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.**

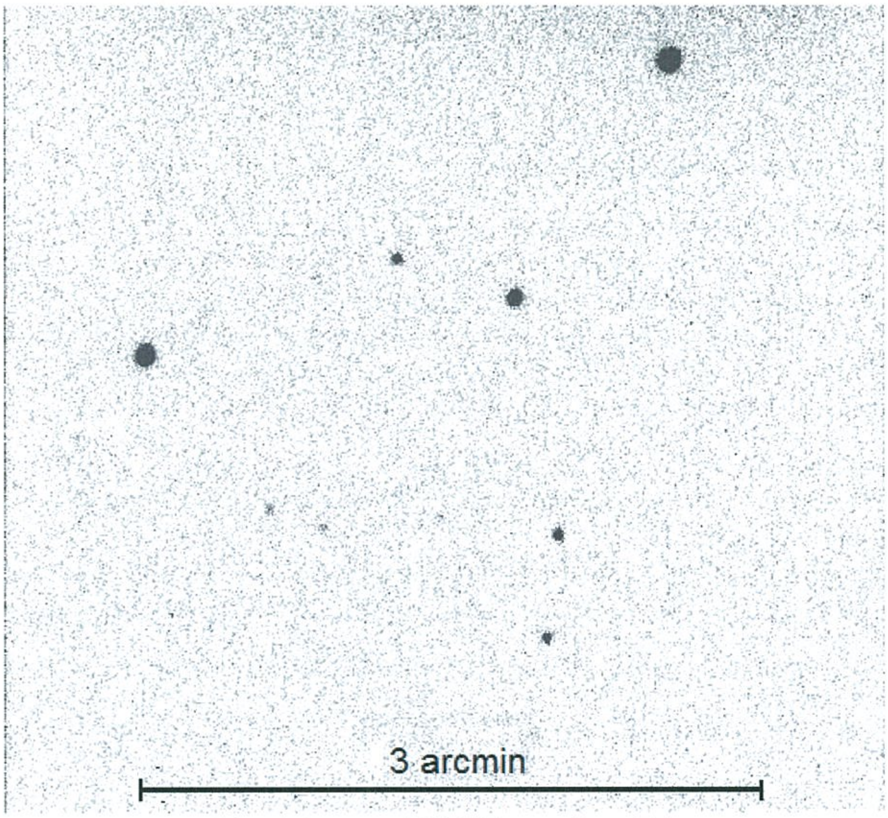


Fig. 7.1. *4:53 UT* *Рис. 7.1.*

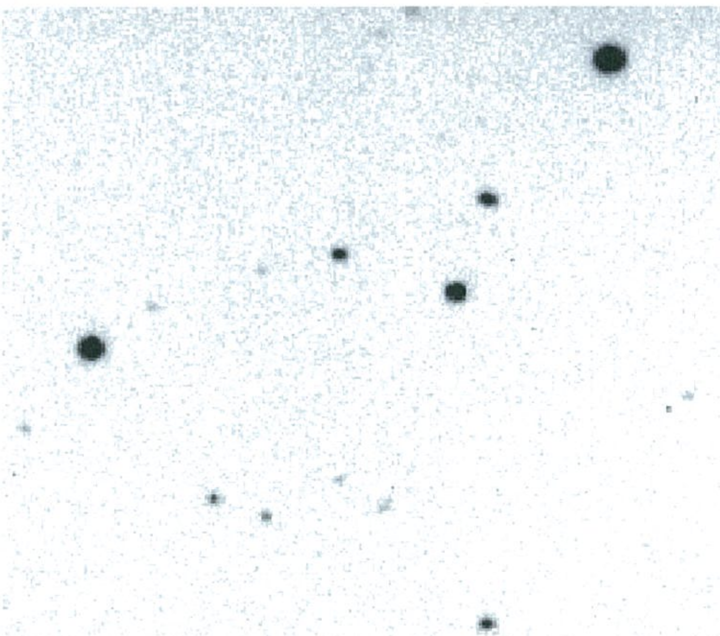


Fig. 7.2. *7:16 UT* *Рис. 7.2.*

7. Asteroid. **7. Астероид.**

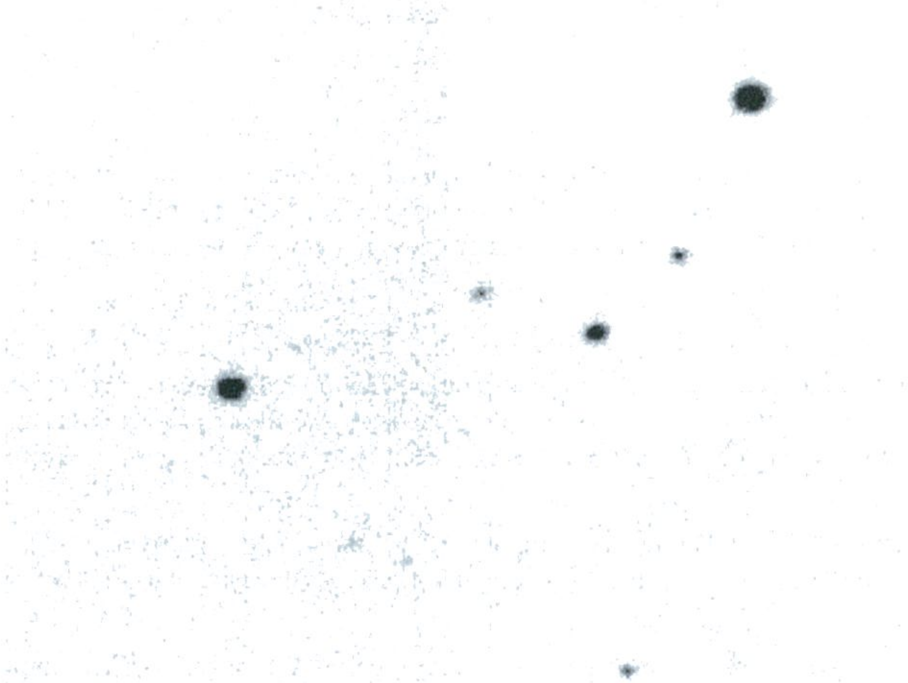


Fig. 7.3. *Observatory 2* *Рис. 7.3.*

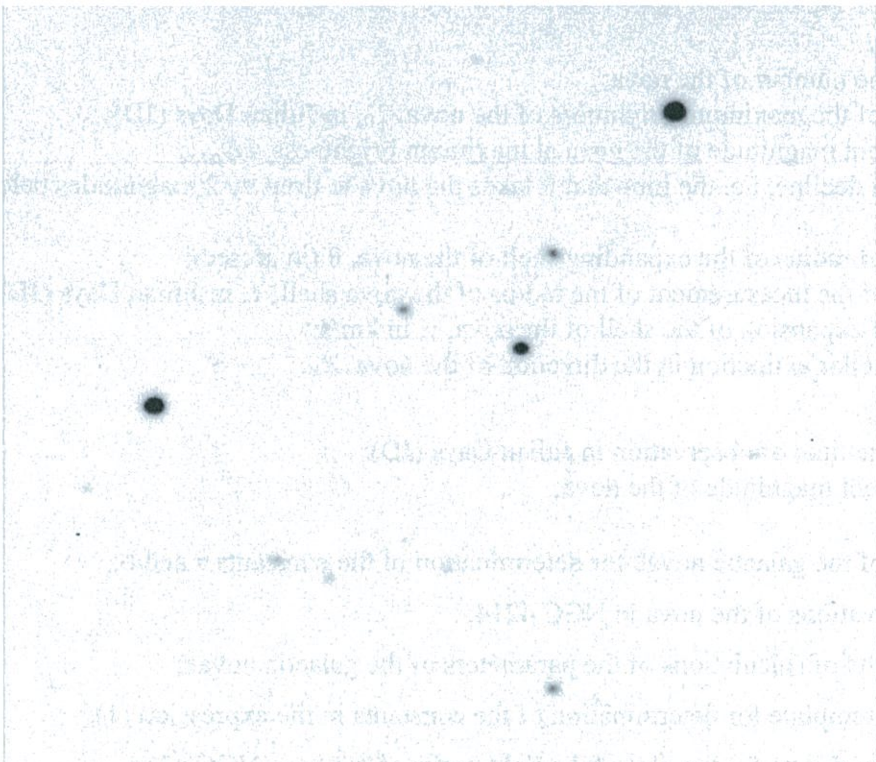


Fig. 7.3. *Observatory 1* *Рис. 7.3.*

Practical round. Problems to solve

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 (**ϕ**) 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.

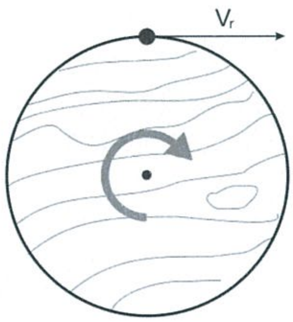
C. Mass and density

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 ($\mathbf{M_J}$**_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

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

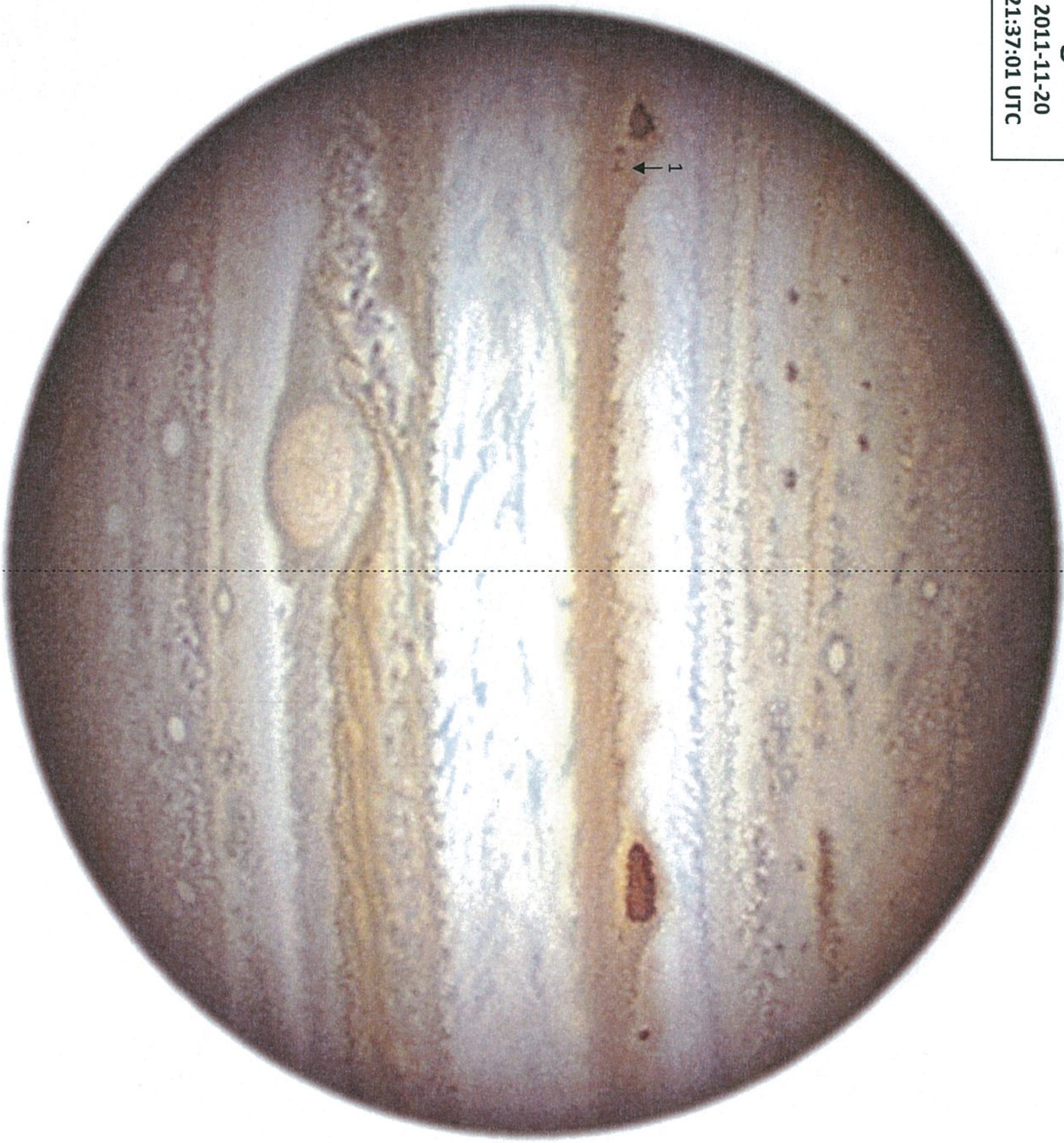

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Fig. 3
2011-11-20
23:28:36 UTC

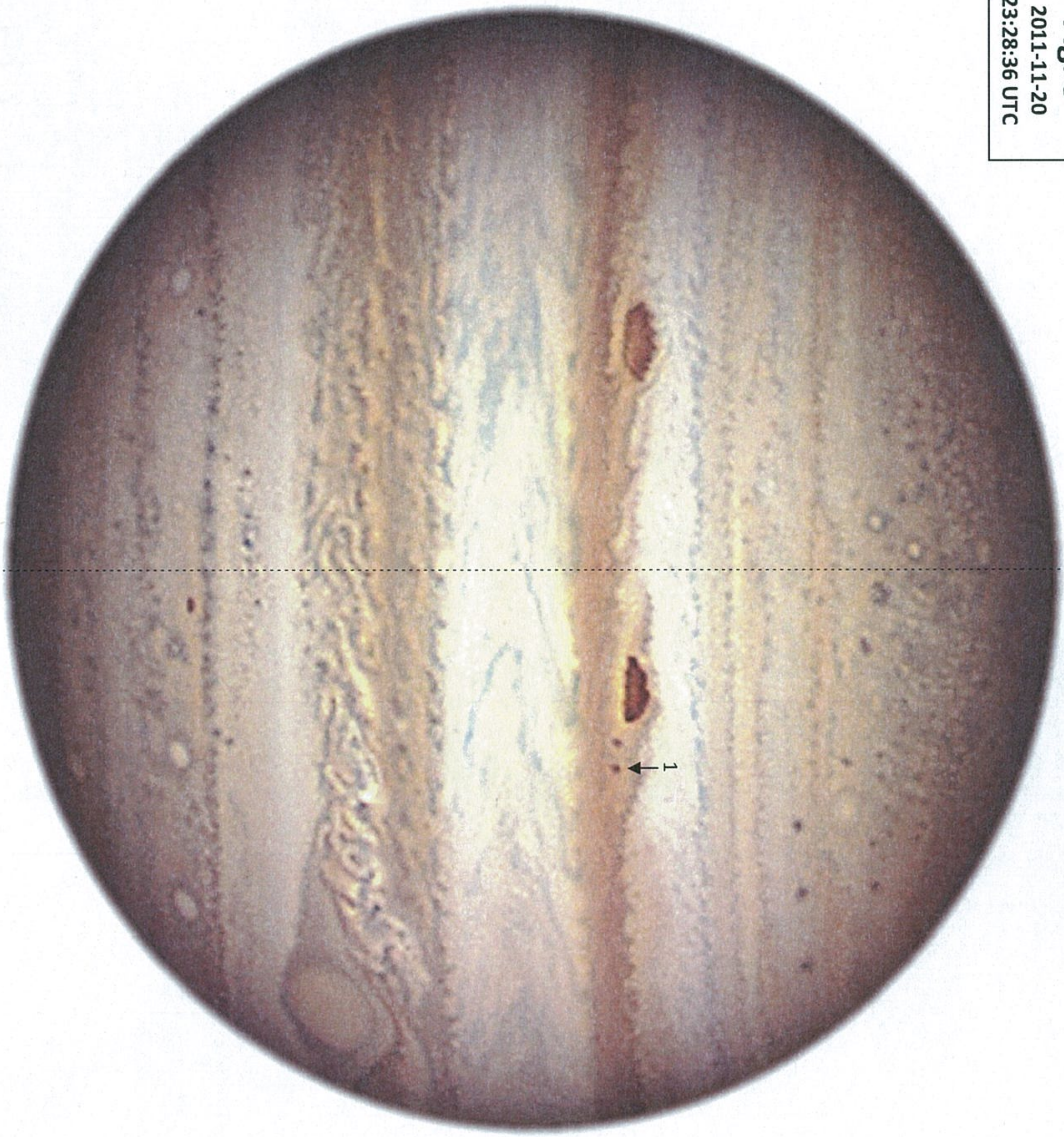


Fig. 4. Moon-1

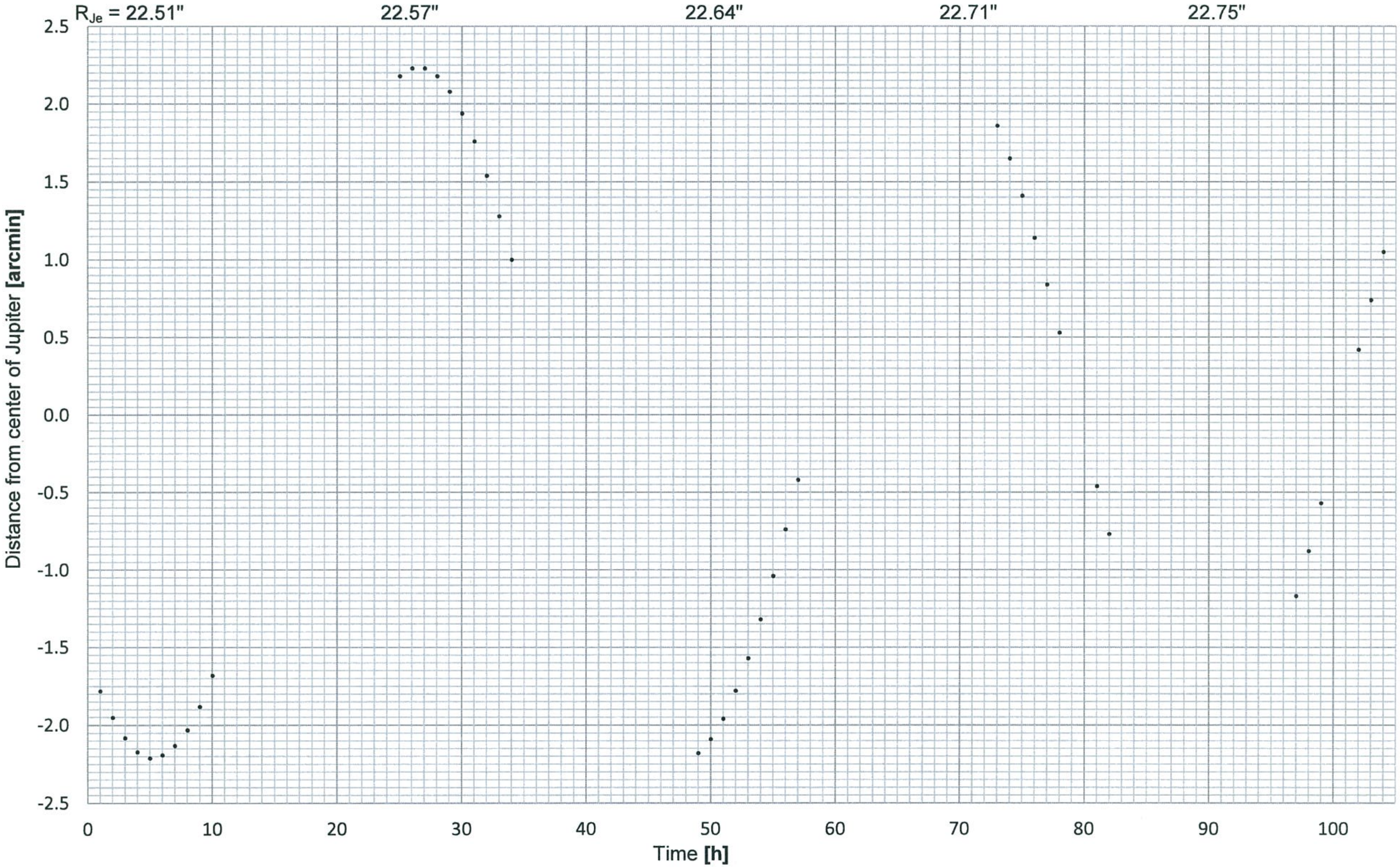
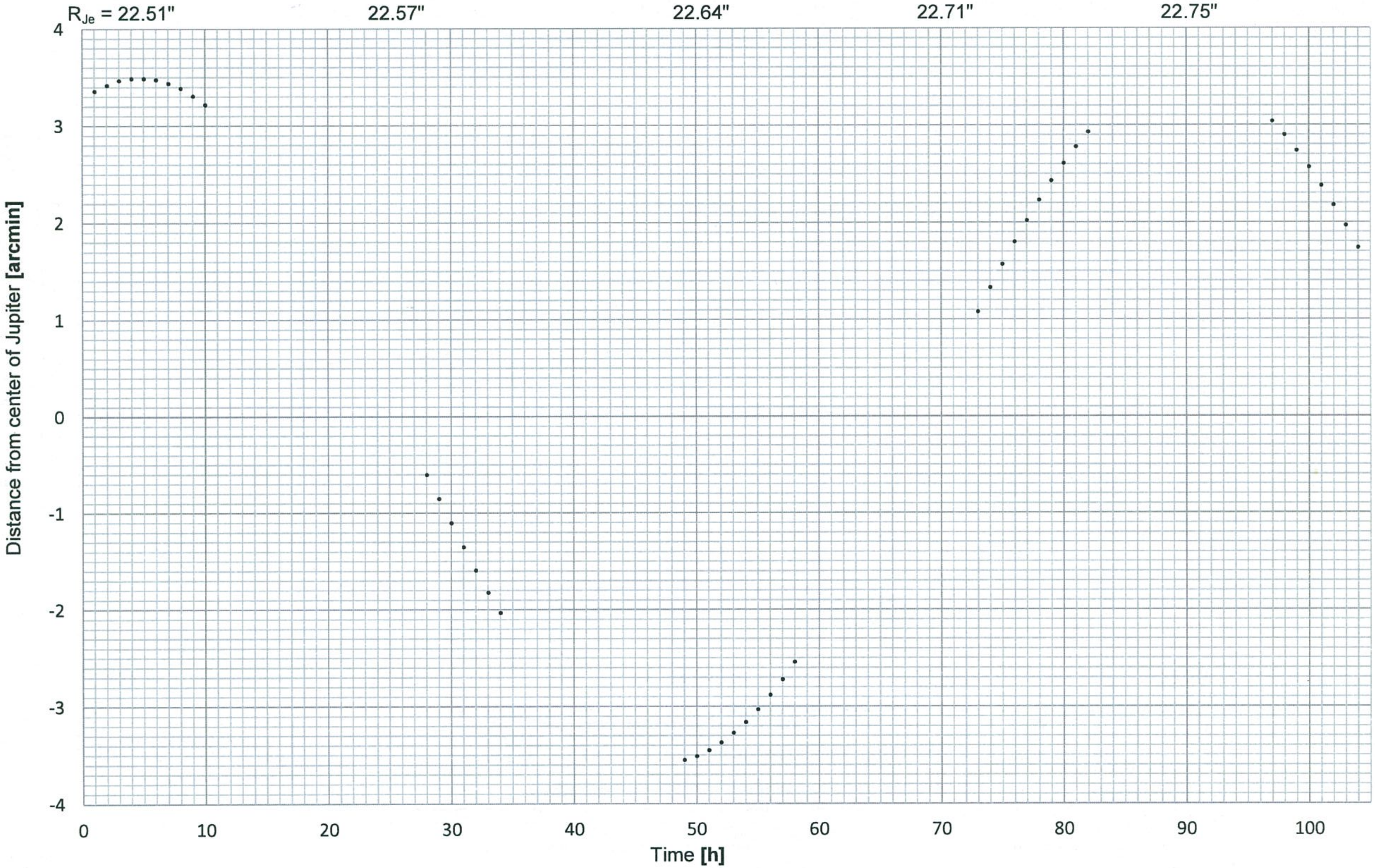

R_Je = 22.51"
22.57"
22.64"
22.71"
22.75"
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
Distance from center of Jupiter [arcmin]
0
10
20
30
40
50
60
70
80
90
100
Time [h]

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]

АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО | EURO-ASIAN ASTRONOMICAL SOCIETY

XVIII Международная астрономическая олимпиада

XVIII International Astronomy Olympiad

Литва, Вильнюс 6 – 14. IX. 2013 Vilnius, Lithuania

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Fig. 6. Moon-3