

**XXII Международная астрономическая олимпиада
XXII International Astronomy Olympiad**

Китай, Вэйхай

27.X. – 04.XI. 2017

Weihai, China

Язык
language **English****Practical round. Problems to solve****6. Transiting extra-solar planet.**

The transit of an extra-solar planet (TrES-3b) across a star (TrES-3) was observed by the 1-m telescope of Weihai Observatory (WHO) on April 16, 2009, using the broad-band V filter and a PI CCD. The photometric data (selected part from the original one) are given in the Table 6 (see separate sheet), the time is in Julian days, and m_V is the V-band magnitude.

- 6.1. Plot the transit light curve (magnitude vs time), determine the moment of mid-transit (the deepest transit) and write result (in Julian days) in form of « $T_{\text{mid}} = \dots$ », estimate the duration of the transit (in days) in form of « $T_d = \dots$ », determine the depth of the transit (in magnitudes) in form of « $D = \dots$ ».
- 6.2. Give the formula and calculate the radius of the extra-solar planet TrES-3b R_p (in units of the radius of Jupiter: R_{Jupiter} , write the answer in form of « $R_p = \dots$ »). The radius of the star (TrES-3) is known to be 0.813 radius of the Sun, $R_s = 0.813 R_{\text{sun}}$.
- 6.3. Estimate the approximate value of the angle i , in unit of degrees ($^\circ$) between the axis of this planet's orbiting and the line of sight of the observer. Write the answer in form of « $i \approx \dots$ ».
- 6.4. The next mid-transit moment after the above transit event was: $JD = 2454939.578$. The mass of the star (TrES-3) is known to be 0.924 mass of the Sun, $M_s = 0.924 M_{\text{sun}}$. Calculate the orbital period of TrES-3b (in units of days, in form of « $P = \dots$ »), and the semi-major axis of the orbit (in units of au, in form of « $a = \dots$ »).

XXII Международная астрономическая олимпиада
XXII International Astronomy Olympiad

Китай, Вэйхай

27.X. – 04.XI. 2017

Weihai, China

Язык	English
language	

Practical round. Problems to solve

7. Extinction in terrestrial atmosphere.

Extinction is a term used in astronomy to describe light attenuation due to its absorption and scattering.

A star ($\alpha = 22^{\text{h}}02^{\text{m}}40^{\text{s}}$, $\delta = +42^{\circ}14'41''$) was observed at different zenith distances on October 26, 2017 (after its upper culmination at 11:34:20 UT), at the Weihai Observatory (WHO) of Shandong University. Astronomers use parameter $F(z)$, air mass, as an extinction characteristic, $F(z) \approx 1/\cos(z)$ if the zenith distance (z) is smaller than 60° . The atmospheric extinction equation can be written as: $m_V = m_0 + K \cdot F(z)$, where m_0 is the magnitude of the star without atmospheric extinction, K is the atmospheric extinction coefficient. Table 7 (see separate sheet) gives the observing times (UT, in units of hour) and the measured magnitudes (m_V) of the star.

- 7.1. Draw the table (similar to that you see below) in your answer book. Calculate zenith distances, z , in unit of degrees ($^{\circ}$), for given observing times in 1st column, and write the result into the 2nd column. Calculate the air mass ($F(z)$) for different zenith distances, and write the result into the 3rd column.

UT_obs (hour)	z ($^{\circ}$)	$F(z)$
12.49484		

- 7.2. Plot the scatter diagram between magnitudes (m_V) vs. air mass ($F(z)$). Draw a straight dashed line on the plot to indicate the linear relation between m_V vs. $F(z)$.
- 7.3. Estimate the atmospheric extinction coefficient (K) and the magnitude of this star without atmospheric extinction (m_0) with help of graphical method, and write results in forms of « $K = \dots$ », « $m_0 = \dots$ ».
- 7.4. Determine the magnitude (m_z) of this star as it was observed in zenith, and write result in form of « $m_z = \dots$ ».

XXII Международная астрономическая олимпиада
XXII International Astronomy Olympiad

Китай, Вэйхай

27.X. - 04.XI. 2017

Weihai, China

язык	<u>Русский</u>
language	
язык	<u>English</u>
language	

Таблица к задаче 6.

Table for problem 6.

time (JD)	m_V
2454938.220	12.4080
2454938.231	12.4094
2454938.239	12.4074
2454938.244	12.4074
2454938.248	12.4144
2454938.251	12.4217
2454938.257	12.4261
2454938.261	12.4292
2454938.267	12.4353
2454938.274	12.4365
2454938.279	12.4333
2454938.283	12.4267
2454938.287	12.4254
2454938.294	12.4172
2454938.297	12.4146
2454938.304	12.4102
2454938.314	12.4075
2454938.324	12.4086

Элементы орбит и физические характеристики Солнца, Земли, Луны и Юпитера

Parameters of orbits and physical characteristics of Sun, Earth, Moon and Jupiter

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 tropical 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		$-26,8^m$	
Земля Earth	1,000	149,6	1,000	365,256	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
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

**) В среднем противостоянии. **) In mean opposition.

XXII Международная астрономическая олимпиада
XXII International Astronomy Olympiad

Китай, Вэйхай

27.X. – 04.XI. 2017

Weihai, China

язык language	<u>Русский</u>
язык language	<u>English</u>

Таблица к задаче 7.

Table for problem 7.

UT _{obs} (hour)	m _v
12.49484	16.9040
12.76648	16.9195
13.30982	16.9135
13.58151	16.8938
13.85316	16.9306
14.12483	16.9460
14.39651	16.9420
14.66817	16.9520
14.93982	16.9528
15.21151	17.0046
15.48372	17.0630
16.02750	17.1581

Координаты Coordinates	Обсерватория Вэйхай WHO Observatory	Набл. станция Синлун Xinglong Observatory
φ (N / с.ш.)	37° 32'	40° 24'
λ (E / в.д.)	122° 03'	117° 35'
Часовой пояс Timezone	UT+08	UT+08