Theoretical round. Problems to solve

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. **Star rise in Moletai.** An observer in Moletai recorded that a star culminated at 02:54 and set at 05:45 on September 8, 2013. Effects of irregularities of the horizon should not be taken into account.
   1.1. At what time will the star rise on September 9, 2013?
   1.2. In approximately which direction do you need to wait for the rising of the star? Choose one of the alternatives: N, NE, E, SE, S, SW, W, NW. Draw a picture with an explanation.

2. **Gliese 581 g.** This celestial body in the system of the star Gliese 581 is the most Earth-like planet found outside the Solar System, and the exoplanet with the greatest recognized potential for harboring albuminous based life.
   Estimate orbital period τ of Gliese 581 g. Consider the orbit to be circular.

3. **Observations from Gliese 581 g.**
   3.1. What is the apparent magnitude of our Sun and **3.2.** what is the approximate constellation in which our Sun will be seen when observed from the planet Gliese 581 g?

4. **XVIII century. Midday.** (Dubingiai is the nearest town to the accommodation place of XVIII IAO.).
   There were different systems of units of measurement in the history of science. This problem is to use historical (at present obsolete) units of measurement.
   4.1. Calculate the capacity of the solar energy that in the end of the XVIII century fell on the unit of area of the territory in the outskirts of Dubingiai at midday time:
   in winter, in spring, in autumn, and in summer.
   The answer must be given using only the «new» physical units, which were coming into operation in those days in this area: horse-powers per square verst.
   
   4.2. Estimate also the capacity of the solar energy incident on a local horse those times. The answer must also be expressed in physical units, which were coming into operation in those days. What can be surprising about the right answer?

5. **XXI century. Midday.** As is known, the Republic of Lithuania (see map) uses zone with winter time UT+02 and summer time UT+03. Calculate and draw a conclusion about the following:
   5.1. Are there any places in Lithuania, where today (September 8, 2013) the Sun will be exactly in the south at a time when the watches of residents will show just 12:00? (**«да-yes»** or **«нет-no»**).
   5.2. And in general, on the other days of the year, are there such places? (**«да-yes»** or **«нет-no»**). If "yes", then calculate in what dates, if "no", then justify it by calculations.

6. **Supernova remnant.** An X-ray image of supernova remnant (SNR) Cas A located at a distance of d = 3400 pc was obtained using Chandra Space Observatory. The negative of this image is shown in Fig. SNR. The boundaries of the SNR region are marked by a circle. The scale of the image is shown in the upper left corner of the figure. A dot located close to the center of the circle is the neutron star – the remaining core of the collapsed star. The rectangular marks outside the circle are given for the reference when determining the center of the circle.
   Assume that the amount of energy released in the supernova explosion was about $E_{SN} \approx 10^{46}$ J, 1% of which drives the expansion of the remnant. The average density of the matter in the SNR is $\rho \approx 10^{-21}$ kg/m^3.
   6.1. Estimate the age of the SNR Cas A.
   6.2. Calculate the average velocity of the motion of the neutron star from the center of the SNR.

Theoretical round. Problems to solve

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. **RadioAstron.** The RadioAstron project is an international collaborative mission lead by Astro-Space Center of Russian Academy of Sciences. On July 18, 2011 a satellite, «Spektr-R», carrying a 10-m (in diameter) space radio-telescope was launched into an elliptical orbit around the Earth. Together with Earth-based radio-telescopes, «Spektr-R» works as interferometer. RadioAstron operates at the standard radio astronomical wavelengths of 1.19–1.63 cm (K-band), 6.2 cm (C-band), 18 cm (L-band), and 92 cm (P-band). Now «Spektr-R» is rotating in a very elongated orbit with a period τ = 8.3 days and a height of perigee h = 600 km from the Earth surface.

   1.1. Estimate the maximum resolving power (angular resolution in arcsec) of RadioAstron. Draw a schematic picture, explaining your choice of the situation when it may occur.

   1.2. Estimate the resolving power of RadioAstron if the target is observed in the direction of the major axis of «Spektr-R» orbit, and also draw a schematic picture.

2. **Gliese 581 g.** This celestial body in the system of the star Gliese 581 is the most Earth-like planet found outside the Solar System, and the exoplanet with the greatest recognized potential for harboring albuminous based life.

   2.1. Estimate orbital period τ of Gliese 581 g. Consider the orbit to be circular.

   2.2. Assume intelligent life resides on Gliese 581 g. The civilization uses radio-waves. Is it possible to determine the size (diameter) of the planet by observations on RadioAstron (**«да-yes»** or **«нет-no»**)? Justify the answer by calculations.

3. **Observations from Gliese 581 g.**

   3.1. What is the apparent magnitude of our Sun and **3.2.** what is the approximate constellation in which our Sun will be seen when observed from the planet Gliese 581 g?

   3.3. Estimate the angular diameter of the star Gliese 581 when observed from the planet Gliese 581 g.

4. XVIII century. Midday. (Dubingiai is the nearest town to the accommodation place of XVIII IAO.).

There were different systems of units of measurement in the history of science. This problem is to use historical (at present obsolete) units of measurement.

4.1. Calculate the capacity of the solar energy that in the end of the XVIII century fell on the unit of area of the territory in the outskirts of Dubingiai at midday time:

in winter, in spring, in autumn, and in summer.

The answer must be given using only the «new» physical units, which were coming into operation in those days in this area: horse-powers per square verst.

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6. Supernova remnant. An X-ray image of supernova remnant (SNR) Cas A located at a distance of d = 3400 pc was obtained using Chandra Space Observatory. The negative of this image is shown in Fig. SNR. The boundaries of the SNR region are marked by a circle. The scale of the image is shown in the upper left corner of the figure. A dot located close to the center of the circle is the neutron star – the remaining core of the collapsed star. The rectangular marks outside the circle are given for the reference when determining the center of the circle.

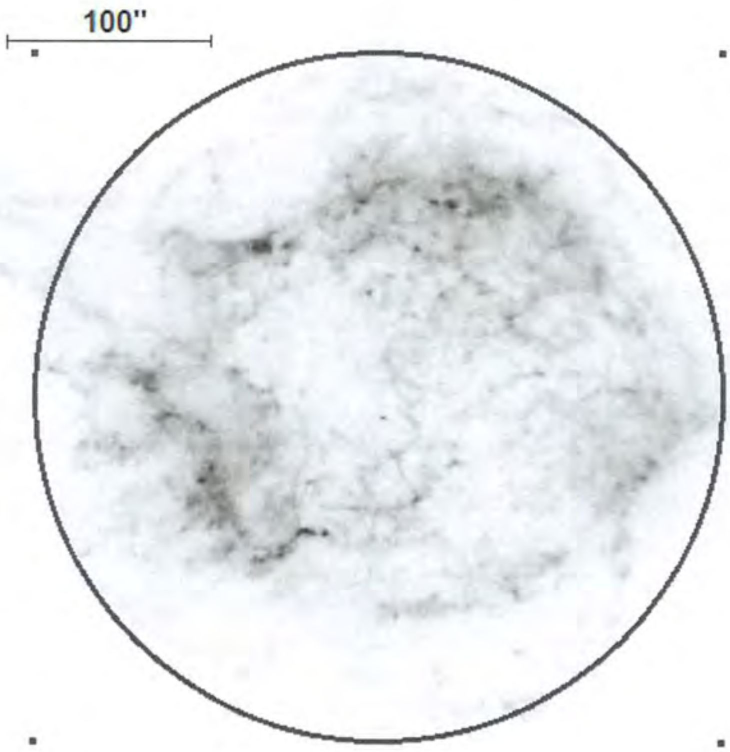
Assume that the amount of energy released in the supernova explosion was about $E_{SN} \approx 10^{46}$ J, 1% of which drives the expansion of the remnant. The average density of the matter in the SNR is $\rho \approx 10^{-21}$ kg/m^3.

6.1. Estimate the age of the SNR Cas A.

6.2. Calculate the average velocity of the motion of the neutron star from the center of the SNR.

Теоретический тур. Рисунок к задаче 6

Theoretical round. Picture for problem 6



S N R

АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО
EURO–ASIAN ASTRONOMICAL SOCIETY

XVIII Международная астрономическая олимпиада
XVIII International Astronomy Olympiad
Литва, Вильнюс 6 – 14. IX. 2013 Vilnius, Lithuania

Round	Theo	
Group	α	β

язык / language	Русский
язык / language	English

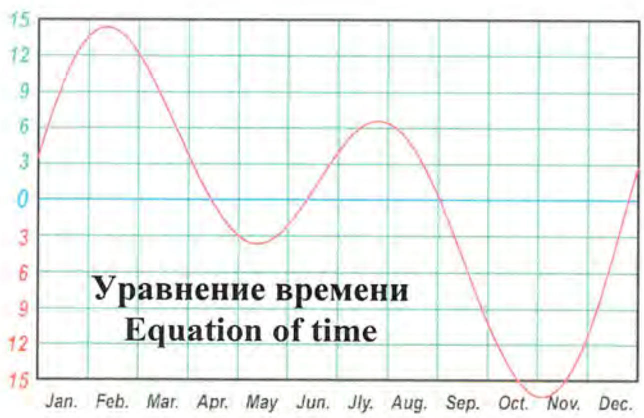
Элементы орбит. Физические характеристики некоторых планет, Луны и Солнца

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

Небесное тело, планета	Среднее расстояние от центрального тела		Сидерический (или аналогичный) период обращения		Наклон орбиты,	Эксцентриситет,	Экваториальн. диаметр	Масса	Средняя плотность	Ускор. своб. пад. у пов.	Наклон оси	Макс. блеск, вид. с Земли **)	Альбедо
	в *астр. ед.*	в *млн. км*	в тропич. годах	в средних сутках	*i*	*e*	*км*	10^{24} *кг*	*г/см*^{3}	*м/с*^{2}			
Body, planet	Average distance to central body		Sidereal period (or analogous)		Orbital inclination,	Eccentricity	Equat. diameter	Mass	Av. density	Grav. accelr. at surf.	Axial tilt	Max. magn. From Earth **)	Albedo
	in *astr. units*	in 10^6 *km*	in tropical years	in days	*i*	*e*	*km*	10^{24} *kg*	*g/cm*^{3}	*m/s*^{2}			
Солнце Sun	$1{,}6\cdot10^9$	$2{,}5\cdot10^{11}$	$2{,}2\cdot10^8$	$8\cdot10^{10}$			1392000	1989000	1,409			$-26{,}74^m$	
Меркурий Mercury	0,387	57,9	0,241	87,969	7,00°	0,206	4 879	0,3302	5,43	3,70	0,01°		0,06
Венера Venus	0,723	108,2	0,615	224,7007	3,40	0,007	12 104	4,8690	5,24	8,87	177,36		0,78
Земля Earth	1,000	149,6	1,000	365,2564	0,00	0,017	12 756	5,9742	5,515	9,81	23,44		0,36
Луна Moon	0,00257	0,38440	0,0748	27,3217	5,15	0,055	3 475	0,0735	3,34	1,62	6,7	$-12{,}7^m$	0,07
Марс Mars	1,524	227,9	1,880	686,98	1,85	0,093	6 794	0,6419	3,94	3,71	25,19	$-2{,}0^m$	0,15
Юпитер Jupiter	5,204	778,6	11,862	4 332,59	1,30	0,048	142 984	1899,8	1,33	24,86	3,13	$-2{,}7^m$	0,66
Сатурн Saturn	9,584	1433,7	29,458	10 759,20	2,48	0,054	120 536	568,50	0,70	10,41	26,73	$0{,}7^m$	0,68

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

Lietuva * Lithuania * Литва



Round	Theo
Group	α β
язык language	Русский
язык language	English

Некоторые константы и формулы
Some constants and formulae

Скорость света в вакууме, c (м/с)	299 792 458	Speed of light in vacuum, c (m/s)
Гравитационная постоянная, G ($Н·м^2/кг^2$)	$6.674·10^{-11}$	Constant of gravitation, G ($N·m^2/kg^2$)
Солнечная постоянная, A ($Вт/м^2$)	1367	Solar constant, A (W/m^2)
Параметр Хаббла, H_0 (км/с/МПк) среднее значение диапазон значений	71 50-100	mean value diapason of values Hubble parameter, H_0 (km/s/Mpc)
Постоянная Планка, h (Дж·с)	$6.626·10^{-34}$	Plank constant, h (J·s)
Заряд электрона, e (Кл)	$1.602·10^{-19}$	Charge of electron, e (C)
Масса электрона, m_e (кг)	$9.109·10^{-31}$	Mass of electron, m_e (kg)
Соотношение масс протона и электрона	1836.15	Proton-to-electron ratio
Постоянная Фарадея, F (Кл/моль)	96 485	Faraday constant, F (C/mol)
Магнитная постоянная, μ_0 (Гн/м)	$1.257·10^{-6}$	Magnetic constant, μ_0 (H/m)
Универсальная газовая постоянная, R (Дж/моль/К)	8.314	Universal gas constant, R (J/mol/K)
Постоянная Больцмана, k (Дж/К)	$1.381·10^{-23}$	Boltzmann constant, k (J/K)
Постоянная Стефана-Больцмана, σ ($Вт/м^2/К^4$)	$5.670·10^{-8}$	Stefan-Boltzmann constant, σ ($W/m^2/K^4$)
Константа смещения Вина, b (м·К)	0.002897	Wien's displacement constant, b (m·K)
Лабораторная длина волны **Hα** (Å)	6562.81	Laboratory wavelength of **Hα** (Å)
Длина тропического года, T (сут)	365.242199	Tropical year length, T (days)
Стандартная атмосфера (Па)	101 325	Standard atmosphere (Pa)
Ослабление видимого света земной атмосферой в зените (минимально)	19%, 0.23^m	Visible light extinction by the terrestrial atmosphere in zenith (minimum)
Показатель преломления воды при 20°C, n	1.334	Refractive index of water for 20°C, n
Момент инерции шара	$I = {}^2/_5\, MR^2$	Moment of inertia of a solid ball
Объём шара	$V = {}^4/_3\, \pi R^3$	Volume of a ball
Площадь сферы	$S = 4\pi R^2$	Area of sphere
π	3.14159265	**π**
e	2.71828183	e
Золотое сечение, **φ**	1.61803399	Golden ratio, **φ**

Данные о некоторых звёздах
Data of some stars

			RA	DEC	p	m	S C	масса mass
Солнце	Sun	⊙	$0^h - 24^h$	-23°26' +23°26'	8".794	vis $-26^m.74$ bol $-26^m.82$	G2	$1 M_⊙$
Проксима Центавра	Proxima Centauri	V645 Cen, α Cen C	$14^h 29^m 43^s$	-62° 40' 46"	0".769	$11^m.05$	M5.5	$0.123 M_⊙$
Альфа Центавра	Alpha Centauri	α Cen A α Cen B	$14^h 39^m 37^s$ $14^h 39^m 35^s$	-60° 50' 02" -60° 50' 14"	0".747	$-0^m.01$ $1^m.34$	G2 K1	$1.1 M_⊙$ $0.9 M_⊙$
Бета Центавра	Beta Centauri	β Cen	$14^h 03^m 49^s$	-60° 22' 23"	0".009	$0^m.61$	B1	$21 M_⊙$
Эпсилон Эридана	Epsilon Eridani	ε Eri	$03^h 32^m 56^s$	-09° 27' 30"	0".311	$3^m.74$	K2	$0.82 M_⊙$
Глизе 581	Gliese 581	HO Lib	$15^h 19^m 27^s$	-07° 43' 20"	0".16	vis $10^m.57$ bol $8^m.0$	M3V	$0.31 M_⊙$

Меры мощности
1 лошадиная сила (л.с.) = 735,49875 Вт

Units of power
1 horse-power (hp) = 735,49875 W

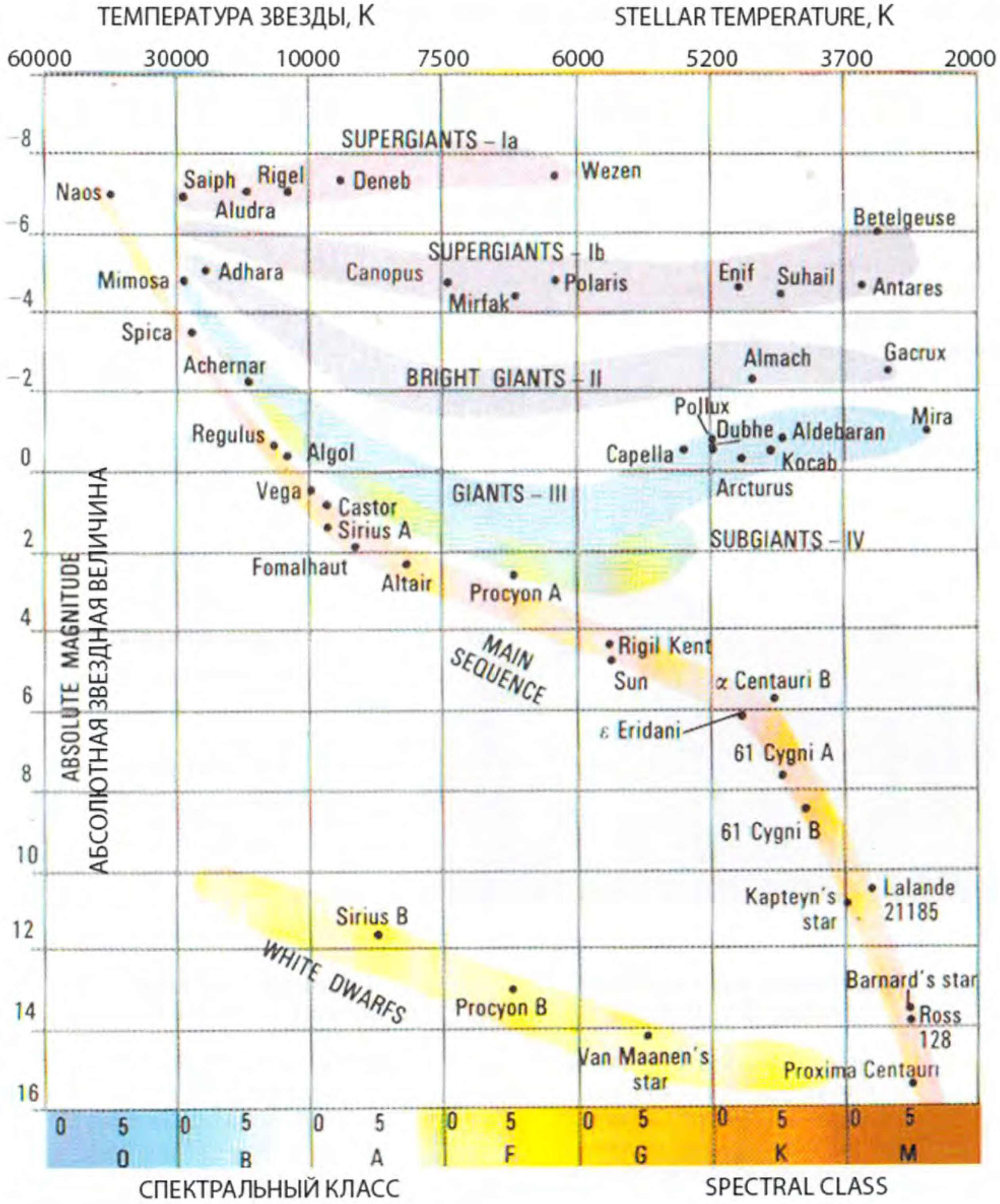
Местные меры длины конца XVIII века

1 аршин (арш) = 0,711187 м
1 пядь (пд) = 1/4 аршина
1 вершок (врш) = 1/4 пяди
1 сажень (сж) = 3 аршина
1 верста (врст) = 500 саженей

Local units of length in the end of XVIII century

1 arshin (arsh) = 0.711187 m
1 span (sp) = 1/4 arshin
1 vershok (vrsh) = 1/4 span
1 sajene (sj) = 3 arshin
1 verst (vrst) = 500 sajene

Диаграмма Герцшпрунга-Рассела Hertzsprung-Russell diagram



Practical round. Problems to solve

7. Asteroid.

Analysis of observations of a near earth asteroid.

Astronomers of two observatories, which are located at a distance of 3172 km from each other, took CCD images of a certain region of the sky for the search of a near earth asteroid. Two images were obtained by Observatory 1 during the same night at 4^h53^m UT and at 7^h16^m UT. These images (negatives) are shown in Figs. 7.1 and 7.2, respectively. The next two images obtained on the same night were made at Observatory 1 .and Observatory 2 simultaneously. These images (negatives) are shown in Figs. 7.3 and 7.4. The scale of all the images is the same as shown in Fig. 7.1.

7.1. Identify and mark the asteroid in the given Figs.

7.2. Measure the angular displacement (in arcsec) of the asteroid as seen from Observatory 1 and calculate its angular velocity in arcsec/s.

7.3. Measure the parallax of the asteroid (in arcsec) and calculate its distance from the earth.

7.4. Calculate the tangential linear velocity (velocity perpendicular to the line of sight) of the asteroid.

Note: You are provided a transparency for measurements of angular displacements of the asteroid.

7. Asteroid. **7. Астероид.**

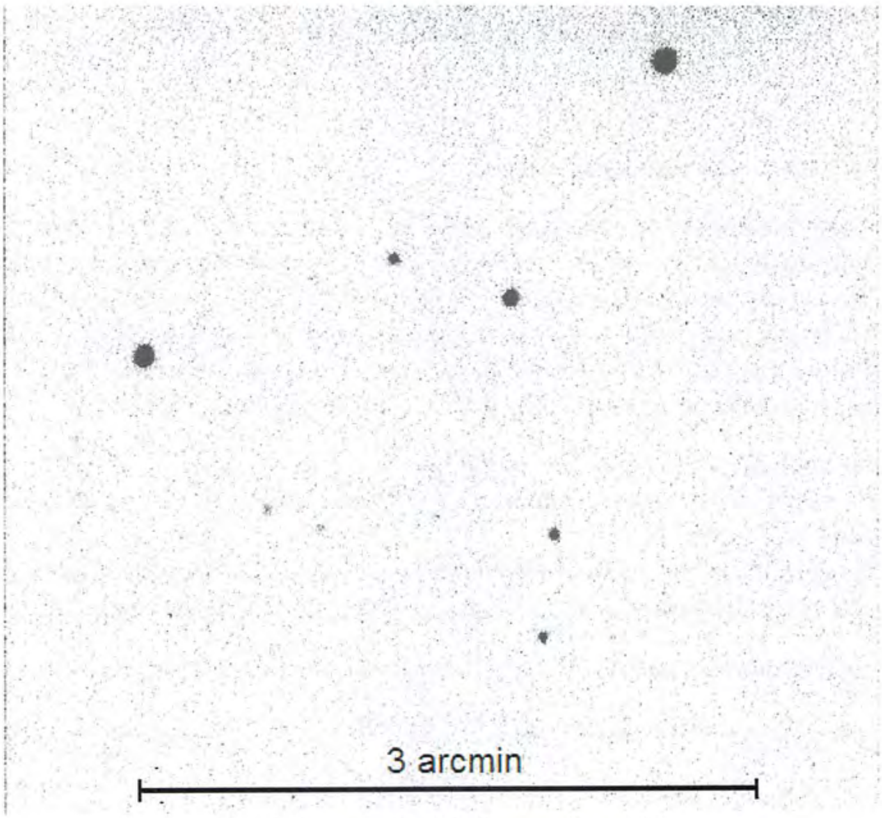


Fig. 7.1. *4:53 UT* *Рис. 7.1.*

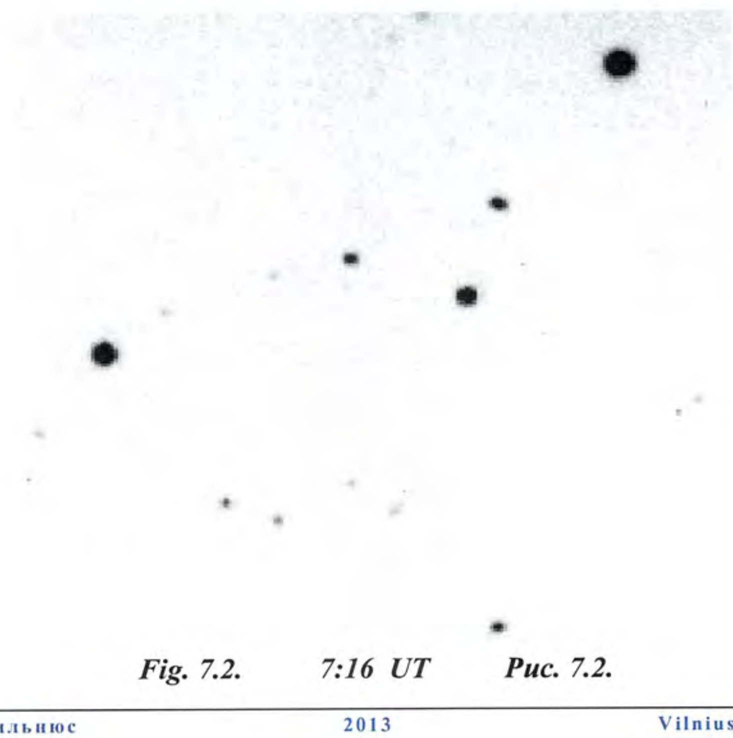


Fig. 7.2. *7:16 UT* *Рис. 7.2.*

код	
code	

7. Asteroid. **7. Астероид.**

Fig. 7.3. *Observatory 2* *Рис. 7.3.*

Fig. 7.3. *Observatory 1* *Рис. 7.3.*

Practical round. Problems to solve

7. Distance to the galaxy NGC 4214

The usage of novae in outbursts as distance indicators is based on the correlation of their absolute magnitudes at maximum brightness with their rates of decline. The simplified relationship between the absolute magnitude at maximum of a nova and its rate of decline may be expressed through the linear expression:

$$M_{Vmax} = a + b\log t_2, \qquad (1)$$

where a and b are constants to be determined using observational data of a certain number of galactic novae with spatially resolved shells, t_2 is the rate of decline, i.e. the time (expressed in days) that it takes the nova to drop by 2 magnitudes below its light maximum. t_2 should be evaluated from the graph of the light curve of a nova.

7.1. Using data of Table 1 determine the constants a and b in the expression (1). The results of the calculations should be written in Table 1a. A graph template (Fig. 1a) should be used for determination of constants a and b.

7.2. Using the obtained expression and photometric data of a nova, which erupted in the galaxy NGC 4214, calculate the distance to this galaxy. Photometric data of this nova are given in Table 2. A graph template (Fig. 2a) should be used for the plot of the light curve of the nova.

Data of Table 1:
1st column is the number of the nova;
2nd – the time of the maximum brightness of the nova, T_0, in Julian Days (JD);
3rd – the apparent magnitude of the nova at maximum brightness, $m_{V\max}$;
4th – the rate of decline, i.e. the time that it takes the nova to drop by 2 magnitudes below maximum, t_2, in days (d);
5th – the angular radius of the expanding shell of the nova, θ (in arcsec);
6th – the time of the measurement of the radius of the nova shell, T, in Julian Days (JD);
7th – the rate of expansion of the shell of the nova, v, in km/s;
8th – the interstellar extinction in the direction of the nova, A_V.

Data of Table 2:
1st column is the time of observation in Julian Days (JD);
2nd – the apparent magnitude of the nova.

Table 1. Data of the galactic novae for determination of the constants a and b;

Table 2. Observations of the nova in NGC 4214;

Table 1a. Results of calculations of the parameters of the galactic novae;

Fig. 1a. Graph template for determination of the constants in the expression (1);

Fig. 2a. Graph template for the plot of the light curve of the nova NGC 4214.

7. Distance to the galaxy NGC 4214.

7. Расстояние до галактики NGC 4214.

Table 1. **Таблица 1.**

No.	T_{max} (JD)	$m_{V\max}$	t_2, (d)	θ (arcsec)	T (JD)	v (km/s)	A_V (mag)
1	2412083	4.5	45	9	2444798	600	1.3
2	2442655	1.9	2	1.5	2445707	1500	1.4
3	2427794	1.6	39	10	2444798	500	0.3
4	2438061	3.5	22	3.5	2445707	1100	0.6
5	2428340	2.0	5	11	2444798	1600	0.8
6	2430676	0.7	6	9	2450898	800	0.3

Table 2. **Таблица 2.**

Time (JD)	Apparent magnitude m_V
2455233.1	17.6
2455233.8	17.3
2455234.5	17.6
2455236.5	18.7
2455237.5	19.4
2455238.5	19.8

Round **Prac**

Group **β**

код	
code	

7. Distance to the galaxy NGC 4214.

7. Расстояние до галактики NGC 4214.

Table 1a. / **Таблица 1a.**

No.	Δt (JD)	R (AU)	d (pc)	$M_{V\max}$	$\log t_2$
1					
2					
3					
4					
5					
6					

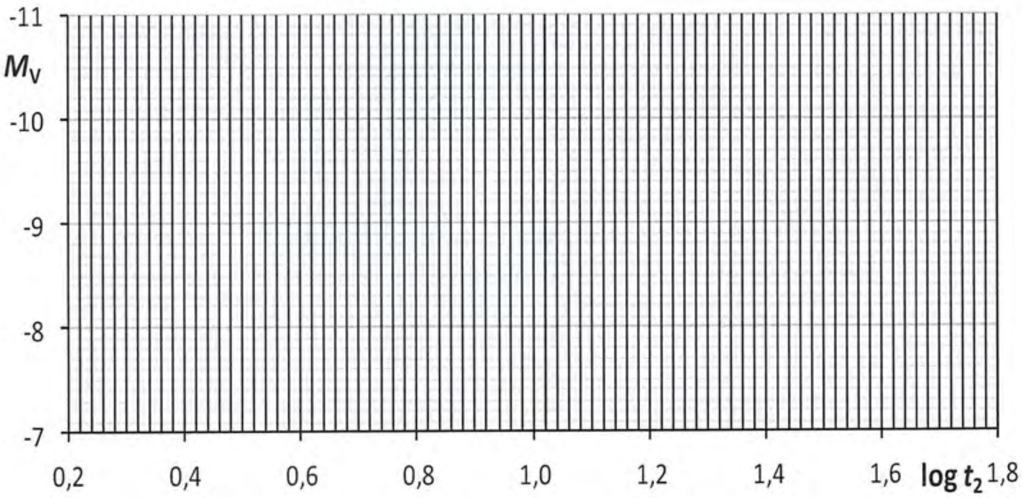


Fig. 1a.

Рис. 1a.

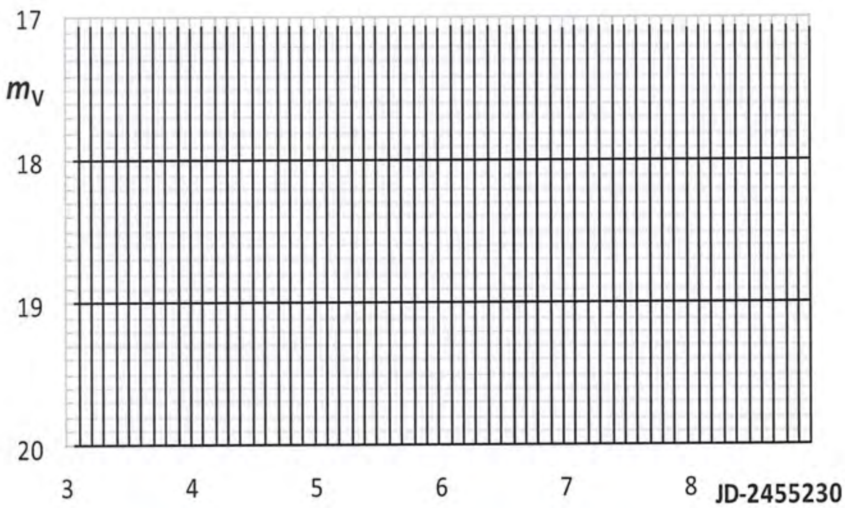


Fig. 2a.

Рис. 2a.

Practical round. Problems to solve

αβ-8. Jupiter. Analysis of observational data of Jupiter and its moons

Observational data of Jupiter and its moons are given on separate sheets.
Your answers (measured values, results of calculations, used formulas) must be written in corresponding tables.

A. See separate sheet.

B. Equatorial rotational period and radius

Two CCD images of Jupiter are shown in Figs. 2 and 3. The vertical lines in figures marks the position of the projection of Jupiter's rotation axis (we assume it is perpendicular to the line of sight). The rotation period can be obtained from horizontal shifts of stable atmospheric features located relatively close to the equator.

B.1. What time interval in seconds (**dt**) separate these images?
B.2. One feature useful for measurements is already marked "**1**". Select and mark two additional features as "**2**" and "**3**" in both pictures.
B.3. Measure distances from the central vertical line to the marked features in both images ($\mathbf{x_1}$ and $\mathbf{x_2}$, respectively) and to the Jupiter limb at the feature's latitude ($\mathbf{L_x}$).
B.4. Calculate the rotational angle ($\boldsymbol{\phi}$) for each feature.
B.5. Calculate the averaged value of rotational angle (**ϕ_avg**).
B.6. Calculate the rotational period ($\mathbf{P_{Je}}$), in hours.
B.7. Calculate Jupiter's equatorial radius ($\mathbf{R_{Je}}$), in km.

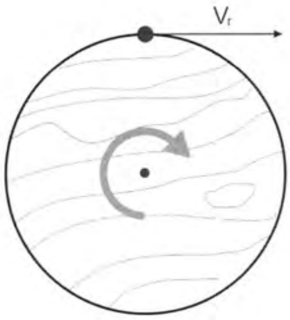
C. Mass and density

Figs. 4-6 display observations of three Jupiter moons obtained during five successive nights in September 2011. Abscissa in those figures is time of observation measured in hours from the beginning of the observing session. Ordinate is the angular distance (in angular minutes) of the moon from the center of Jupiter at the moment of observation. The equatorial radius of Jupiter in the angular seconds is also given for some moments.

C.1. Estimate the period of revolution of each Jupiter's moon ($\mathbf{P_m}$), in hours.
C.2. Estimate the semimajor axis of the orbit of each Jupiter's moon expressed in Jupiter's equatorial radii (**a_Je**) and convert it into meters (**a**).
C.3. Use your mesurements of each moon to calculate the mass of Jupiter ($\mathbf{M_J}$) independently.
C.4. Calculate the averaged value of Jupiter mass (**M**$\mathbf{M_J}$**_avg**).
C.5. From Jupiter image estimate the ratio of Jupiter's polar and equatorial radii ($\mathbf{R_p/R_e}$).
C.6. Calculate the mean radius of Jupiter ($\mathbf{R_J}$**_avg**).
C.7. Calculate the density of Jupiter ($\boldsymbol{\rho_J}$).

8.

A.



V_r = 12.6 km/s

Practical round. Problems to solve

β-8. Jupiter.

A. Rotational velocity

Spectrum of Jupiter (Fig. 1) was obtained when the slit of a spectrograph was aligned along the planet's equator. Wavelengths (**λ**) of several recognized lines are shown. Due to Jupiter rotation the reflected Sunlight was affected by the Doppler effect. The spectral lines become inclined, because the spectrum of light reflected from the receding part of Jupiter is red-shifted, and of light reflected from the approaching part is blue-shifted. Non-inclined lines, which are visible in the spectrum, were formed in the Earth atmosphere.

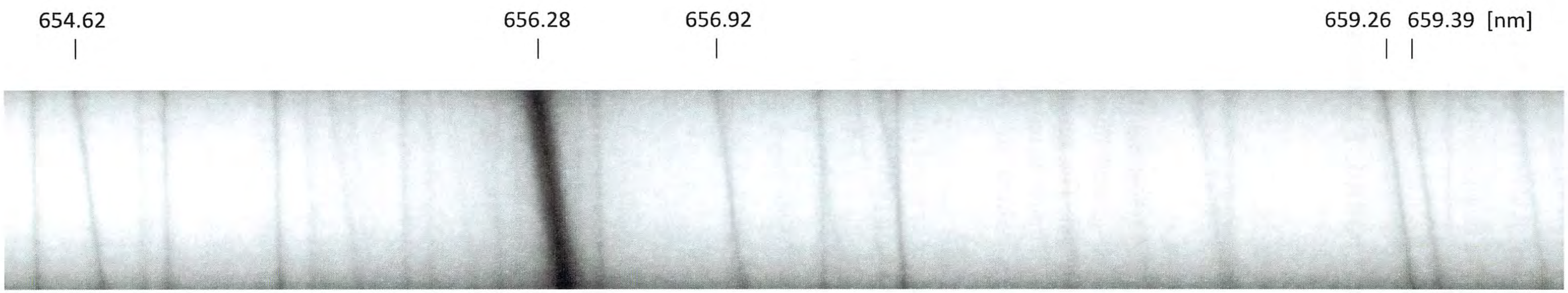
A.1. Evaluate the mean scale of the given spectral interval (**N**), in nm per mm.
A.2. Measure the difference between the uppermost and the lowermost end of an inclined spectral line in mm (**dx**) and convert it into nm (**dλ**). Do this for 3 lines independently.
A.3. Calculate the equatorial rotational velocity of Jupiter (**v_r**) for each measured line and the final averaged value (**v_r_avg**).

Round **Prac**

Group **β**

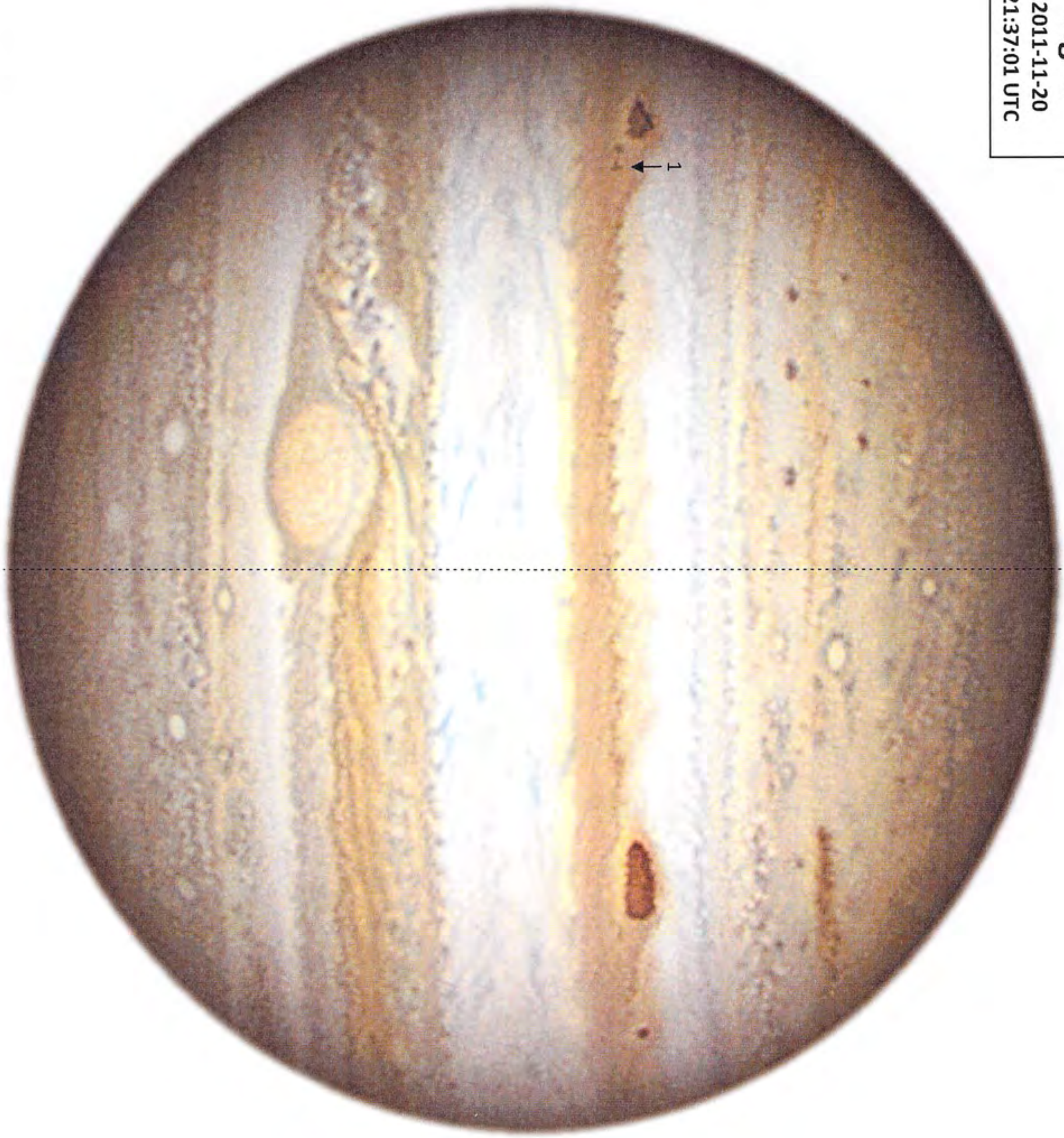
код	
code	

Fig. 1



код	
code	

Fig. 2
2011-11-20
21:37:01 UTC



код	
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Fig. 3
2011-11-20
23:28:36 UTC

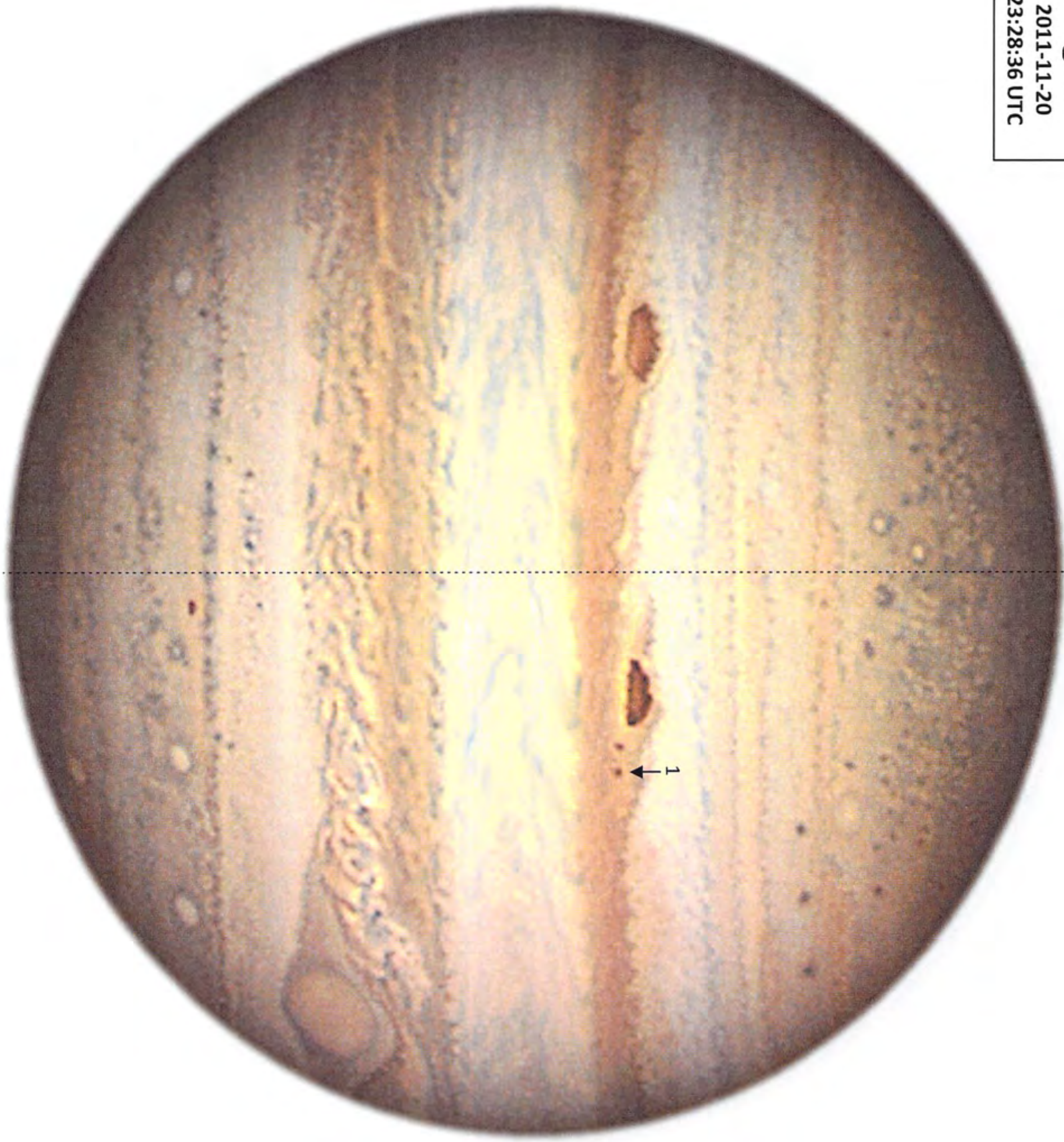


Fig. 4. Moon-1

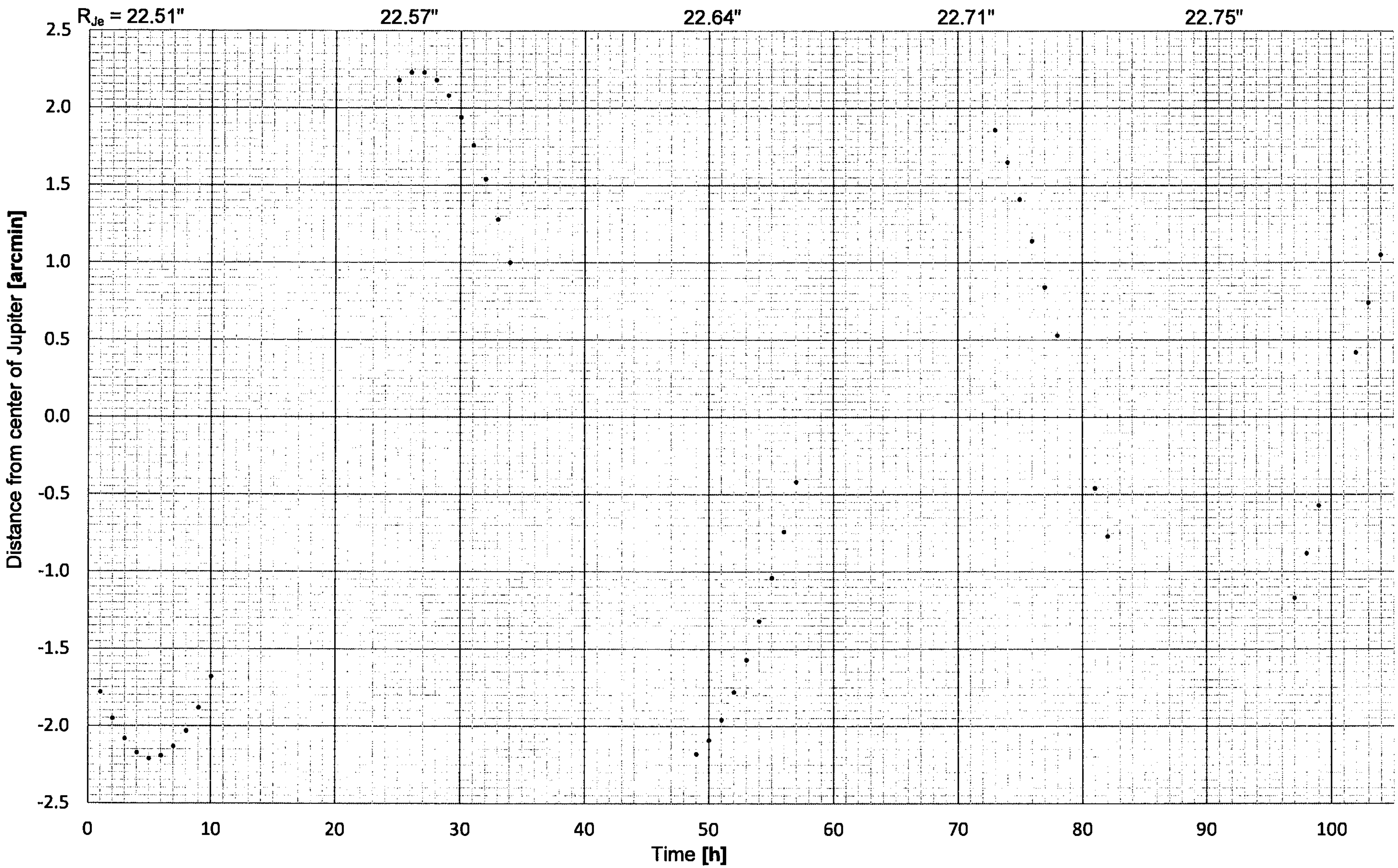

R_{Je} = 22.51"
22.57"
22.64"
22.71"
22.75"
Distance from center of Jupiter [arcmin]
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
0
10
20
30
40
50
60
70
80
90
100
Time [h]

Fig. 5. Moon-2

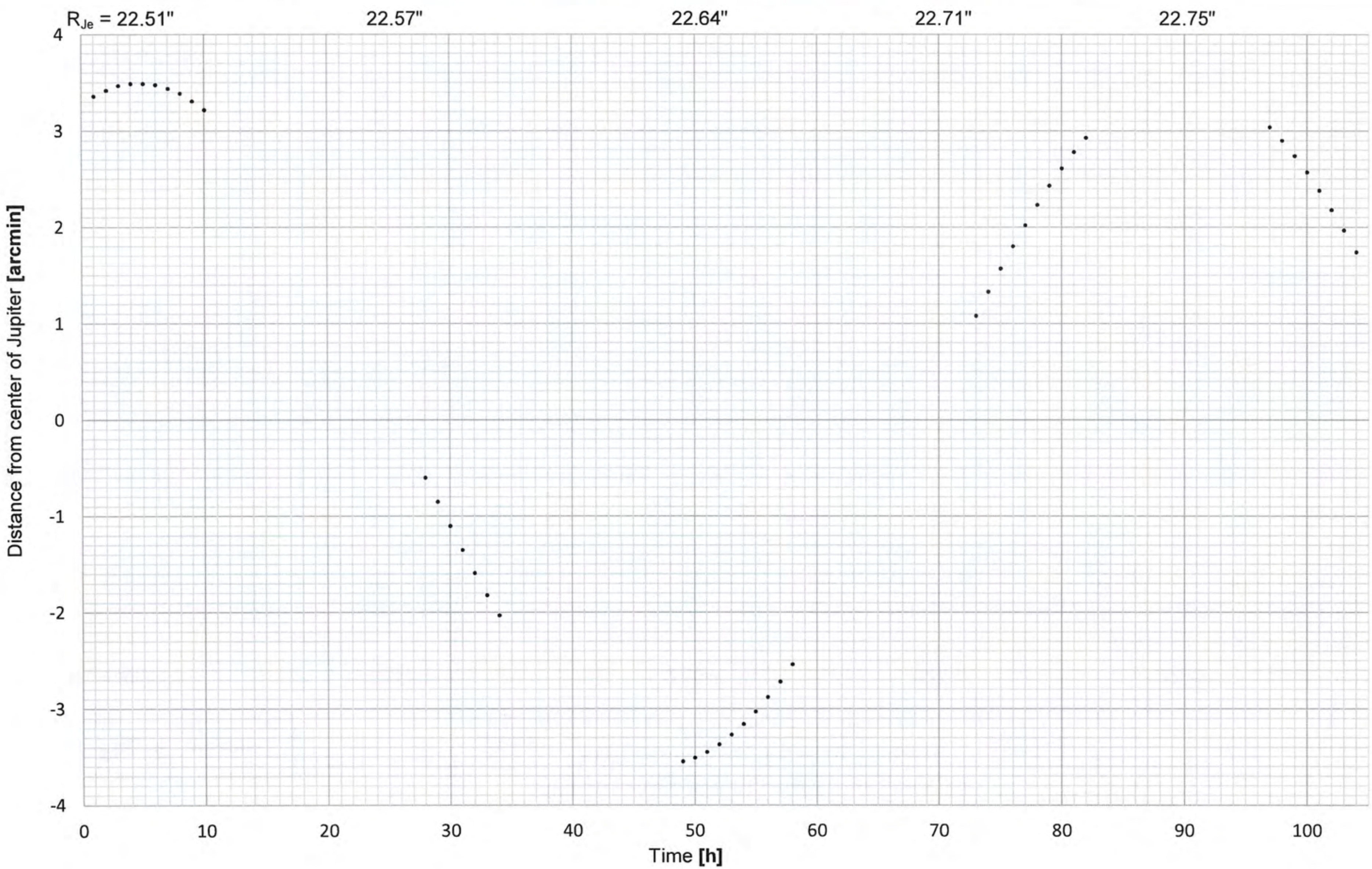
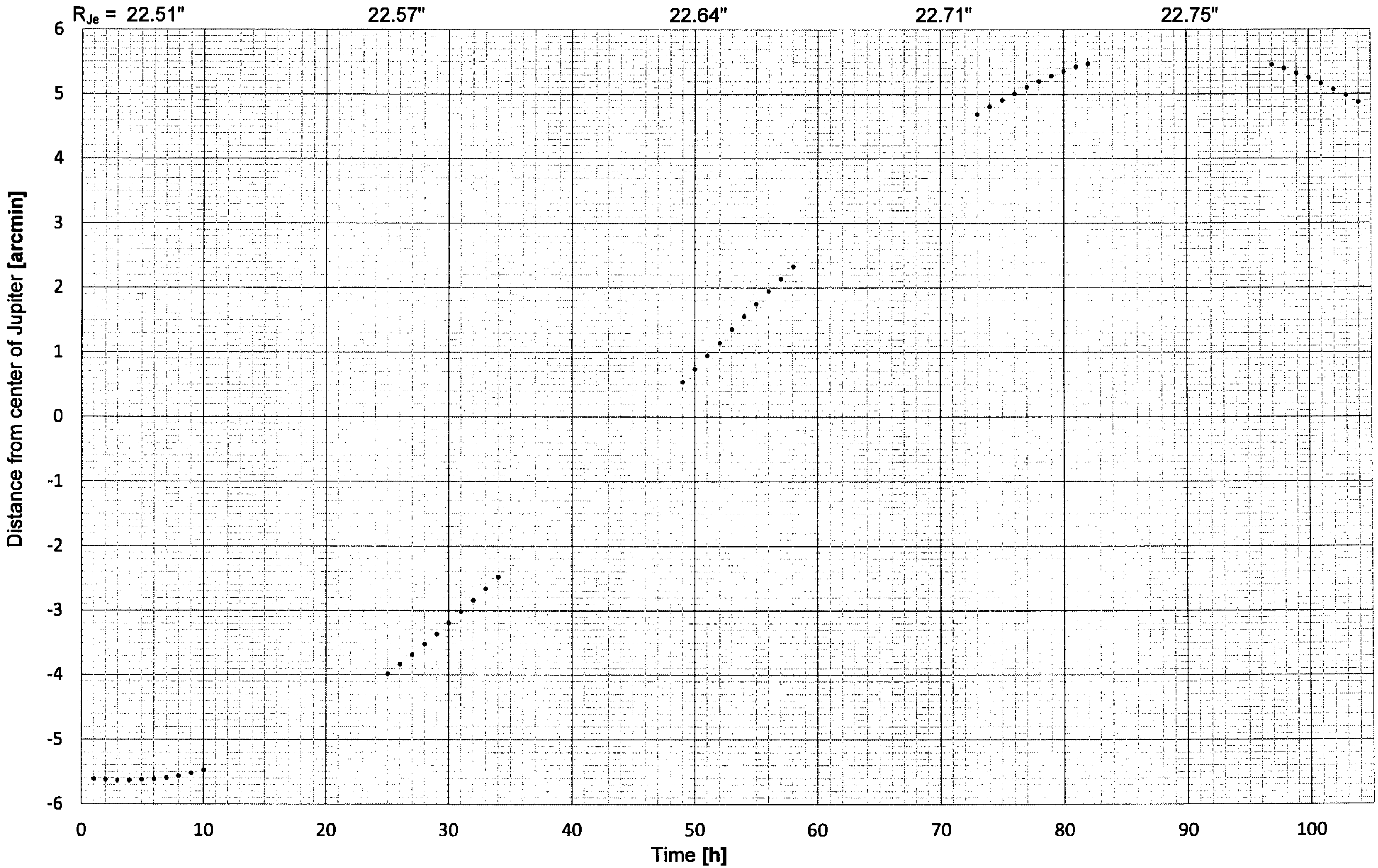

R_{Je} = 22.51"
22.57"
22.64"
22.71"
22.75"
Distance from center of Jupiter [arcmin]
4
3
2
1
0
-1
-2
-3
-4
0
10
20
30
40
50
60
70
80
90
100
Time [h]

Fig. 6. Moon-3



R_{Je} = 22.51"
22.57"
22.64"
22.71"
22.75"
Distance from center of Jupiter [arcmin]
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
0
10
20
30
40
50
60
70
80
90
100
Time [h]

Round	Obs	
Group	α	β

язык / language	English

Code of participant	код участника

Observational round. Questions.
Clear sky

Observations by the naked eye

9. Find the object corresponding to the following criteria:
- The object is the second brightest star in its constellation.
- The object is visible approximately 28 degrees from α UMi.
- The equatorial coordinates of the object are: **RA 11^h, dec +62°**.

Answer the questions: *Answers:*

a) What is the Bayer designation (e.g. β Ori) of the identified object?

b) Write the name of the constellation in Latin, which the object is visible in.

Answer:

10. What is the angular distance between Vega (α Lyr) and Albireo (β Cyg)?

Answers:

11. a) Find the horizontal coordinates of Thuban (α Dra).

b) Find the zenith distance of Alcor (near ζ Ursae Majoris).

Observations with telescope

12. There are 3 binary stars on the given sky chart: β Cyg, δ Lyr, and ε Lyr.
For each of the binaries do the following:
Point the telescope to the binary. Compare the star field seen in telescope's field of view with three star charts given on a separate sheet. Write down the designations of the binary stars in each blank box under appropriate star chart. Mark North direction on every star chart.

*The maximum total time for all tasks is **20 minutes**.*

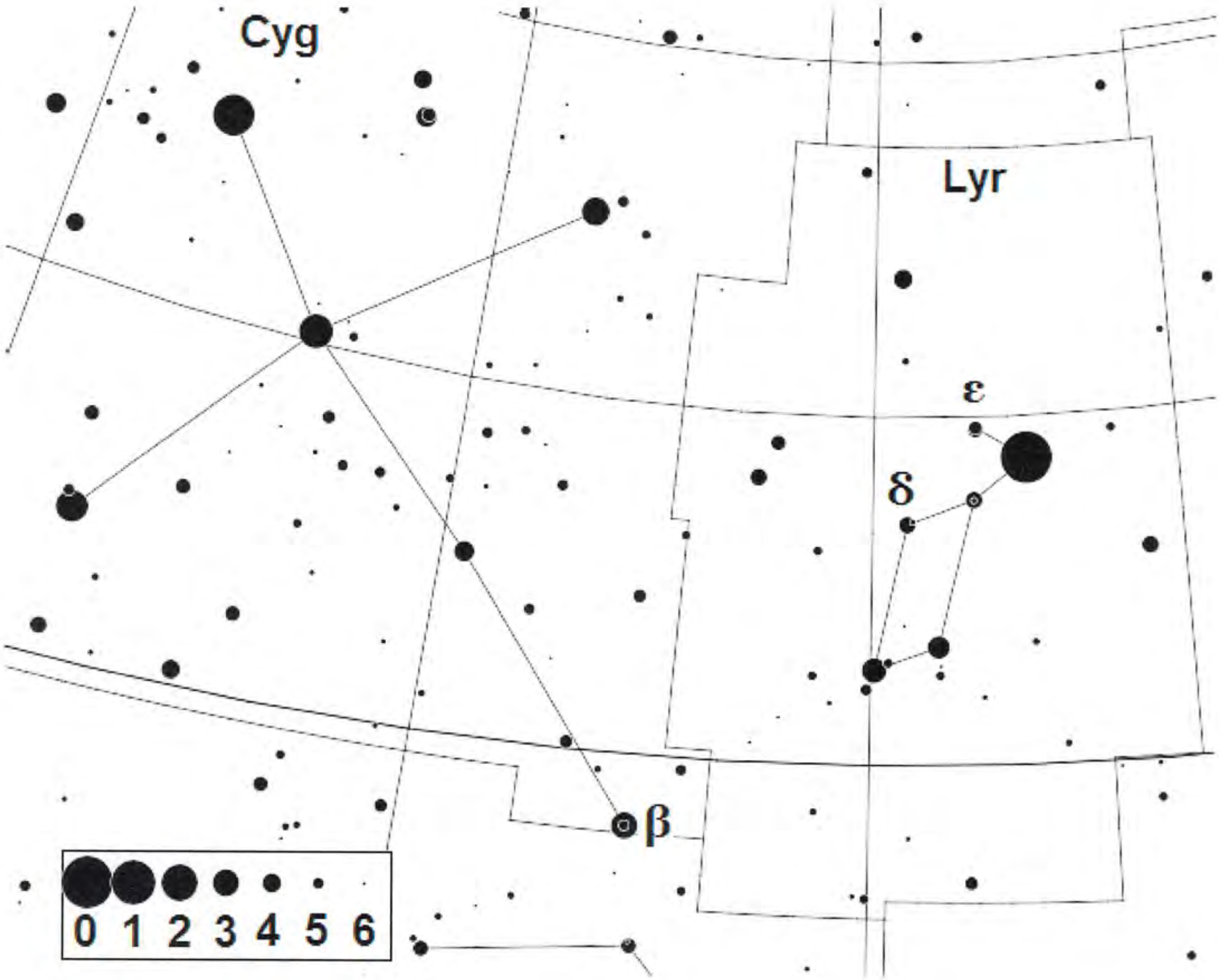
Round **Obs**

Group **α** **β**

XVIII Международная астрономическая олимпиада
XVIII International Astronomy Olympiad

Code of participant	код участника

Наблюдательный тур. Чистое небо
Observational round. Clean sky



Code of participant	код участника

Вопросы наблюдательного тура. Чистое небо
Observational round. Clean sky