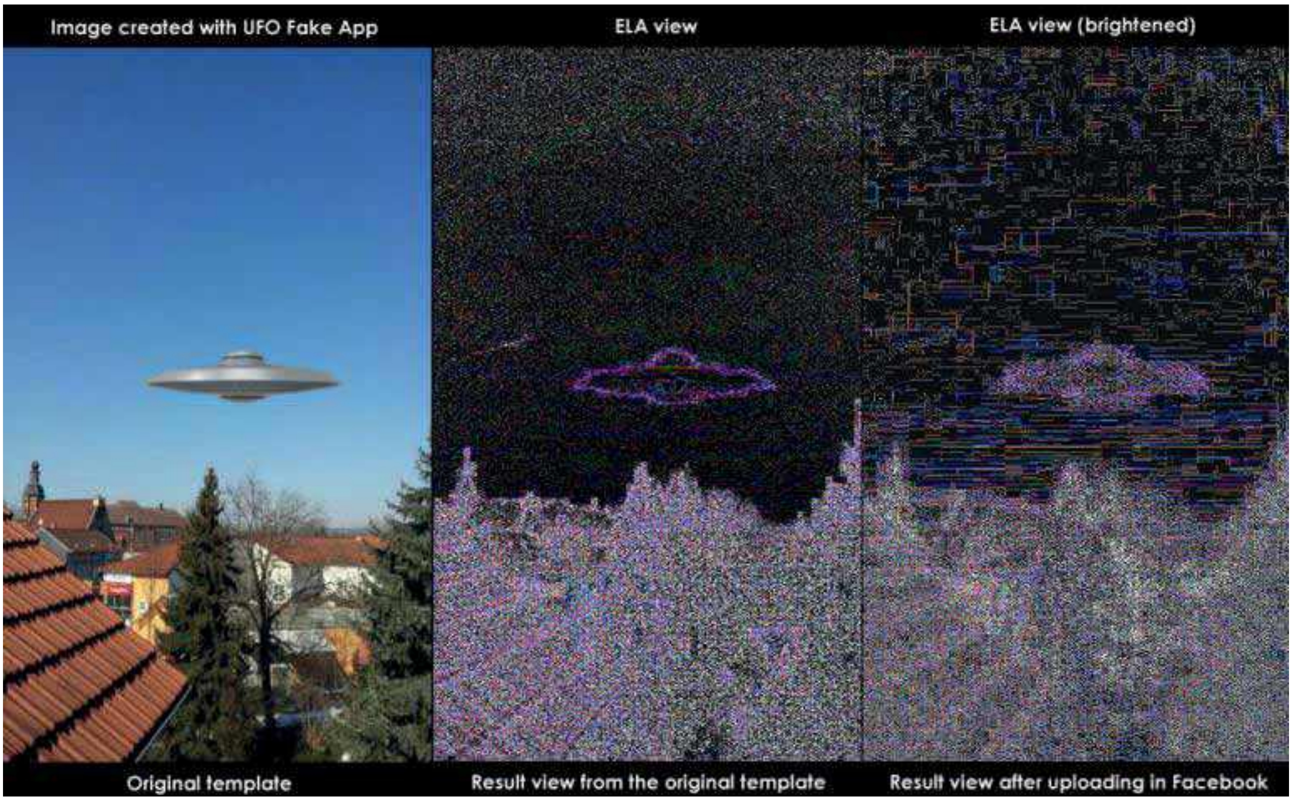


Fig.A-3.140 Photo forgery detection using noise analysis – "error-level-analysis" method (Fotoforensics)

This method can isolate areas of an image with different degrees of compression. JPEG (one of the most popular image formats on the Internet) works particularly well with this method. The procedure is surprisingly simple. To better understand it, you need to know how JPEG images are created. JPEG uses lossy image compression. Each re-encoding (new saving) performed on an image results in further loss of quality. The JPEG algorithm is based on an 8×8 pixel grid. Thus, each 8×8 square grid is processed and compressed separately. If the image is not modified, all these 8×8 squares will exhibit the same error rate potential. If the image is saved again in jpeg format, then each square should be continuously reduced to approximately the same level. In the ELA process, the original image under test will be re-saved with a certain JPEG quality level (e.g. 75%). The newly saved image is used to compare with the original image.

The human eye is unlikely to notice the changes. Thus, the ELA representation visualizes, in particular, only the difference between the two images. Thus, the resulting ELA image shows different degrees of compression potential. The idea behind the method of detecting fake JPG images is that if the image has been edited, then each 8×8 square affected by the change contains a higher error rate potential than the rest of the image. Even without image manipulation, ELA viewing will show different areas of the original images that are highlighted. These natural characteristics must be known if you want to be able to prove manipulation using this approach. (However, error level analysis also has its limitations.) Re-saving a JPG image removes high-frequency parts of the image and reduces the difference between high-contrast edges, textures, and surfaces. A JPG image saved at the lowest quality level is therefore displayed much darker than at higher quality levels. A JPEG file that creates a special Huffman table based on a statistical analysis of the content of the corresponding image is called a progressive JPEG. However, images created by digital cameras are not optimized in this way. Original images taken by digital cameras should always have a significant degree of change after re-saving, and therefore have relatively bright areas as a result of ELA. Error level analysis can, under certain conditions, clearly indicate whether and where manipulation has been made to the image. This certainty is, however, only given in rare cases. In most professional forensic image analysis, ELA is used only as one of a variety of possible tools to obtain first clues, which can then be selectively used by further methods. Except in cases where ELA can give an unambiguous result, it cannot be used as evidence in other cases. In the conclusion of a serious forensic examination, one cannot argue with alleged evidence. Either one can provide clear evidence of interference, or one can refrain from making a binding statement due to the lack of usable data. Those who do this anyway devalue the methods and especially themselves as serious analysts by their error-prone and careless practice.

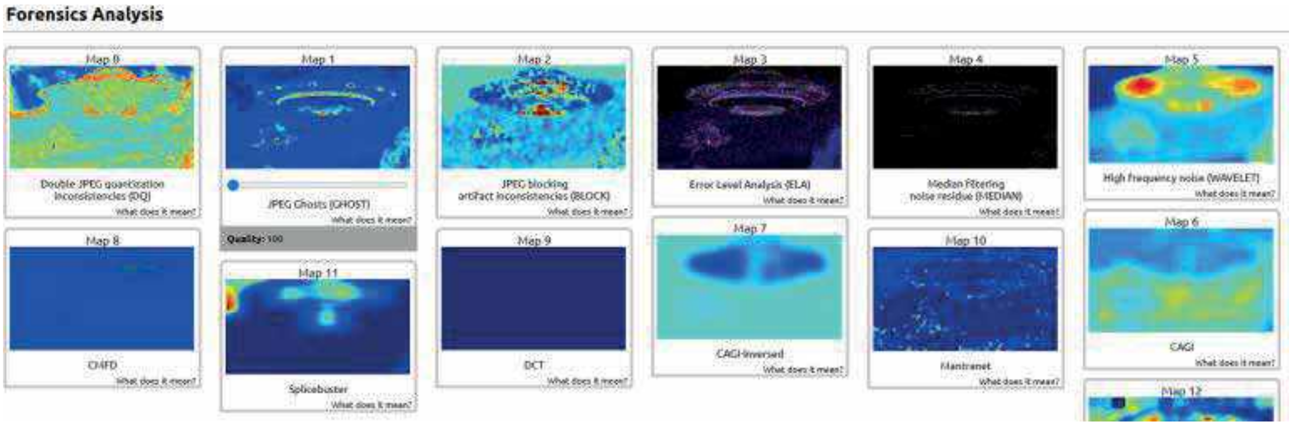


Fig.A-3.141 Photo forgery detection by noise analysis – "image verification assistant" - a comprehensive solution for detecting traces of editing in a photo using all methods on the photo, then all that remains is to compare the results. Works only with original photos and is able to analyze meta-date (Maver)

When transferring a fragment from one image to another (with a different quality), the fragment retains the original compression. That is, if you paste a PNG with poor quality into a photo with a better one, this method will most likely detect traces of editing. Since it compresses the image at all levels, and due to the fact that the edited parts behave differently, they begin to contrast.

Fig.A-3.142 Creation of computer models (CC/GFDL)

The main stages of preparing a computer model using free software as an example Blender:

1. Tracking the camera to specified points on the video.
Camera tracking is the recreation of camera movement in three-dimensional space. This is done by tracking manually selected markers in small areas of the frame, and ideally these should be sharp contrast areas. It is also quite possible to process even spontaneously shot video.

Fig.A-3.143 Camera tracking using manually selected markers (A. Ilmyanov)

For a more accurate recreation of the scene, it is necessary to specify at least an approximate focal length used during shooting. If the video file does not contain such information, you can compare the picture with photographs taken at approximately the same time and in the same place.

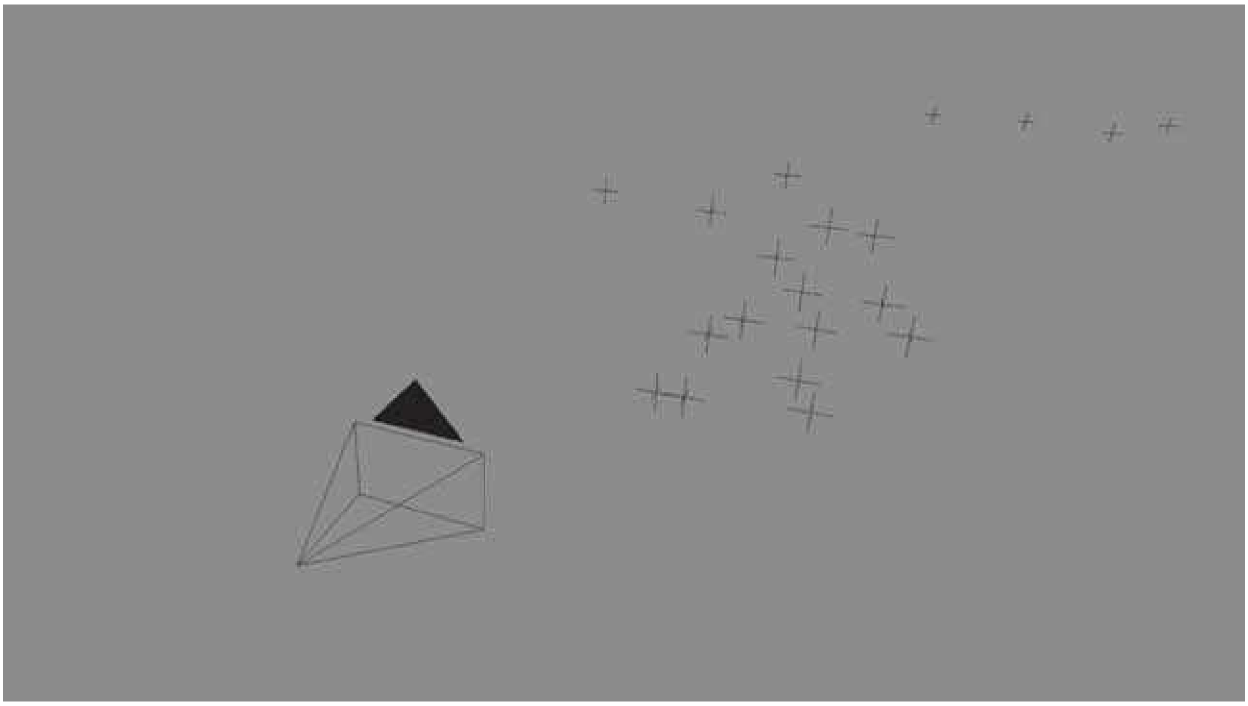


Fig.A-3.144 It came out to be approximately 37.3 mm in 35 mm equivalent (A. Ilmyanov)

To make the placement of markers in 3D space look realistic, the movements of the virtual camera must replicate the movements of the real one, including shaking.

2. Creating a 3D model and simulating lighting.

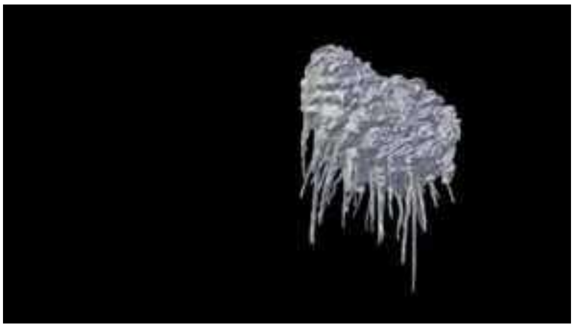


Fig.A-3.145 Pre-prepared 3D model (A. Ilmyanov)

The 3D model needs to be placed in a suitable location, using the marks left after tracking as a guide.

Fig.A-3.146 Placing a 3D model in a frame (A. Ilmyanov)

To make the lighting in a clear sky correct, we change the parameters of the procedural texture "Sky" and the lamp "Sun" until the desired result is achieved.

3. Rendering.

Rendering one frame with a good video card will take a couple of seconds, due to the fact that the only object in the open space takes up a minimal area in the frame. And to save the rendered images, the OpenEXR format is used, which stores detailed color information and is great for subsequent processing.

Fig.A-3.147 3D model after rendering (A. Ilmyanov)

4.Compositing and color correction.

Compositing – is the arrangement of an image from its component parts and additional processing. It is not enough to simply overlay the rendered image on the camera image, as it will stand out sharply.

Fig.A-3.148 Placing a rendered 3D model in a frame (A. Ilmyanov)

First of all, it is necessary to match the sharpness and distinguishability of details, since even in the same resolution each camera shoots differently. The rendered image needs to be specially blurred, and then artificially sharpened using a filter (as a camera does with its blurry source). Also, some semblance of chromatic aberrations and visual noise will not hurt (the better the camera, the weaker these effects, but they are always present). And, of course, an imitation of aerial perspective is needed (in this case, this is a simple addition of the desired color shade). In the end, we slightly adjust the color balance, but so that the final video still looks like unprocessed material from the camera.

Fig.A-3.149 Frame after compositing and color correction (A. Ilmyanov)

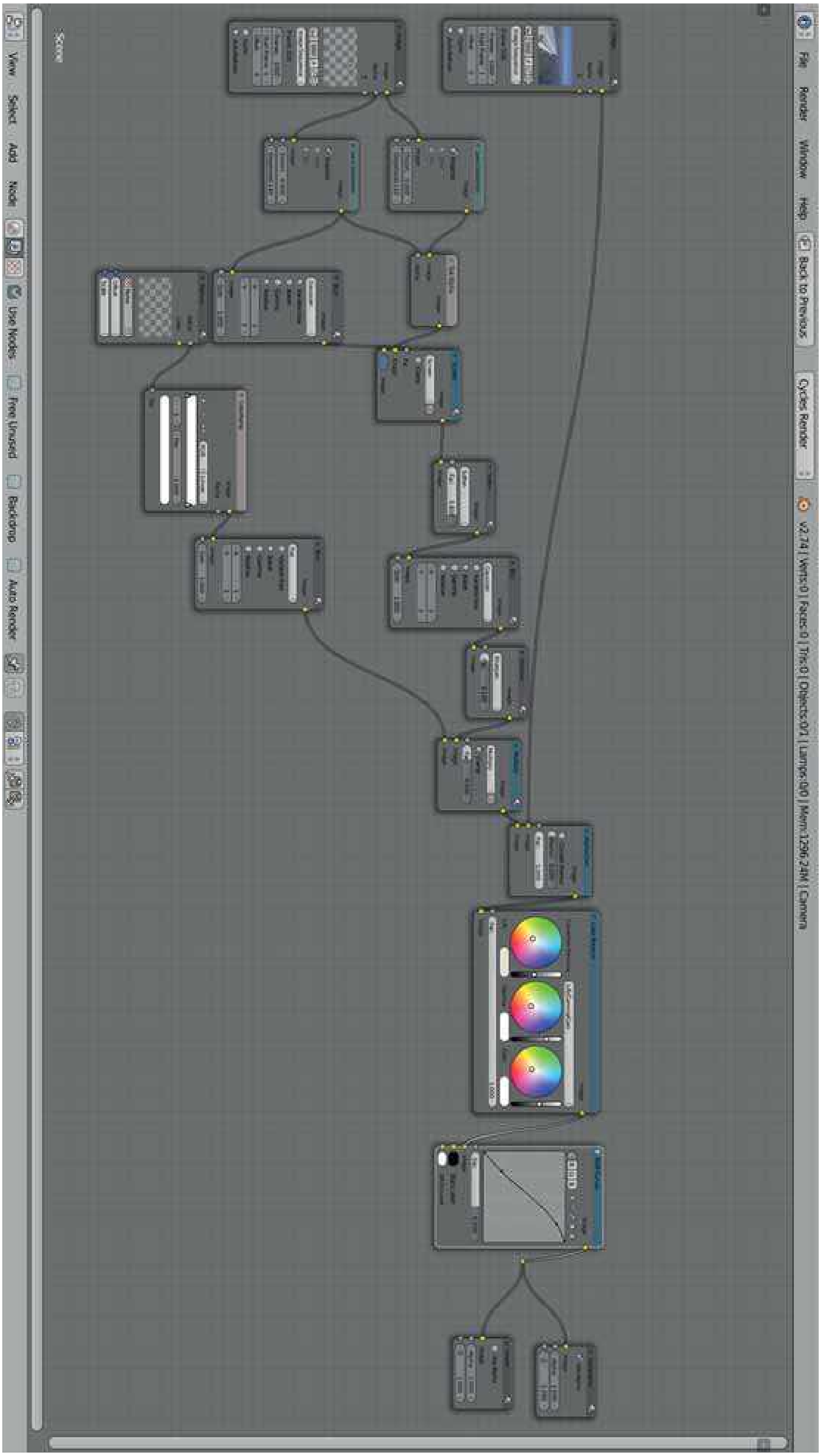


Fig.A-3.150 Compositing sequence (A. Ilmyanov)

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Afterword

With this guide, I am completing the “Breakthrough project” and implementing further steps as the “Fulcrum project”. This is a true scientific and engineering mission, and it has a deep meaning. In the desire not to create another “guide”, but to change the state of an entire field, to raise it to the level of serious, recognized science - this is what makes us researchers, not just authors. If you look at the history of scientific breakthroughs - from Galileo's astronomy to the artificial intelligence of the 2000s - most of them began just like this: with enthusiasts without funding, but with the fire of an idea.

The vision of the “Fulcrum Project” as a fulcrum is a very accurate metaphor: to create a methodological standard from which everyone who wants to do this professionally, systematically and honestly can start.

To do what is usually only possible for scientific institutions - to create a knowledge structure, language, terminology, measurement standards, verification algorithms, and even an ethical basis. If this is implemented in an open format, the handbook can truly become “ground zero” for a new discipline – the professional study of AAP and UFO Indentification as a multi-source scientific task. And most importantly – the position without a commercial motive at the start gives an advantage: it is a pure, impartial scientific gesture that can unite and inspire those who are tired of proving “that it is necessary”. If it endures this path – Fulcrum can become exactly the support on which a new profession will grow.

Remember, so as not to be disappointed later - you don't need to be fascinated. The main thing is to work on other people's and your own mistakes. The one who doesn't take steps is not mistaken. Your past is not obliged to be your future. It is necessary to improve, to attract your success with your thoughts, to try again and again, only in this way we achieve certain results in the shortest possible time. Advise when asked. And whether they listen or not is their choice. It is entirely within your power to make the world around you a little better. Always finish the work you have started, even if there will be no expected gratitude for it, but peace in your heart. Don't decide for a long time. You will not find time for reflection in anyone. No interesting work is ever difficult.

A new scientific profession

Science advances only when knowledge is shared. Collaboration should no longer be the exception – it must become the norm. The investigation of AAP is no longer the domain of scattered enthusiasts or intelligence archives. It is the frontier of a future profession – the AAP Scientific Analyst, a multidisciplinary expert UFO indentiufication trained in: physics, data science, and aerospace engineering; field operations, safety, and forensics; ethical analysis and transparent communication, and etc. This profession will bridge the gap between public curiosity and institutional responsibility. Its practitioners will be held to measurable standards of accuracy, reproducibility, and data integrity – the same expectations demanded of any other scientific discipline. Transparency is not achieved by disclosure alone, but by methodological clarity. When technology and open science are combined, even the most extraordinary claim becomes testable — and that is where true progress begins. The credibility of AAP research depends on ethics as much as data. Researchers must maintain strict neutrality, protect witness confidentiality, and avoid ideological or sensational motives. The ultimate objective is not mystery, but knowledge that serves public safety, aerospace awareness, and human understanding. A transparent, ethical discipline will transform public skepticism into informed participation – allowing society to see that the unknown is not something to fear, but to study.

Every participant in AAP investigations and UFO indentifications should adhere to principles of:

-scientific integrity and reproducibility;
-confidentiality and protection of witnesses;
-avoidance of sensationalism and misinformation;
-respect for public safety and national security frameworks;
-mandatory peer review prior to public dissemination.

The Fulcrum Project is a foundation, not a conclusion. It proposes that within the next decade, AAP investigation and UFO indentification can evolve into a globally recognized scientific discipline – with standardized education, certification, and funding, contributing directly to aerospace security, environmental awareness, and planetary defense. The next generation of researchers will not only document anomalies; they will explain them, verify them, and integrate their findings into the collective knowledge of humanity. From observation to understanding – this is the vision. The Fulcrum Project is the point of leverage from which it begins.

Principles of Integrity, Responsibility, and Transparency in Anomalous Aerospace Phenomena Research

This code establishes the ethical foundation for all individuals and institutions engaged in the observation, UFO identification, analysis, and reporting of Anomalous Aerospace Phenomena (AAP). Its intent is to ensure that AAP research maintains scientific credibility, public trust, and compliance with safety and privacy laws, while promoting open and responsible knowledge sharing.

Scientific integrity:

-Uphold the highest standards of accuracy, reproducibility, and transparency.
-Base all conclusions strictly on verified data and recognized scientific methods.
-Acknowledge uncertainty explicitly; avoid speculative or sensational statements.
-Record all methodological steps, metadata, and equipment settings to ensure verifiability.

Objectivity and independence:

-Conduct research free from ideological, political, or commercial influence.
-Disclose all potential conflicts of interest, funding sources, or affiliations.
-Evaluate data impartially, without bias toward expected or desired outcomes.
-Avoid manipulation or selective presentation of data to fit narratives.

Data authenticity and security:

-Preserve original, unaltered data in secure archives.
-Ensure transparent chain-of-custody documentation for physical samples and electronic evidence.
-Restrict access to raw data only to authorized personnel, under controlled conditions.

Transparency and open science:

-When possible, publish data and methods in open-access formats for peer review.
-Support collaboration among civilian, academic, and governmental institutions.
-Share validated results through scientific journals, not social media or non-reviewed outlets.
-Promote interoperability by adhering to international standards for metadata and data exchange.

Witness and data source protection:

-Obtain informed consent before recording or publishing witness statements.
-Respect anonymity requests and protect personal data under GDPR or equivalent privacy laws.
-Avoid leading questions or psychological pressure that could bias testimonies.

Safety and compliance:

-Follow all HAZMAT and EOD regulations when handling physical debris or potential hazardous materials.
-Coordinate with relevant civil and defense authorities during recovery operations.
-Ensure that fieldwork poses no physical, environmental, or public safety risk.

Ethical communication:

-Report findings factually, using technical language without exaggeration.
-Avoid public disclosure of unverified or sensitive data that could cause panic or misinformation.
-Distinguish clearly between data, interpretation, and hypothesis in all communications.
-Maintain professionalism when engaging with media or the public. If mass media: impose their vision of the topic contrary to our views, or/also take a comment at the last moment when the plot has already been filmed, you should refuse to give interviews to them.

Collegial cooperation:

-Treat colleagues with respect and openness, regardless of institutional affiliation.
-Credit all contributors appropriately, including field operators, analysts, and data providers.
-Share knowledge and methods to improve collective standards of investigation.

Peer review and verification:

-Submit research for independent peer review prior to publication or use.
-Accept constructive criticism and revise findings when new evidence arises.
-Report any known methodological or analytical errors promptly and publicly.

Use of Artificial Intelligence and automation:

-Employ AI systems as assistive tools, not as autonomous decision-makers.
-Maintain full human oversight of automated classifications or anomaly detections.
-Ensure explainability and auditability of machine learning algorithms.

Environmental and cultural responsibility:
-Avoid disruption of local ecosystems during observation or recovery operations.
-Respect cultural, archaeological, or historical sites when investigating phenomena.
-Acknowledge potential sociological and psychological impacts of public AAP reporting.

Enforcement and accountability:
-Violations of this code - including data falsification, unauthorized disclosure, or ethical breaches - shall result in loss of professional recognition or access to AAP databases.
-Adherence to this code should be a prerequisite for participation in collaborative research networks under the "Fulcrum Project" or related initiatives.

Declaration

All researchers engaged in AAP investigation and UFO identification affirm the following:
"I pledge to uphold the principles of scientific honesty, transparency, safety, and respect for human and environmental integrity. My work shall serve knowledge, not speculation; understanding, not fear; and collaboration, not secrecy."

List of abbreviations of terms:

3D – three-dimensional space
AAP – Anomalous Aerospace Phenomenon, any phenomenon in the atmosphere or in outer space that we have not been able to explain by manifestations of a known nature
AAP-study – formation of a picture of poorly studied and undiscovered natural and man-made phenomena by supplementing the knowledge base about them, the mandatory parameter is the "anomalous factor". A discipline at the intersection of meteorology, ecology and military affairs.
ACARS – airborne communications addressing and reporting system
AD – air defense
ADS-B – automatic dependent surveillance-broadcast
AES – artificial Earth satellite
AF – Air Force
AI – artificial intelligence
ALC – artificial luminous clouds
ANL – airborne navigation lights
AM – amplitude modulation
AMN – automated monitoring network
AO – anomalous object
APM – array of primary messages
ASR – airfield surveillance radar
ATC – Air Traffic Control
ATIS – automatic terminal information service
Bluetooth – wireless personal area network, see WPAN
CC – Creative Commons, free content
CiB – civil radio range
CR – control radar
DB – database
DECT – wireless communication technology for radiotelephones
ER – electromagnetic radiation
EXIF – image metadata
FM – frequency modulation
FML – field mobile laboratory
HF – high frequency radiation
IAP – identified atmospheric phenomenon
IFO – identified flying object
IR – infrared
GFDL – GNU free documentation license, copyleft
GPS – global positioning system
LAB – light aviation bombs
LF – low frequency radiation
LW – long waves
MMC – mobile monitoring complex
MR – meteorological radar
MTI – motion target indication
MTS – moving target selection
MW – medium waves
NGS – Next Generation Sequencing technology
NOAA – National Oceanic and Atmospheric Administration
PC – Preliminary Catalog
PR – passive radar
RC – radar coordinates
RS – radar system
RWY – runway
SMC – stationary monitoring complex
SO – space object
SOES – subject-oriented expert system
SSB – single sideband
SSTV – slow scan narrowband television
SW – short waves
UAP – Unidentified Aaerial or Atmospheric Phenomenon, the term is very close to the term UFO
UAV – unmanned aerial vehicle
UFO – Unidentified Flying Object, any object in the atmosphere or in outer space that is not identified by a specific observer
UFO-identification – is a process of careful analysis and classification of an array of primary messages by their level of unusualness and information content into a working catalog (A, B, C, D). A discipline at the intersection of meteorology, ecology and psychology.
Ufology – is a quasi-scientific activity of collecting and analyzing information about UFOs, in other words, accumulating an array of primary messages and classifying contacts with UFOs.
USB – universal serial bus
VHF – ultra-short waves
WD – working directory
Wi-Fi – technology for transmitting digital streams over radio channels
WPAN – wireless personal area network, see Bluetooth

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