XI International Astronomy Olympiad
Mumbai, India
10-19 November 2006
Бомбей, Индия
10-19 ноября 2006 г.
XI Международная астрономическая олимпиада

Round Th

Group α β

язык / language	English

Theoretical round. Problems to solve 1-3 (page 1 of 2)

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

1. **Telescope.** On the observational round you will use a simple Newton-system telescope with the mirror diameter D = 125 mm, focal length F = 1025 mm and 3 eye-pieces with focal lengths f_1 = 12 mm, f_2 = 25 mm and f_3 = 38 mm. Find on what distances (Δx_1 =, Δx_2 =, Δx_3 = in vertical direction on the middle figure) it is necessary to move the corresponding eye-pieces (1,2,3) to readjust the telescope from observation of the sky objects to observation of a monkey sitting at a distance L = 50 m from you. (Your answer should have both formula and numerical values.) What eyepiece is the most suitable for observation of the monkey? Why?

Addition for β group.

1+β. **Telescope.** L = 50 м as before, but now the monkey is running directly towards you (to steal something to eat) with a speed v = 3 m/s. Find the rate (in mm/s) of moving the most suitable eye-piece for readjusting the telescope to keep the monkey in focus.

2. **False star.** The White Bear (whom was already met in the VII, VIII, IX and X International Astronomy Olympiads) decided to connect a telescope to a film photo camera to make photos of constellations. The exposure times used were of order of 5 minutes. His comrade Penguin appears to be a great joker and bought a photoflash lamp. He decided to play a trick on the Bear and to "put" an extra star in his sky image, while the Bear photographed near-horizon constellations. The Penguin sitting in the photographic area of the Bear's telescope (of course, relatively far from the telescope – 2.5 km) flashed once (sent one light pulse) to the camera during the exposure. Estimate the stellar magnitude of the false star in the Bear's image.

   Take into account the parameters of the flash pulse. The photographic conditions (sensitivity of film, diaphragm) while photographing objects with the flash at the distance of 1.5 metres (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 images of the telescope, Bear and Penguin.

3. **Polar day and night.** Find the boundaries of the region of the polar day and the region of polar night at the dates when the Sun may be in Zenith in Mumbai, HBCSE. The latitude and longitude of HBCSE are are λ_C = 72° 56', φ_C = 19° 03'. Take as many effects as possible into account.

Theoretical round. Problems to solve 4-5 (page 2 of 2)

4. Galaxy. Figure 4.1. shows the distribution of hydrogen gas in the disk of the spiral galaxy NGC 1325 as a contour map. The contour image is superimposed on an optical image of the galaxy. Assume the disk of the galaxy to be nearly circular. Find the angular diameter of the galaxy. (As the angular size of the galaxy is small to an observer on the Earth, you can use plane geometry as an approximation.) Estimate the diameter and distance to the galaxy in kpc. Find the angle of inclination of the galaxy plane with respect to the plane of the sky.

Addition for β group.

4+β. Galaxy. Figure 4.2. shows 2° in diameter region of sky near NGC 1325. A radiomessage on the wavelength $\lambda = 20$ cm has been sent to this region from the Earth in hope that after 260 years the sapiens habitants of system of star τ_4 Eri receive it. But the signal passed further and has been registered only by habitants of NGC 1325. Scientists of NGC 1325 also think that intelligence exists in τ_4 Eri system. What size of radiotelescope should be possessed by citizens of NGC 1325 to identify that the signal issued in Solar system but not in τ_4 Eri system.

α group only.

α-5. Lunar satellite. These are two photos of the Moon taken by the same camera mounted on a lunar satellite. The first photo has been made while the satellite was near its periselenion and the second one near the aposelenion. Find from these data the value of the satellite's orbit eccentricity. Estimate the minimum period between the moments at which these two photos could be taken.

β group only.

β-5. Lunar satellite. These are two photos of the Moon taken by the same camera mounted on a lunar satellite. The first photo has been made while the satellite was near its periselenion and the second one near the aposelenion. Estimate from these data the maximum possible period of orbit around the Moon of this satellite. Consider the lunar orbit around Earth as circular.

Data from the "Table of planetary data" may be used for the solving of every problem.

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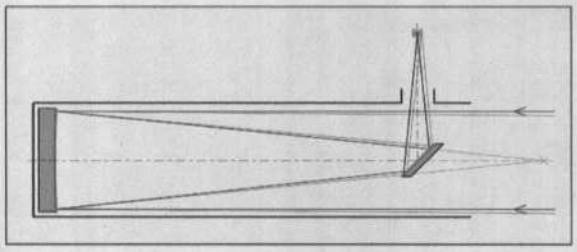
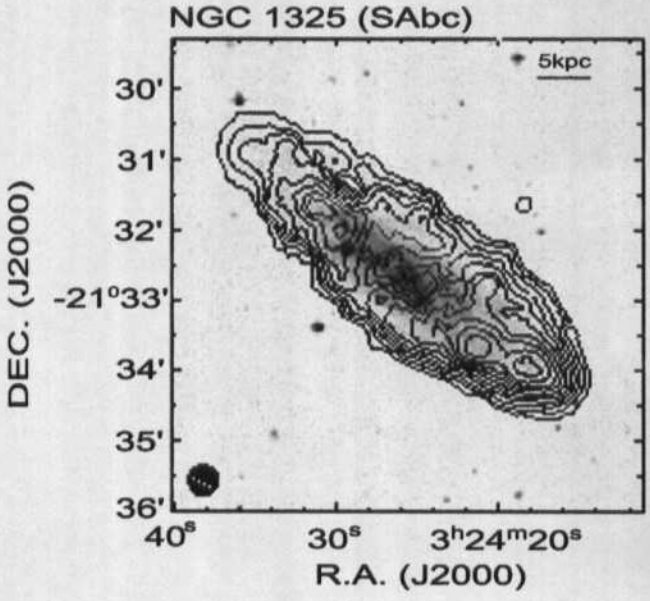
языки / languages	***Все***
языки / languages	***All***

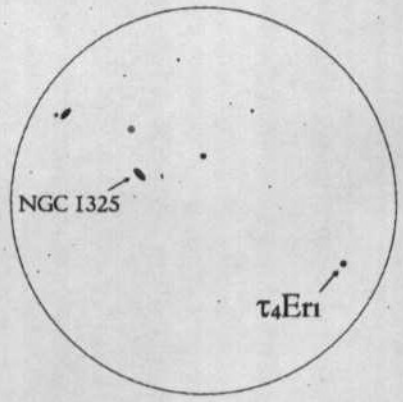
Рисунки к задачам теоретического тура
Theoretical round. Pictures

1. Телескоп. **1. Telescope.**



4. Галактика. **4. Galaxy.**





5. Спутник Луны.
5. Lunar satellite.

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Элементы орбит.
Физические характеристики некоторых планет, Луны и Солнца

Parameters of orbits.
Physical characteristics of some planets, Moon and Sun

Небесное тело, планета	Среднее расстояние от центрального тела		Сидерический период обращения		Эксцентриситет, *e*	Экваториальн. диаметр *км*	Масса 10^{24} *кг*	Средняя плотность $г/см^3$	Ускор. своб. пад. у пов. $м/с^2$	Макс. блеск, вид. с Земли **)	Альбедо
	в *астр. ед.*	в *млн. км*	в тропич. годах	в средних сутках							
Body, planet	Average distance to central body		Sidereal (or analogous) period		Eccentricity *e*	Equat. diameter *km*	Mass 10^{24} *kg*	Av. density g/cm^3	Grav. acceler. at surf. m/s^2	Max. magn. from Earth **)	Albedo
	in *astr. units*	in *mln. km*	in troph. years	in days							
Солнце Sun	$1{,}6 \cdot 10^9$	$2{,}5 \cdot 10^{11}$	$2{,}2 \cdot 10^8$	$8 \cdot 10^{10}$		1392000	1989000	1,409		$-26{,}8^m$	
Меркурий Mercury	0,387	57,9	0,241	87,97	0,206	4 879	0,3302	5,43	3,70	$-2{,}2^m$	0,06
Венера Venus	0,723	108,2	0,615	224,70	0,007	12 104	4,8690	5,24	8,87	$-4{,}7^m$	0,78
Земля Earth	1,000	149,6	1,000	365,26	0,017	12 756	5,9742	5,515	9,81		0,36
Луна Moon	0,00257	0,38440	0,0748	27,3217	0,055	3 475	0,0735	3,34	1,62	$-12{,}7^m$	0,07
Марс Mars	1,524	227,9	1,880	686,98	0,093	6 794	0,6419	3,94	3,71	$-2{,}0^m$	0,15
Юпитер Jupiter	5,204	778,6	11,862	4 332,59	0,048	142 984	1899,8	1,33	24,86	$-2{,}7^m$	0,66
Сатурн Saturn	9,584	1433,7	29,458	10 759,20	0,054	120 536	568,50	0,70	10,41	$0{,}7^m$	0,68

**) Для внешних планет и Луны – в среднем противостоянии.
**) For outer planets and Moon – in mean opposition.