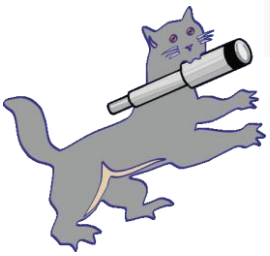
АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО
EURO–ASIAN ASTRONOMICAL SOCIETY



X Азиатско-Тихоокеанская астрономическая олимпиада

X Asian-Pacific Astronomy Olympiad

Round **Theo**

Group **β**

язык / language	English

Россия, Иркутск-Листвянка 24.XI. – 2.XII. 2014 Irkutsk-Listvyanka, Russia

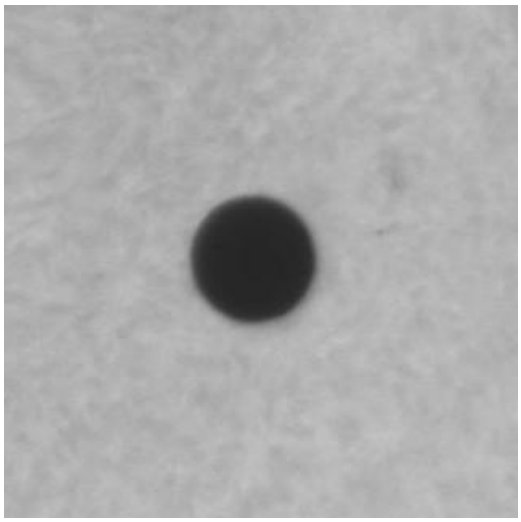
Theoretical round

General note. Maybe not all problems have correct questions. Some questions (maybe the main question of the problem, maybe one of the subquestions) may make no real sense. In this case you have to write in your answer (in English or Russian): «**impossible situation – ситуация невозможна**». Of course, this answer has to be explained numerically or logically.

Data from the tables (Planetary data, stars, constants, etc.) may be used for solving every problem.

The answers «**Да-Yes**» or «**Нет-No**» have to be written in English or Russian.

1. Footstep of babr. Babr is a local representative of the biological family of cats (felidae) depicted on the coat of arms of Irkutsk, and the emblem of the X APAO (with a telescope in his mouth). On June 6, 2012, Irkutsk astronomers have photographed the transit of the planet Venus passing across the solar disk (fig. 1). And on November 19, 2014, they saw a sunspot, like a paw print of babr, and named this spot "footstep of babr" (fig. 2). The surface of the Sun is shown in the same scale in both images.



1.1. Estimate the typical size of the sunspot "footstep of babr".

1.2. Estimate, at what magnitude the sunspot "footstep of babr" would shine (calculating without the emission of the rest solar surface). With the magnitude of what celestial body can the result be compared?

2. LSVT and babr. The Large Solar Vacuum Telescope (LSVT) of the Institute of Solar-Terrestrial Physics, located in Listvyanka, has the main mirror 760 mm in diameter and focal length 40 m. One of the main activities of the scientists observing with the LSVT is the research of active features in solar atmosphere. Scientists regularly observe sunspots.

2.1. Draw in real scale a picture of image of the sunspot "footstep of babr" (see picture and condition of the previous problem) obtained in the focal plane of the LSVT.

2.2. When observing the Sun during sunset scientists have seen a running animal on the hill on the opposite side of the Angara river (approximately 5 km away). Scientists have suggested it is a babr, cat's like animal (felidae) about the size of a tiger. Estimate how far you need to

move the screen on which the Sun was recorded to clearly see on it the silhouette image of the animal.

2.3. Draw in actual scale in your notebook something (a point, spot, silhouette, image or something else) that will be visible on the screen.

2.4. Will the resolving power of LSVT be enough to understand what kind of animal is observed? (**«да-yes»** or **«нет-no»**).

3. **Orion's Belt.** The Babr decided to join company of astronomy animals-observers and came to Listvyanka to the X APAO to take photos of stars of Orion's Belt near the horizon. Will this be possible? (**«да-yes»** or **«нет-no»**). When is it better to take the photos: on rising, culmination or setting of Orion? At approximately what time (use time of Irkutsk) should the photos be taken? The solution has to include an artistic picture with an image of the Babr-observer taking photos of Orion's Belt.

4. **Fourth star of Orion's Belt.** As you know, there is a Penguin among animals-observers, and he is a great joker. The Penguin decided that something is missing for artistic perception of Orion, and one must "put" a fourth star on the Babr's picture of Orion's Belt. For this, he found a photoflash lamp and, sitting somewhere in the field of view of the camera during the exposure, flashed once (sent one light pulse) to the camera during the exposure. Estimate at what distance from the Babr the Penguin was, if the shining of the "fourth star of Orion's Belt" approximately corresponds to that of the three others in the picture. When photographing, the Babr-observer used an exposure time of the order of 10 seconds.

   Take into account the parameters of the flash pulse. The photographic conditions (sensitivity of CCD, diaphragm) while photographing objects with the flash at the distance of 1 meters (from both flash and camera) should be the same as while photographing the same objects on a sunny day with an exposure time of about 1/1000 second.

   The solution has to include a picture with artistic images of the Penguin and his flash lamp.

5. **Eclipses.** Our Moon is moving away from Earth at a rate of 3.8 cm per year. Estimate how many years the habitants of Earth will have a possibility to see total solar eclipses.

6. **ISS near Zenith.** On the day of the beginning of the X APAO, November 24, 2014, at 05 h 01 min (Irkutsk time) the spacecraft Soyuz-TMA-15M was launched. At 10 h 48 min it was docked with the ISS. It is interesting to note that sometimes ISS flies very close to Zenith for an observer in Listvyanka. At what minimum zenith distance can ISS be seen from Listvyanka?

   November 24, 2014, the main parameters of the orbit of the ISS are:

   Inclination of the orbit: $i = 51.648°$.

   Mean motion (revolutions per day): $n = 15.5142$.

   The shape of the Earth can be considered as spherical (with radius equal to the distance from Listvyanka to the center of the Earth), and the ISS orbit as circular.

Note: It is not a problem to estimate. Precise calculations may be necessary to get correct result.