АСТРОНОМИЧЕСКОЕ
ОБЩЕСТВО

EURO–ASIAN
ASTRONOMICAL SOCIETY

Round **Prac**

Group **α**

ЯЗЫК
language   *English*

XIX **Международная астрономическая олимпиада**
XIX **International Astronomy Olympiad**

Бишкек – Чолпон-Ата   12–21. X. 2014   Bishkek – Cholpon-Ata

Practical round. Problems to solve

7. Jupiter. In 2009, a nucleus of unknown comet or an asteroid crashed into Jupiter's atmosphere. A powerful explosion formed a dark cloud, which gradually stretched parallel to equator due to zonal flow in the atmosphere. Hubble Space Telescope was able to take a few pictures of Jupiter during this period.

Determine the rate at which the dark cloud on the surface of Jupiter increased its length after the impact with the comet or asteroid by measuring the length of image fragments on the set of the 3 top images displayed on the right.

The photos were taken in the same position of the cloud relative to the central meridian. The scale is determined from the image of Jupiter and position of the fragment marked on it. The equatorial diameter of Jupiter is 143842 km.

8. Comet. In the middle of July 2014, an automatic interplanetary spacecraft Rosetta of European Space Agency made the discovery that the comet 67P/Churyumov–Gerasimenko had a bipartite nucleus. On September 5th Rosetta was able to determine that its albedo was about 0.04 and the maximum nucleus length, 4 km.

On a separate sheet are the pictures demonstrating rotation of the comet nucleus, taken with 40 minutes intervals. Each picture has the date when it was taken and the angle of nucleus rotation relative to the first picture indicated on it. Using these images, determine the rotation period of the comet and plot its light curve based on them. Assume the same albedo over the entire surface of the comet.

According to NASA, the estimated distances at that time were as following:

Rosetta to Sun 557 794 935 km,
Rosetta to Earth 407 252 536 km,
Rosetta to the comet 12 294 km.
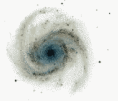
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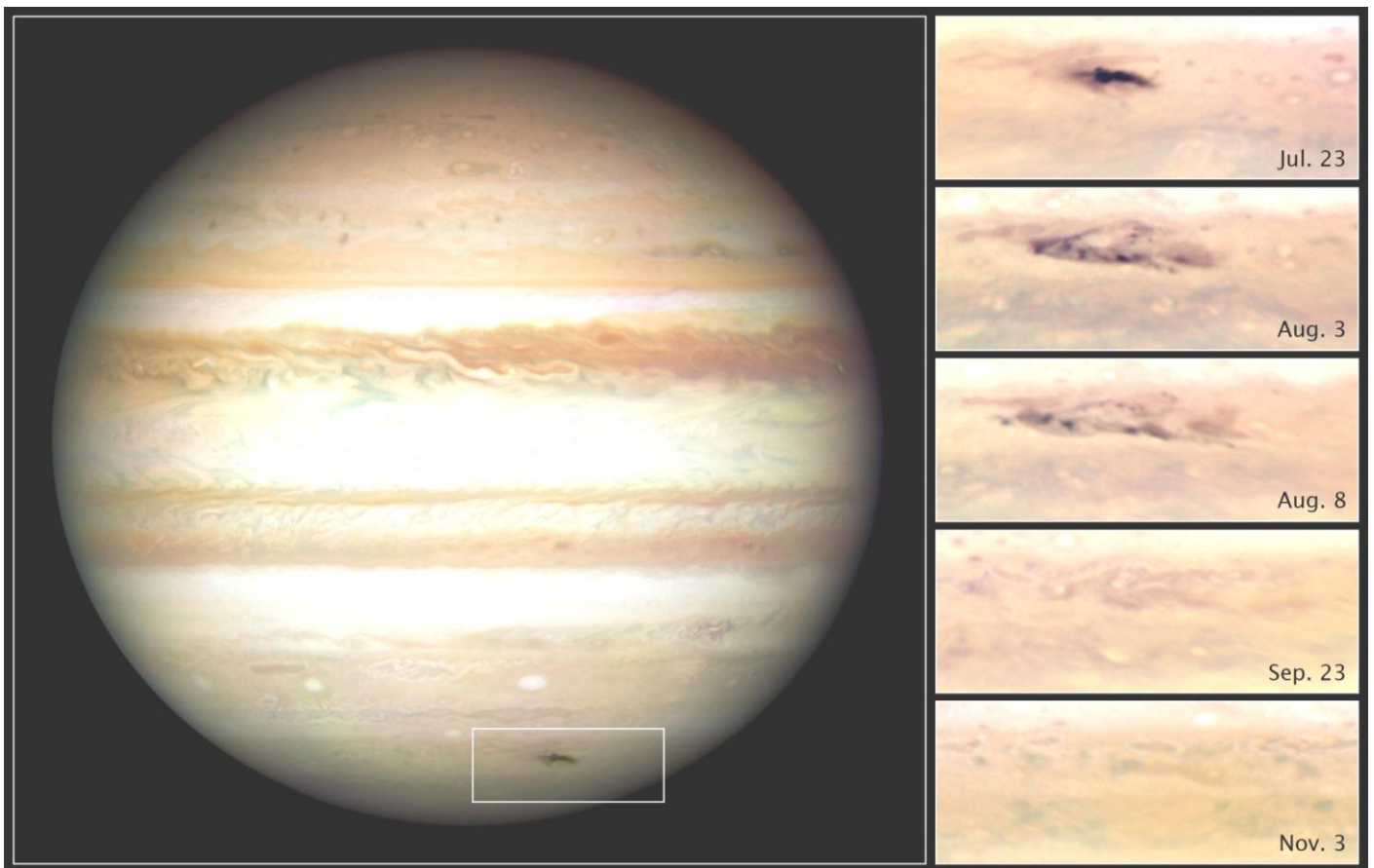
Бишкек – Чолпон-Ата   12–21. X. 2014   Bishkek – Cholpon-Ata

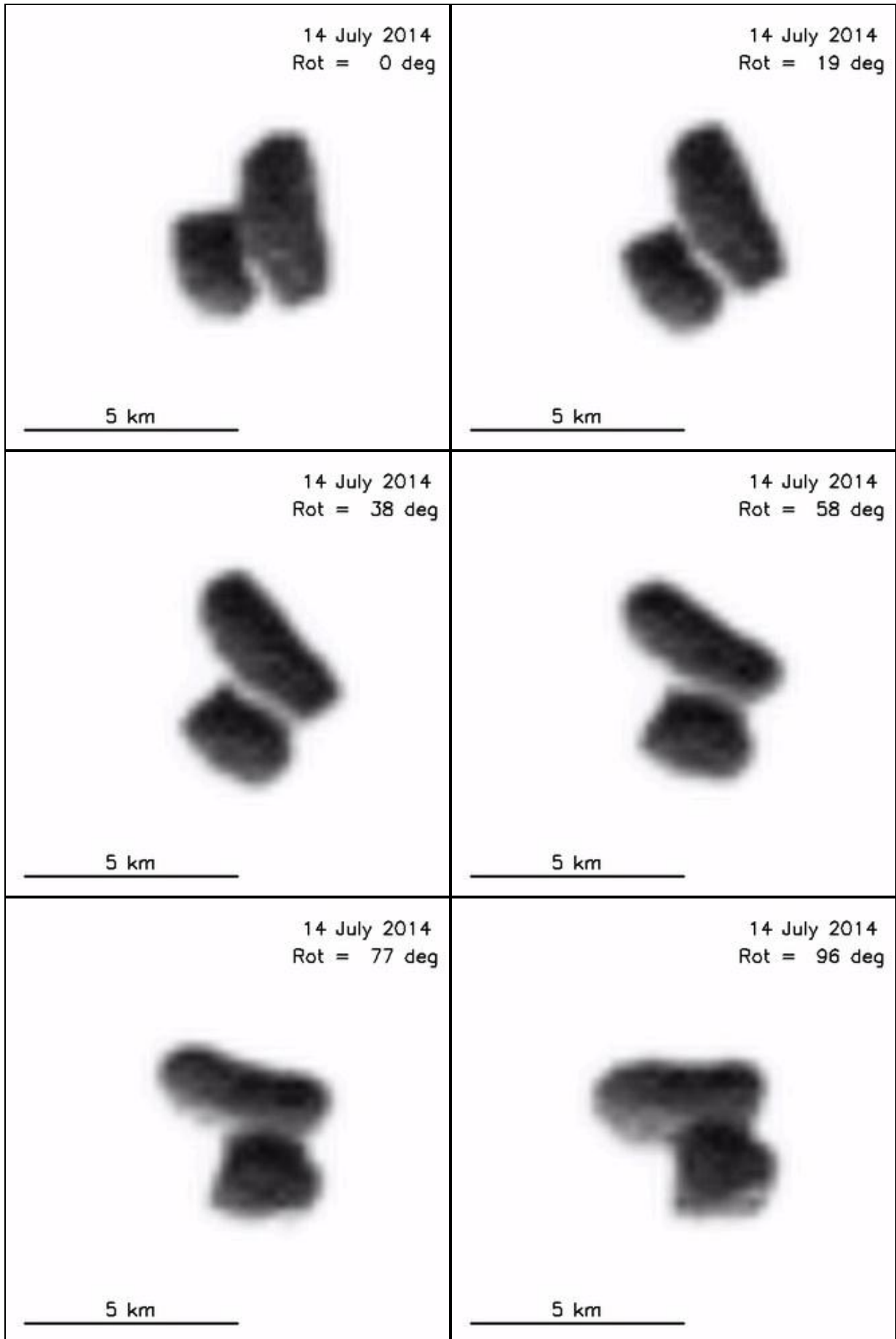# 7. Юпитер.

7. Jupiter.

8. Комета. **8. Comet.**

14 July 2014
Rot = 0 deg
5 km

14 July 2014
Rot = 19 deg
5 km

14 July 2014
Rot = 38 deg
5 km

14 July 2014
Rot = 58 deg
5 km

14 July 2014
Rot = 77 deg
5 km

14 July 2014
Rot = 96 deg
5 km

8. Комета. 8. Comet.

14 July 2014
Rot = 116 deg

5 km

14 July 2014
Rot = 135 deg

5 km

14 July 2014
Rot = 154 deg

5 km

14 July 2014
Rot = 174 deg

5 km

14 July 2014
Rot = 193 deg

5 km

14 July 2014
Rot = 213 deg

5 km

8. Комета.   8. Comet.   3

14 July 2014
Rot = 232 deg

5 km

14 July 2014
Rot = 251 deg

5 km

14 July 2014
Rot = 270 deg

5 km

14 July 2014
Rot = 290 deg

5 km

14 July 2014
Rot = 309 deg

5 km

14 July 2014
Rot = 328 deg

5 km

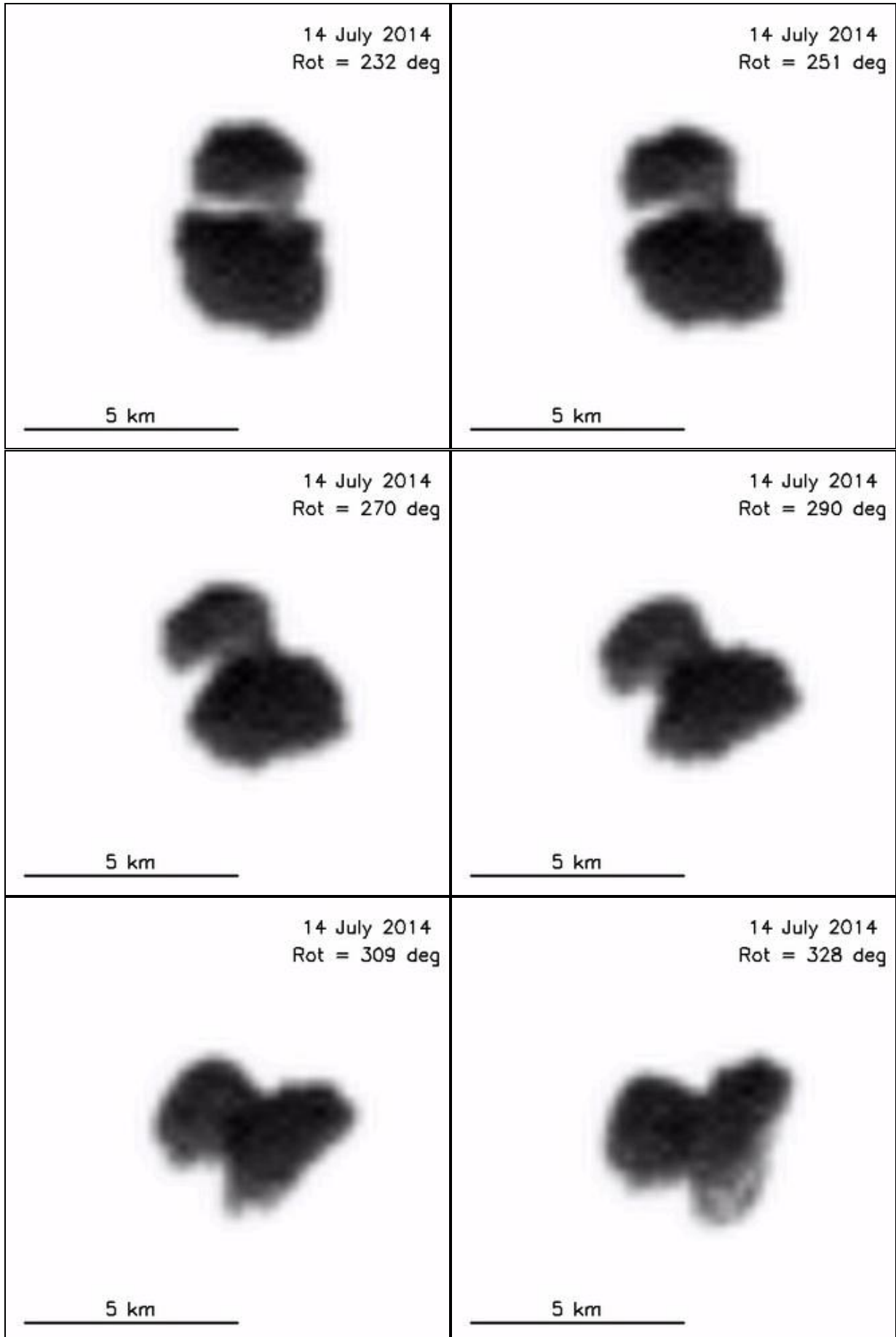| АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО | EURO–ASIAN ASTRONOMICAL SOCIETY | Round **Prac** |
| | | Group β |

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8. **A new variable star.** During late winter – early spring, 2014, a recently discovered variable star GSC 4560-02157, in the constellation of Ursa Minor, was observed at the Tien Shan Observatory of the Kazakhstan Astrophysical Institute, located in the mountains to the south of Almaty city, approximately in 60 km to the north of Cholpon-Ata (Kyrgyzstan). The star features complex physical variability along with regular eclipses. During the night of February 28 – March 1, the star was observed non-stop for almost 9 hours. The table (right) presents the most important data points derived from these observations. The time in the table is the mean solar time for the Almaty time zone.

At times of the primary minimum, the star's properties correspond to the K0 spectral type.

Plot the light curve. At the time axis, mark times of minimal brightness in the primary minima and in the secondary minimum. Knowing that the Julian date 2456949.000 begins at today's (October 18) Greenwich noon, label the times of minimal brightness with their Julian dates, with three digits after the decimal point.

One of simplified models describing the event assumes that the process involves two stars only. From your analysis of the light curve in the frame of such a model, determine the spectral types (for example, that of the Sun is G2) of the larger (1) and smaller (2) components as well as the ratio of the radii of the larger (R_1) and smaller (R_2) components. Illustrate the solution with necessary figures.

Almaty and Cholpon-Ata are in the same time zone.

T	m
22 h 00 m (February 28)	14.92
22 h 12 m	15.08
22 h 24 m	15.41
22 h 36 m	15.44
22 h 48 m	15.37
23 h 00 m	15.12
23 h 12 m	14.92
23 h 30 m	14.89
00 h 00 m (March 1)	14.80
00 h 18 m	14.78
00 h 42 m	14.80
01 h 00 m	14.82
01 h 24 m	14.85
01 h 48 m	14.96
02 h 12 m	14.72
02 h 30 m	14.72
03 h 12 m	14.63
03 h 36 m	14.65
04 h 15 m	14.77
04 h 25 m	14.84
04 h 36 m	15.10
05 h 00 m	15.43
05 h 12 m	15.32
05 h 24 m	15.05
05 h 36 m	14.90
05 h 48 m	14.75
06 h 12 m	14.73
06 h 48 m	14.70
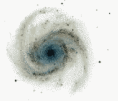
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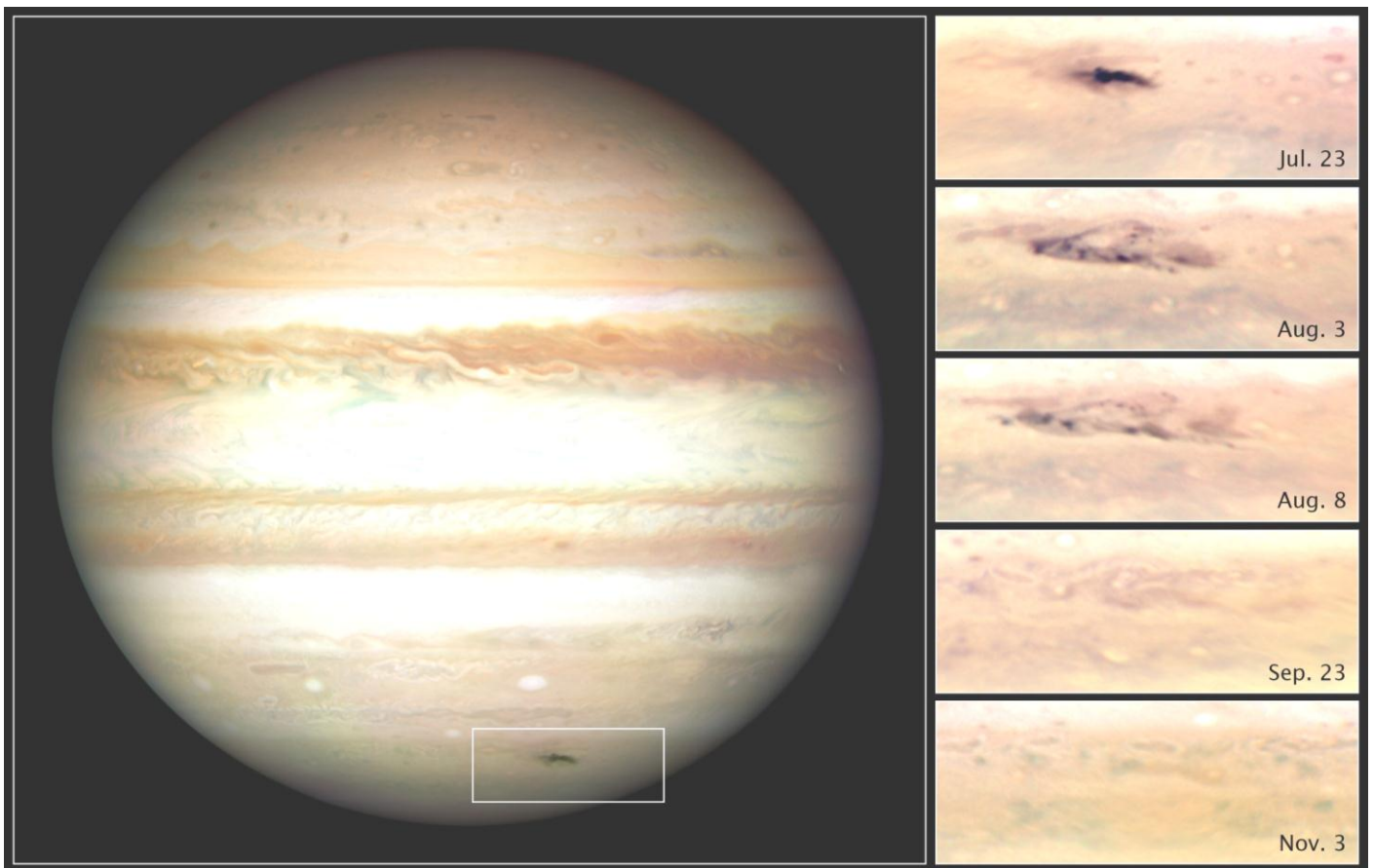XIX **International Astronomy Olympiad**

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7. Юпитер.

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Диаграмма Герцшпрунга-Рассела

Hertzsprung-Russell diagram

ТЕМПЕРАТУРА ЗВЕЗДЫ, К

STELLAR TEMPERATURE, K

60000   30000   10000   7500   6000   5200   3700   2000

SUPERGIANTS – Ia

Wezen

Naos

Saiph Rigel Deneb

Aludra

Betelgeuse

SUPERGIANTS – Ib

Mimosa Adhara Canopus Polaris

Enif Suhail Antares

Mirfak

Spica

Almach Gacrux

Achernar

BRIGHT GIANTS – II

Pollux

Regulus Algol

Dubhe Aldebaran Mira

Capella Kocab

Vega

Arcturus

GIANTS – III

Castor

Sirius A

SUBGIANTS – IV

Fomalhaut

Altair Procyon A

MAIN SEQUENCE

Rigil Kent

Sun

α Centauri B

ε Eridani

61 Cygni A

61 Cygni B

Kapteyn's star Lalande 21185

Sirius B

WHITE DWARFS

Barnard's star

Procyon B Ross 128

Van Maanen's star

Proxima Centauri

ABSOLUTE MAGNITUDE
АБСОЛЮТНАЯ ЗВЕЗДНАЯ ВЕЛИЧИНА

-8
-6
-4
-2
0
2
4
6
8
10
12
14
16

0 5 0 5 0 5 0 5 0 5 0 5 0 5

O   B   A   F   G   K   M

СПЕКТРАЛЬНЫЙ КЛАСС

SPECTRAL CLASS