АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО

EURO–ASIAN ASTRONOMICAL SOCIETY

*Round* **Prac**

*Group* **α**

XVI **Международная астрономическая олимпиада**
XVI **International Astronomy Olympiad**

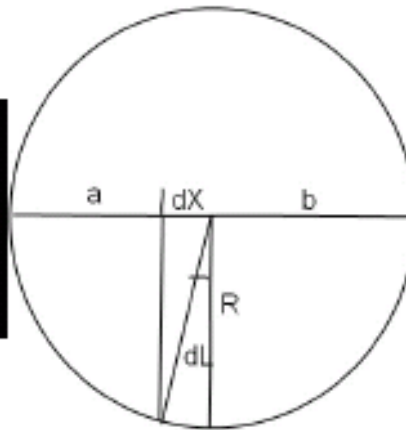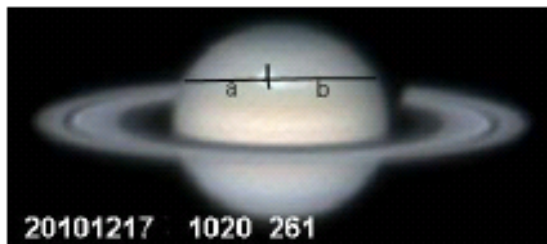Казахстан, Алма-Ата        22 – 30. IX. 2011        Almaty, Kazakhstan

язык
language **English**

# Practical round. Problems to solve
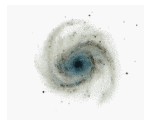
**6. Saturn 2010.**



You are provided with a series of Saturn images. Find the rotational period for Saturn, and the velocity and the direction of the movement of unique formation in the atmosphere of Saturn – Great Northern Disturbance (GND), which appeared on December 8, 2010.

**6.1.** Use measurements of two images on Saturn on 13 December 2010 to determine the rotational period T for Saturn from the angular change of the GND position during the time interval between two images.

**6.2.** Plot from all measurements of the GND core a graph showing how the core longitude L depends on time t. The time should be expressed in hours and parts of hours. Set the time of the first image as zero time ($0.0^h$). The inclination of the graph must show the direction and the angular velocity of GND.

**6.3.** Determine the value of radius $R=(a+b)/2$ at the GND latitude in kilometers and determine the linear velocity of the GMD core latitude in kilometers using the graph that shows L vs t.

You may neglect the tilt of the equator to the line of sight (the direction Earth-Saturn). In the images north is up. Saturn's equatorial radius $R_0 = 60266$ km. The planet is rotating counterclockwise if you look from the north pole, or from left to right in the images. The longitude of the central meridian of the planet increases following the planet's rotation. It means that L increases from right to left in the images.

Data on the images: date (2010, December, day), time UT (h, m), and LCM, the longitude of the central meridian (in degrees) in system of coordinates of planet.

On the above drawing you can see the scheme (a view from the North), R is the radius on the GND latitude. Evidently $R < R_0$.

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6. Сатурн 2010.

6. Saturn 2010.

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20101217 1020 261



20101223 1619 237



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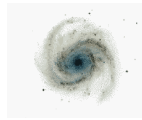| язык language | *English* |
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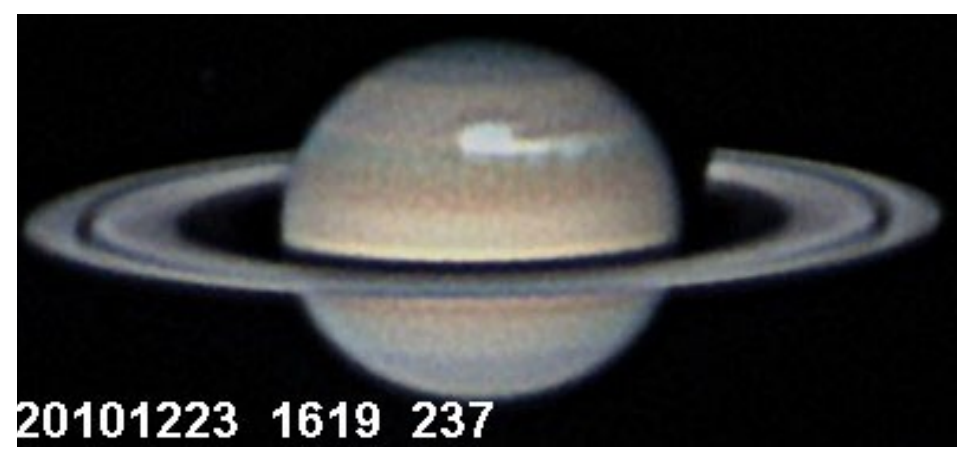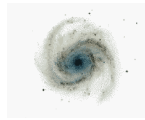
## Practical round. Problems to solve

**6. Planetary nebula.**

The table provides the results of the measurements of the wavelength of the spectral line of hydrogen with $\lambda_0 = 6562{,}81$Å (Hα) of the planetary nebula NGC 5643 (points shown in the picture on separate sheet). Draw a graph that shows the dependence of the radial velocity of the points on the declination $\delta$. Draw a diagram showing the direction in which each point is moving. Assuming that the extreme points in the table correspond to the boundary of the nebula, calculate the motion velocity (the velocity at which the nebula as a whole approaches or recedes) and the velocity of the nebula expansion.

| $\delta$ | +66° 34′ | +66° 35′ | +66° 36′ | +66° 37′ | +66° 38′ | +66° 39′ | +66° 40′ |
|---|---|---|---|---|---|---|---|
| $\lambda$, Å | 6563,17 | 6562,80 | 6562,68 | 6562,40 | 6562,65 | 6562,77 | 6563,16 |

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**6. Планетарная туманность.**

**6. Planetary nebula.**

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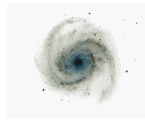
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язык
language   ***English***
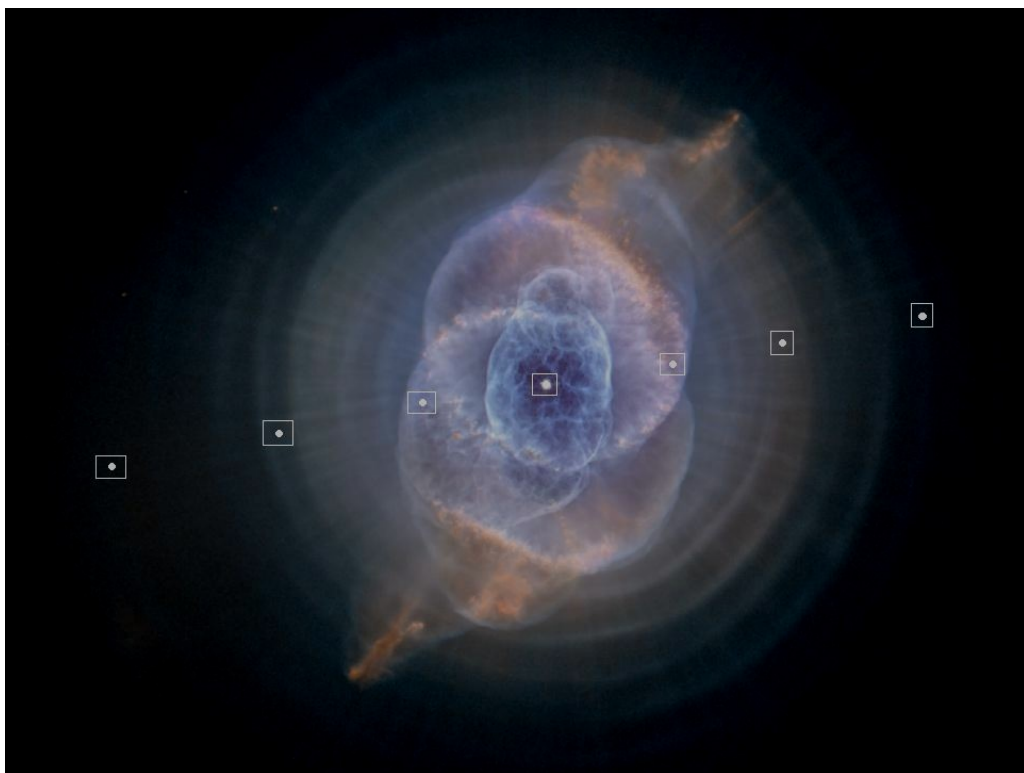
# Practical round. Problems to solve

### 7. Exoplanet.

Recently astronomers discovered an exoplanet that practically reflects no light and belongs to the class of hot Jupiters. Its mass corresponds to 12 Jupiter's masses, the average orbit radius is 0.036 AU and the period is 2.47 days. The given data about the exoplanet has been obtained with the help of the data from the "Kepler" telescope which continuously monitors the sky region between the constellations Cygnus and Lyra. The device was launched in March 2009 and is capable of seeing not only gas giants, but also planets with the size of Earth. Recently scientists have discovered that exoplanets are capable of causing huge tidal waves in the stars that have a significant influence on the spectral parameters of the emitted light from the star. In fact, with the help of this effect scientists have been able to prove that the planet moves around a star in a circular orbit.

In the graph (see separate sheet) the flux of radiation from the system vs. the phase (phase $\phi$ given in radians) can be seen, normalized to the radiation flux from the star.

**7.1.** During the transit there are four "contacts" when the contour of the smaller object touches the contour of the larger object at one point. The contacts take place in the following order:
- First contact: The smaller body is completely outside of the larger and moving inside.
- Second contact: The smaller body is completely inside of the larger and continues to move inwards.
- Third contact: The smaller body is completely inside of the larger and moves outwards.
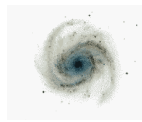- Fourth contact: The smaller body is completely outside of the larger and starts to move away.

In the given graph mark the points of the first, second, third and the fourth contacts. Write in the copybook the value of the phase for each contact.

**7.2.** Determine the duration of the transit (duration of the passage of the disk of planet over the disk of the star).

**7.3.** Determine the inclination of the orbit (for exoplanets and binary stars the reference plane is assumed to be the "image plane" – the plane that is perpendicular to the line of sight).

**7.4.** Calculate the radius of the star.

**7.5.** Calculate the radius of the planet.

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**7. Экзопланета.**

**7. Exoplanet.**