Unidentified aerial phenomena. UAPs over Kyiv

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NASA commissioned a research team to study Unidentified Aerial Phenomena (UAP), observations of events that cannot scientifically be identified as known natural phenomena. The Main Astronomical Observatory of NAS of Ukraine conducts an independent study of UAP also. For UAP observations, we used a meteor station installed in Kyiv. We have identified three groups of objects (1) a group of bright spinning objects, (2) a group of bright structured objects and (3) a group of dark flying objects. Monitoring of the daytime sky led to the detection of bright and dark objects, moving at a speed from about 1M to 16M and sizes from about 20 to 100 meters. The detection of these objects is an experimental fact. Estimates of their characteristics follow from observational data. The authors do not interpret these objects.

Key words: methods: observational; object: UAP; techniques: imaging

Introduction

The Main Astronomical Observatory of NAS of Ukraine conducts an independent study of unidentified phenomena in the atmosphere. Our astronomical work is daytime observations of meteors and space invasions. Unidentified anomalous, air, and space objects are deeply concealed phenomena. The main feature of the UAP is its extremely high speed. Ordinary photo and video recordings will not capture the UAP. To detect UAP, we need to fine-tune (tuning) the equipment: shutter speed, frame rate, and dynamic range.

According to our data, there are two types of UAP, which we conventionally call: (1) Cosmics, and (2) Phantoms. We note that Cosmics are luminous objects, brighter than the background of the sky. Phantoms are dark objects, with a contrast, according to our data, to several per cent. Both types of UAPs exhibit extremely high movement speeds. Their detection is a difficult experimental problem. They are a by-product of our main astronomical work, daytime observations of meteors and space invasion.

The results of our previous UAP study are published in [2], [3]. Here we present our recent results. Flights of single and groups of cosmics and phantoms were detected. We have identified three groups of objects (1) a group of bright spinning objects, (2) a group of bright structured objects and (3) a group of dark flying objects.

Astronomical observations of bright flying objects

Observations

For UAP observations, we used a meteor station installed in Kyiv. The station has an ASI 294 Pro camera and lens with a focal length of 28 and 50 mm. ASI 294 Pro camera has a FOV of up to 9.7 deg, a pixel size of 34.1 and 19.1 arc second, and a frame rate of up to 120 fps.

The SharpCap 4.0 program was used for data recording. Observations of objects were carried out in the daytime sky. Frames were recorded in the .ser format with 14 bits.

Results

Group of bright spinning objects

Pictures 1 and 2 show 6 moving objects of different brightness with an interval of one and a half seconds. Field of view is 2.3 x 3.0 degrees. One object made a circle, covering a path of 1.3 degrees in about 1 second (Fig. 4).

Fig. 1: First object. Kyiv.

Fig. 2: Secong object. Kyiv.

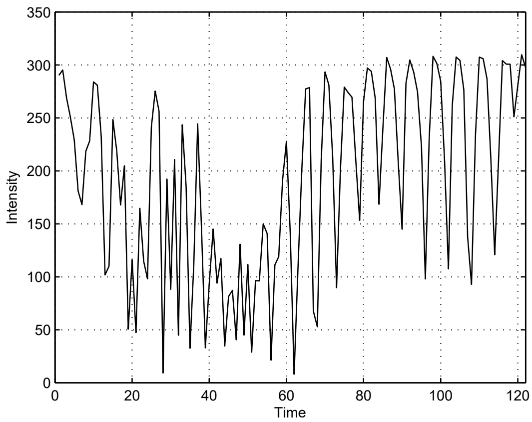

Fig. 3: First object. Intensity variations.

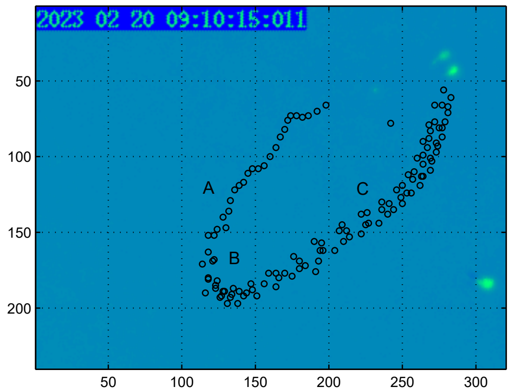

Fig. 4: The path of the first object.

Fig. 3 shows the intensity variations of first object. Fig. 4 shows the path of it. Fig. 3 demonstrate two facts: (1) strong variations of intensity; (2) and drop of intensity in time interval 40 - 60. Fast variations can be associated with the rotation of the object, and a drop in intensity with a change in orientation.

The path of the object in Fig. 4 shows three areas with different character of movement. Area A, in which, apparently, there is no rotation of the object; region B is associated with a change in orientation; area C is associated with rotation.

Images of the object in Fig. 4 show a stable pattern in regions A and C. The images of the object in region B show a change in the orientation of the object during turning on its path.

In Fig. 5 and 6 in pseudocolors, we can see that the object shows a bright, sunlit side (red) and a dark side (blue).

The dimensions of the object can be estimated at 15 pixels. An estimate of the camera's resolution from point sources of radiation gives a PSF value of two pixels (68 arc seconds). It can be concluded that the object has an angular size of 8.5 arc minutes (about a quarter of the size of the Moon). In Fig. 6 we can clearly see two bright spots on a bright, sunlit side of the object.

Fig. 7 shows the path flutter of the first object in area C. The intensity of the object (upper panel) and the area of the illuminated surface (lower panel) are shown in Fig. 8. It's clearly seen that object varies in intensity three times. Area indicator shows the illuminated surface varies synchronously with intensity variations.

Figures 9 and 10 show the rotation of the second object. In Fig. 9 in pseudocolors, we can see that the object shows a bright, sunlit side (red) and a dark side (blue). It is easy to see that (1) the object is rotating; (2) The area of the illuminated surface (red) changes. In Fig. 10, it can be seen that the maximum brightness of the object at points 5 and 13 corresponds to the maximum area of the illuminated surface (red color) in Fig. 9.

Figure 10 shows two facts: (1) the intensity of the object (upper panel) and the area of the illuminated surface (lower panel).

Variations in intensity and area can be interpreted as: (1) the object is rotating; (2) the object has a flattened shape with an aspect ratio of 1:3.

The objects of this group move at a speed of 1 - 2 degrees per second. Their angular size is 8 - 9 arc minutes. One arc minute gives the size of an object at a distance of 1 km equal to 0.5 meters. Thus, a typical object of this group at distances of 1, 5 and 10 km will have a size of 4, 20, and 40 meters, and tangential velocities of 18, 90 and 180 meters per sec.

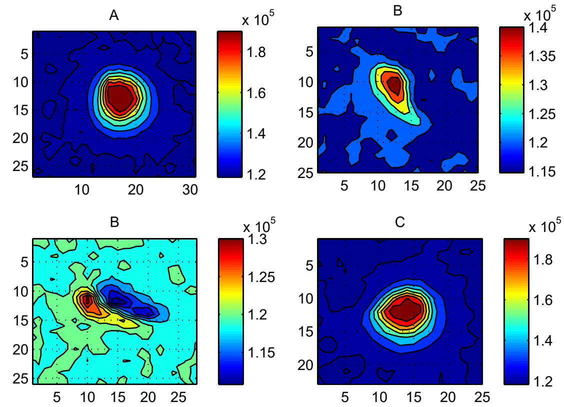

Fig. 5: Images of the first object.

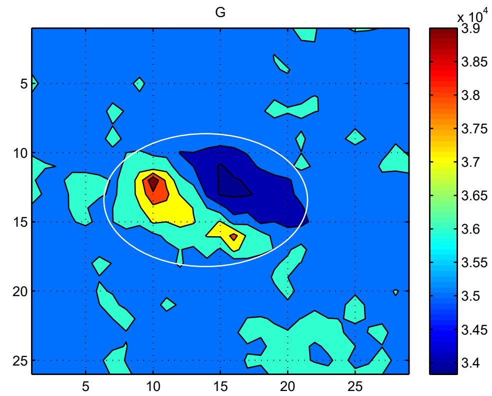

Fig. 6: Detailed image of the first object.

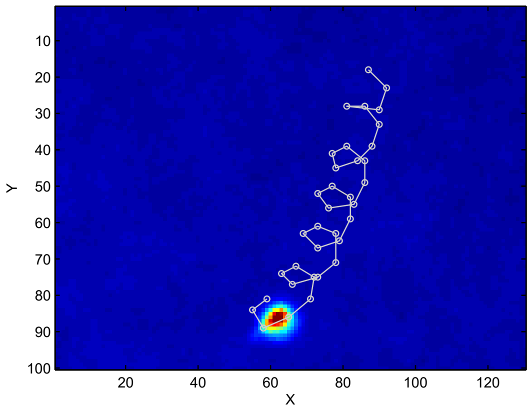

Fig. 7: First object. Area C. Path flutter.

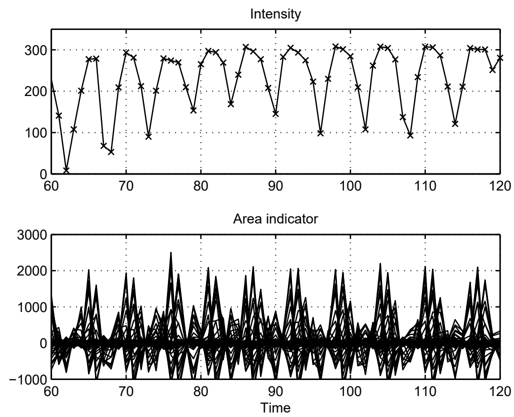

Fig. 8: The intensity variations of the first object (upper panel) and the area of the illuminated surface (lower panel).

Group of bright structured objects

Observations in Kyiv on 06/30/2022, 02/12/2023 and 03/14/2023 revealed UAP objects of a particular type. This group of bright objects of large angular sizes has clearly defined structural features. Two of them have almost identical characteristics. The third shows anomalous temporal characteristics.

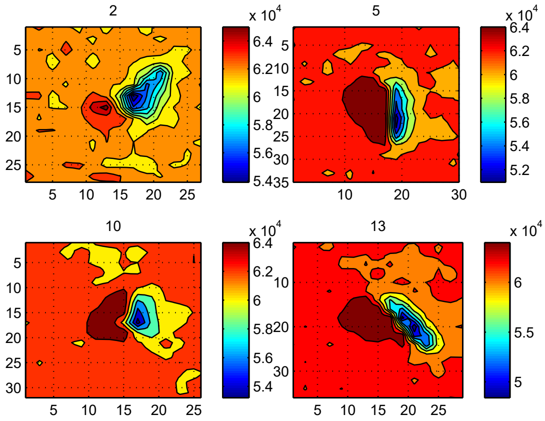

Fig. 9: Second object.

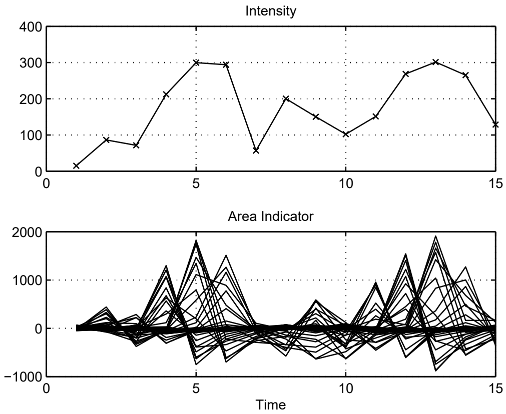

Fig. 10: The intensity of the object (upper panel) and the area of the illuminated surface (lower panel).

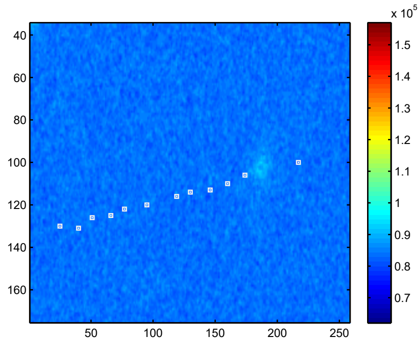

Fig. 11: UAP Kiev 2022.

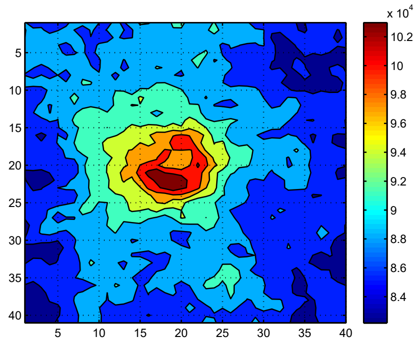

Fig. 12: UAP Kiev 2022.

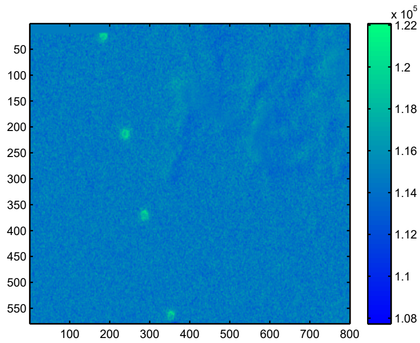

Fig. 13: UAP Kiev 2023.

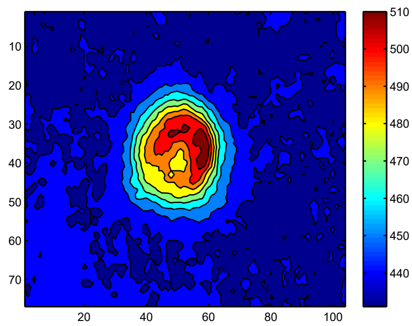

Fig. 14: UAP Kiev 2023.

A feature of this group is regular flashes of objects. In addition, the intensity of the glow drops to almost zero.

Observation start times are (1) UTC: 06/30/2022 07:22:08; (2) UTC: 12/02/2023 11:02:58; (3) UTC: 14/03/2023 09:43:58.

Object number 1 on 06/30/202 in Fig. 11 crosses a frame of 2.2 degrees for 0.40 sec with 50 frames per second with 1 ms exposure. It demonstrates a speed of 5.5 degrees per second and periodicity with a frequency of about 10 Hz.

Fig. 12 shows its size of about 25 pixels (14.2 arc minutes, about half the size of the Moon), which indicates the final dimensions. Its contrast is about 28%. If we assume that it is at a distance of 1 km, its size will be about 7 meters, if at a distance of 4 km, then 28 meters. In the latter case, its speed will be about 380 m/s (about 1M).

Figs 13 and 14 show object number 2 on 02/12/2023 with 59.4 frames per second.

These two objects were observed in the central part of Kyiv with an interval of 8 months, in summer and winter, respectively. The latter is important since insects, the main source of interference in observations of bright objects, are absent during winter. Figures 12 and 14 clearly defined structural features, they have almost identical characteristics.

Fig. 15 shows object number 3 on 14/03/2023 09:43:58 (capture area is 800x600, exposure is 3.28 ms, the actual frame rate is 56.37 fps, and the time resolution is 7.74 ms)

Fig. 16 shows the object flashes for no more than two-hundredth of a second at an average of 20 times per second. The next feature of the object is the intensity of the glow drops to almost zero. It is natural to assume that a bright object shines by reflected sunlight. But this is not compatible with the intensity drop to zero. Figs 17 and 18 show images during flash and drop. Figs 19 and 20 show color maps of objects.

The color map in Fig. 20 shows that the radiation of the object in the R and G rays is practically absent. The radiation of the object in B rays is negligible. This means that the object has become invisible. The situation with the "invisible" is repeated 20 times per second.

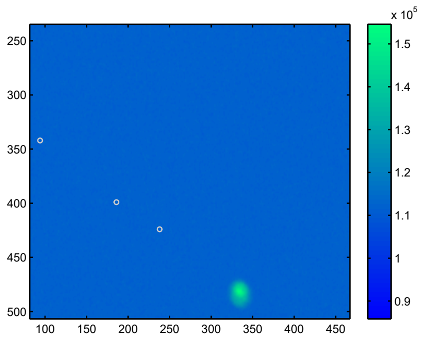

Fig. 15: UAP Kiev 2023.

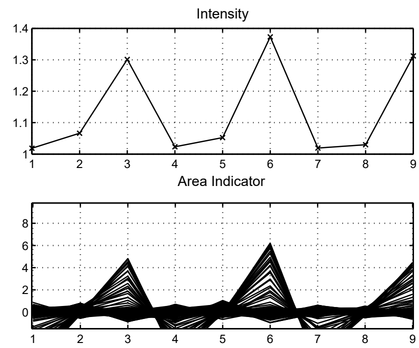

Fig. 16: The object flashes for no more than two-hundredth of a second at an average of 20 times per second.

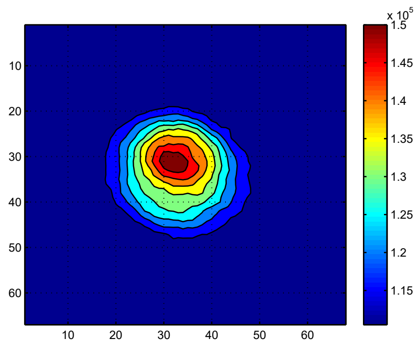

Fig. 17: UAP Kiev 2023.

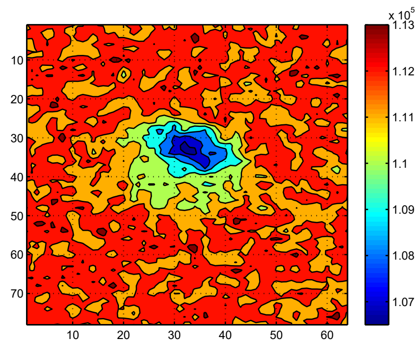

Fig. 18: UAP Kiev 2023.

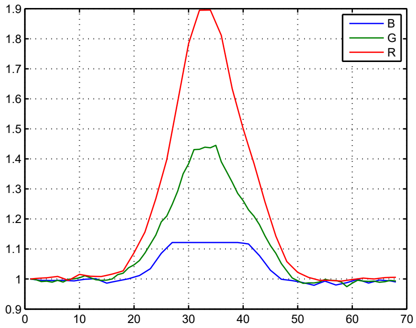

Fig. 19: Color map of the object.

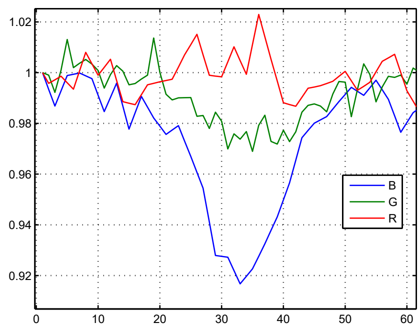

Fig. 20: Color map of the object.

Group of dark flying objects

The phantoms were observed three times at an interval of about a week. Observation start times are (1) UTC: 02/03/2023 13:43:32; (2) UTC: 10/03/2023 15:54:28; (3) UTC: 19/03/2023 13:10:53. Objects were observed in the daytime sky at the zenith.

Figs. 21 - 23 shows a group of dark objects on start time UTC: 02/03/2023 13:43:32 (capture area is 320 x 240, exposure is 1.5 ms, and the time resolution is 8.2 ms). Figs. 23 - 24 shows the object's size of about 15 pixels (8.5 arc minutes). Objects cross the field of view in 1.5 seconds at a speed of 2.5 degrees per second. Its distance from the color map in Fig. 24 is 9.0 km, and its size will be about 22 $\pm$ 3 meters. If we assume the speed of the object equals 2.5 degrees per second and a distance of 9.0 km we can estimate its speed equal to 395 m/s (1.22 M).

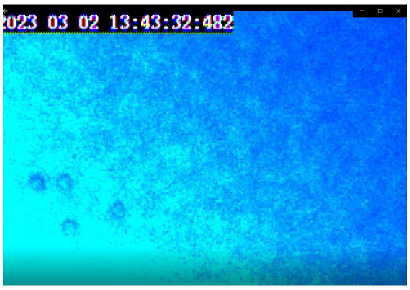

Fig. 21: Image of objects at 32.482 sec.

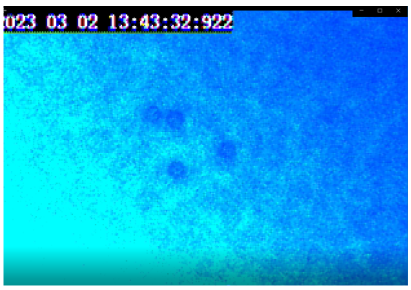

Fig. 22: Image of objects at 32.922 sec.

Figs. 25, and 26 show a pair of dark objects on start time UTC: 10/03/2023 15:54:28 (capture area is 640 x 480, exposure is 1.5 ms, the actual frame rate is 47.6 fps and the time resolution is 21 ms). Fig. 26 shows its size of about 10 pixels (5.7 arc minutes). Objects cross the field of view in 1.45 seconds at a speed of 2.6 degrees per second.

Color map of the dark object image in RGB wavelengths in Fig. 27 gives an estimate of the distance to the object according to the formula (3) of the Appendix equal to 9.6 km. The distance can also be determined from the value of the residual intensity in Fig. 27 according to the graph in Fig. 28.

Assuming angular size and distance we can find the linear size of objects equal to 16 $\pm$ 3 meters. If we assume the speed of the object equals 2.6 degrees per second and a distance of 9.6 km we can estimate its speed equal to 436 m/s (1.35 M).

It can be assumed that we are observing balloons. It is easy to estimate that they should be at a distance of about 120 meters (if the size of the ball is 20 cm). Then they can be seen with the naked eye.

Observation of dark object shown in Figs. 29, 30 was on start time UTC: 19/03/2023 13:10:53 (capture area is 1280 x 1024, a lens with a focal length of 50 mm, exposure is 1.5 ms, and the time resolution is 27 ms).

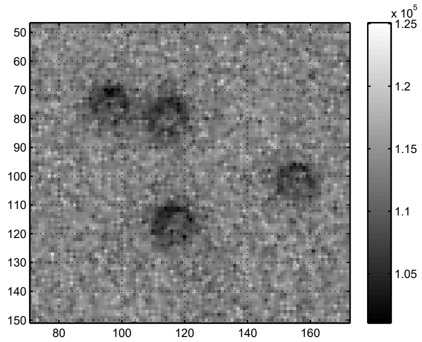

Fig. 23: Image of group of dark objects.

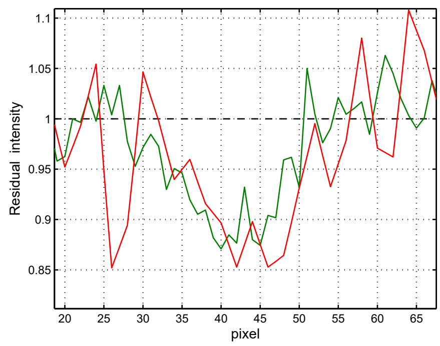

Fig. 24: Color map of the dark object image in RG wavelengths.

Fig. 30 shows its size of about 70 pixels (22.2 arc minutes). Low image contrast (2 - 7%) makes detecting the object difficult. The thing shows a bright rim and a dark bottom (Figs. 30 - 32). Its distance from the color map in Fig 31 is 9.3 km, and its size will be about 102 $\pm$ 5 meters. The object in Fig. 29 crosses a frame of 6.8 degrees for 0.3 sec. It demonstrates a speed of 23 degrees per second. Its transversal speed will be about 3.7 km/s (about 16 M).

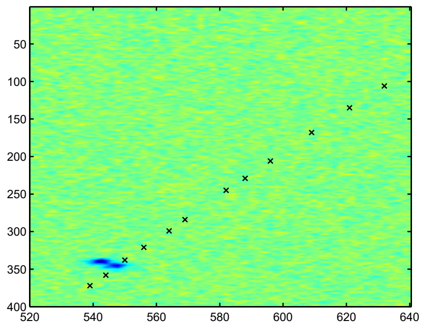

Fig. 25: Dark objects on start time UTC: 10/03/2023 15:54:28.

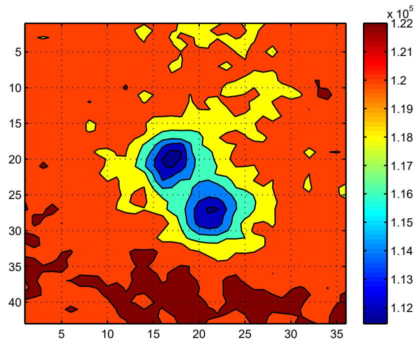

Fig. 26: Image of pair of dark objects.

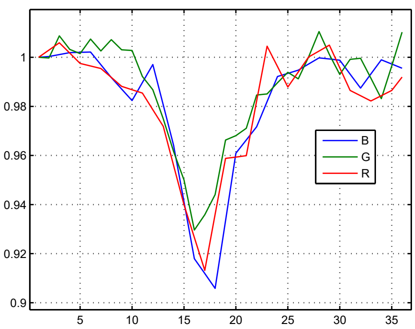

Fig. 27: Color map of the dark object image in RGB wavelengths.

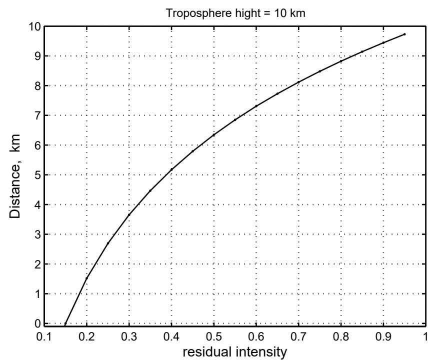

Fig. 28: Distance to object vs residual intensity.

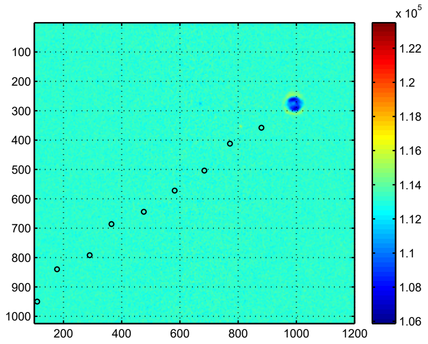

Fig. 29: The dark object on start time UTC: 19/03/2023 13:10:53.

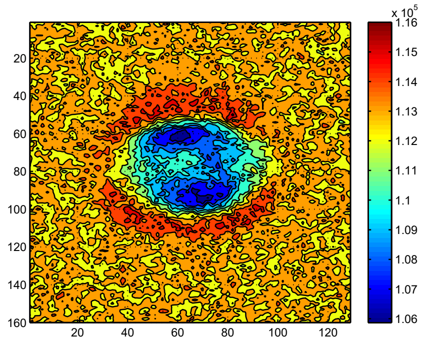

Fig. 30: The dark object on start time UTC: 19/03/2023 13:10:53.

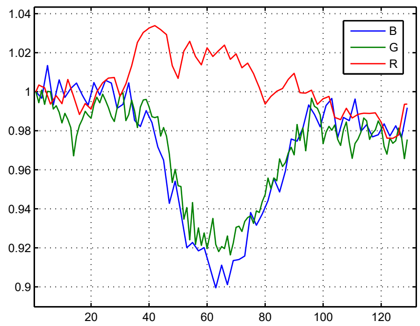

Fig. 31: Color map of the dark object image in RGB wavelengths.

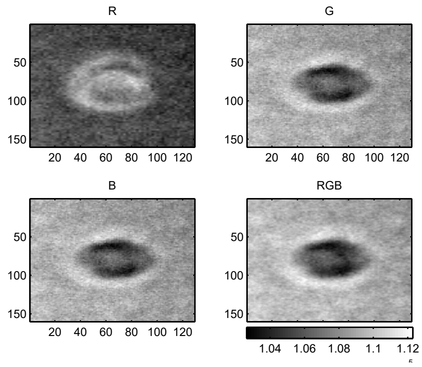

Fig. 32: Image of object in RGB wavelengths.

Discussion

The Main Astronomical Observatory of NAS of Ukraine conducts a study of UAP. We used a meteor station installed in Kyiv. Observations were performed with color video camera in the daytime sky. A special observation technique had developed for detecting and evaluating UAP characteristics.

There are two types of UAP, conventionally called Cosmics, and Phantoms. Cosmics are luminous objects, brighter than the background of the sky. Phantoms are dark objects.

We have identified three groups of objects (1) a group of bright spinning objects, (2) a group of bright structured objects and (3) a group of dark flying objects.

- Group of bright spinning objects

The objects of this group can be observed quite often. They move at a speed of 1 - 2 degrees per second. Their angular size is 8 - 9 arc minutes. A typical object of this group at distances of 1, 5 and 10 km will have a size of 4, 20, and 40 meters, and tangential velocities of 18, 90 and 180 meters per sec.

Objects show variations in intensity and the area of the illuminated surface. Variations in intensity and area can be interpreted as (1) the object is rotating; (2) the object has a flattened shape with an aspect ratio of about 1:3.

- Group of bright structured objects

Observations in Kyiv in June 2022, February and March 2023 revealed UAP objects of a particular type. This group of bright objects of large angular sizes has clearly defined structural features. Two of them have almost identical characteristics.

Objects show a size of about 14 arc minutes (about half the size of the Moon) their contrast is about 28%. If assuming a distance of 4 km, the size will be about 28 meters and the speed about 380 m/s (about 1M).

The third object shows anomalous temporal characteristics. The object flashes two-hundredth of a second at an average of 20 times per second (Fig. 16). Its intensity drops practically to zero. The object has become invisible. The situation with the "invisibility" is repeated 20 times per second.

- Group of dark flying objects

Practice shows that phantoms are remote objects at high altitudes. Their intensity is weakened due to the Rayleigh scattering of radiation in the atmosphere. The attenuation can reach 0.2 - 0.3 magnitudes. Image contrast can be only a few per cent, making them difficult to detect.

It is possible that some phantoms are not completely blackbody. Some objects exhibit an inhomogeneous surface.

The UTC object 19/03/2023 13:10:53 (Fig. 29) exhibits unique properties:

1. Dark contrast is 7%, and bright halo contrast is 2%. The object is difficult to detect.
2. The angular velocity of the object is 23 degrees per second. The object crosses the sky in a few seconds.
3. An object is moving at an altitude of about 9 km at an unprecedented speed of 3.7 km/s (16 M).
4. The object has an unprecedented size of 102 ± 5 meters.

Figures 23 and 25 show group objects. They have moderate sizes of 16 ± 3 and 22 ± 3 meters and moderate speeds of 1.2 M and 1.4 M.

It is important to know how often phantoms can be observed. Practice shows that a set of observations lasting a few hours allows us to detect one object in a 3 x 3 degree area. For an area of 90 x 90 degrees, one can expect objects a thousand times more. Statistically, a phantom can be observed in the sky every few seconds. However, the brightness of the sky is highly dependent both on the distance of the object from the sun and atmospheric conditions. The real estimate can be an order of magnitude smaller.

All we can say about UAPs is to repeat the famous quote: "Coming from the part of space, that lies outside Earth and its atmosphere".

APPENDIX

Determination of distance to an object by colorimetry methods

The colors of the object and the background of the sky make it possible to determine the distance using colorimetric methods. The necessary conditions are (1) Rayleigh scattering as the main source of atmospheric radiation; (2) and the estimated value of the object's albedo. The scattered radiation intensity has the form:,

$$I = I_0 \cdot e^{-\sigma \cdot s} \tag{1}$$

Here s is the current distance, σ is the Rayleigh scattering coefficient, and I_0 is the value of the intensity observed at sea level. The linear Rayleigh scattering coefficient σ has the form [1]:

$$\sigma = 3 \cdot 10^{18} \cdot \delta \cdot (n-1)^2/\lambda^4/N \tag{2}$$

Here n is the refractive index of air, λ is the wavelength of light in microns, δ is the depolarization coefficient equal to 0.97 for the Earth's atmosphere, and N is the number of molecules in 1 cm^3 (Loshmidt number). Expression (1) can be written for both sky background and object. Expression (1) can be represented in stellar magnitudes as:

$$\Delta m = 1.086 \cdot \sigma \cdot (S - s_{obj}) \tag{3}$$

In the approximation of a homogeneous atmosphere with a height of 10 km, $S = 10/\sin(h)$, h is the height of the object above the horizon, s_{obj} is the distance to the object from the observer.

Using the approximation of a homogeneous atmosphere instead of a real atmosphere with an exponential density distribution gives an error of no more than 6% at small distances.

Color maps show that the contrast of the object image is the same in all RGB rays, that is, it does not depend on the λ, (Fig. 27). This is true only if the object is an entirely black body. Since the contrast value is proportional to the distance to the thing, the distance can be determined for any of the RGB rays.

Expression (1) can be integrated over λ also for any of the RGB rays or overall RGB wavelengths of the system. In doing so, the distance can be determined using formula (3) for the average value of the linear Rayleigh scattering coefficient σ.

The distance can also be determined from the value of the residual intensity in the color map according to the graph given in Fig. 28.

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