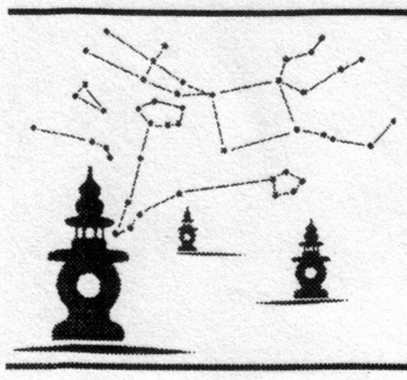

XIV Международная астрономическая олимпиада
XIV International Astronomy Olympiad

Китай, Ханчжоу 8 – 16. XI. 2009 Hangzhou, China

язык / language	***English***

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 have 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 table of planetary data may be used for solving every problem.

The answers «Да-Yes» or «Нет-No» has to be written in English or Russian.

1. **Sirius.** It is known that the so called "Dog Star" (Sirius) is the brightest star in the Chinese sky. And in what else districts on the Earth Sirius is also the brightest star in the real sky of this district? What are numerical characteristics of the borders of these districts? Note: you should take into account only stars in their historical-classical meaning, i.e. Sun, planets, etc. should not be taken into account.

2. **Number of molecules.** Estimate the number of molecules in the Earth's atmosphere.

3. **Efficiency of eye.** Estimate the theoretical limit of the maximum magnitude of stars that the human eye can see under very optimal conditions. Take into account that the eye's retina "remembers" the image about 1/7 of a second. A 0^m star sends us about 10^{10} photons/m^2 every second.

4. **Catastrophe.** Imagine, that on July 5, 2084 the mass of the Sun suddenly has decreased to half its original value. Calculate a new period of revolution of the Earth around of the new Sun.

5. **Mirror for a telescope.** You have a disc of glass with thickness b = 40 mm, from which one has to make (by grinding) a spherical mirror with a diameter of D = 500 mm. What could the focal distances F be of a mirror made from this disc?

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2. **Number of molecules.** Estimate the number of molecules in the Earth's atmosphere.

3. **Eris.** The largest discovered now in our Solar system Transneptune body is the dwarf planet Eris (Эрида). Now Eris is near its aphelion point. Find the apparent stellar magnitude of Eris as visible from Earth. Approximately when will the next "Great opposition" of Eris be? What will the magnitude of Eris be as visible from Earth at this "Great opposition"?

4. **Catastrophe.** Imagine, that on July 5, 2084 the mass of the Sun suddenly has decreased to half its original value. Calculate a new period of revolution of the Earth around of the new Sun.

5. **Galaxy pair.** This famous galaxy pair contains two interacting galaxies, IC563 and IC564. The coordinates of the centers of IC563 and IC564 are respectively RA 146.58479, DEC 3.04558 and RA 146.58783, DEC 3.07137. Using the 2.16m telescope of The National Astronomical Observatories of China (NAOC), their R-band image in 2009 has been obtained, which is presented at the fig.1. The spectrum of the center of IC563 is shown at the fig.2.

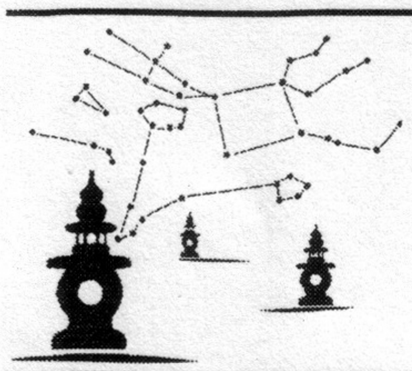
   5.1. We were assigned two periods of time in 2009 to carry out our observation. One was in April and another was in September. Please find out, when IC563, IC564 has been observed? (Write "**Apr**" or "**Sep**" in English.)

   5.2. Mark IC563 and IC564 at the fig.1.

   5.3. Find out the redshift of the galaxies. Consider the redshift of one of them can be realized as the redshift for the other.

   5.4. NAOC astronomers want to take Hα photo of IC563 and IC564 next year to seek the star formation regions in or around them. There is a series narrow band Hα transmission filters in NAOC, as listed in table (the center wavelength is given in the terms of velocity). Select the most suitable filter for the observation.

   5.5. How many parsecs away are the galaxies? What is the projected distance between the two galaxies?



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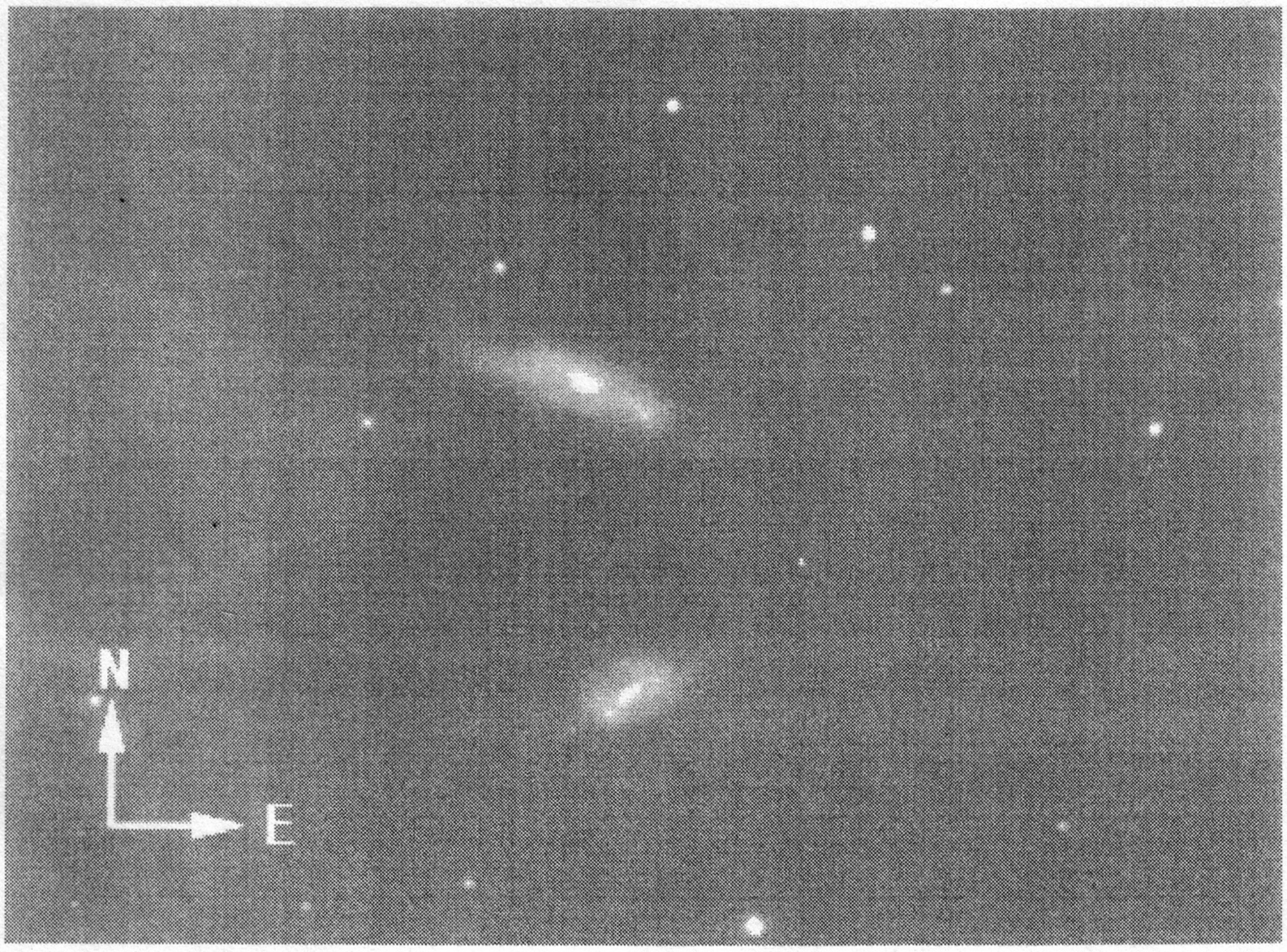
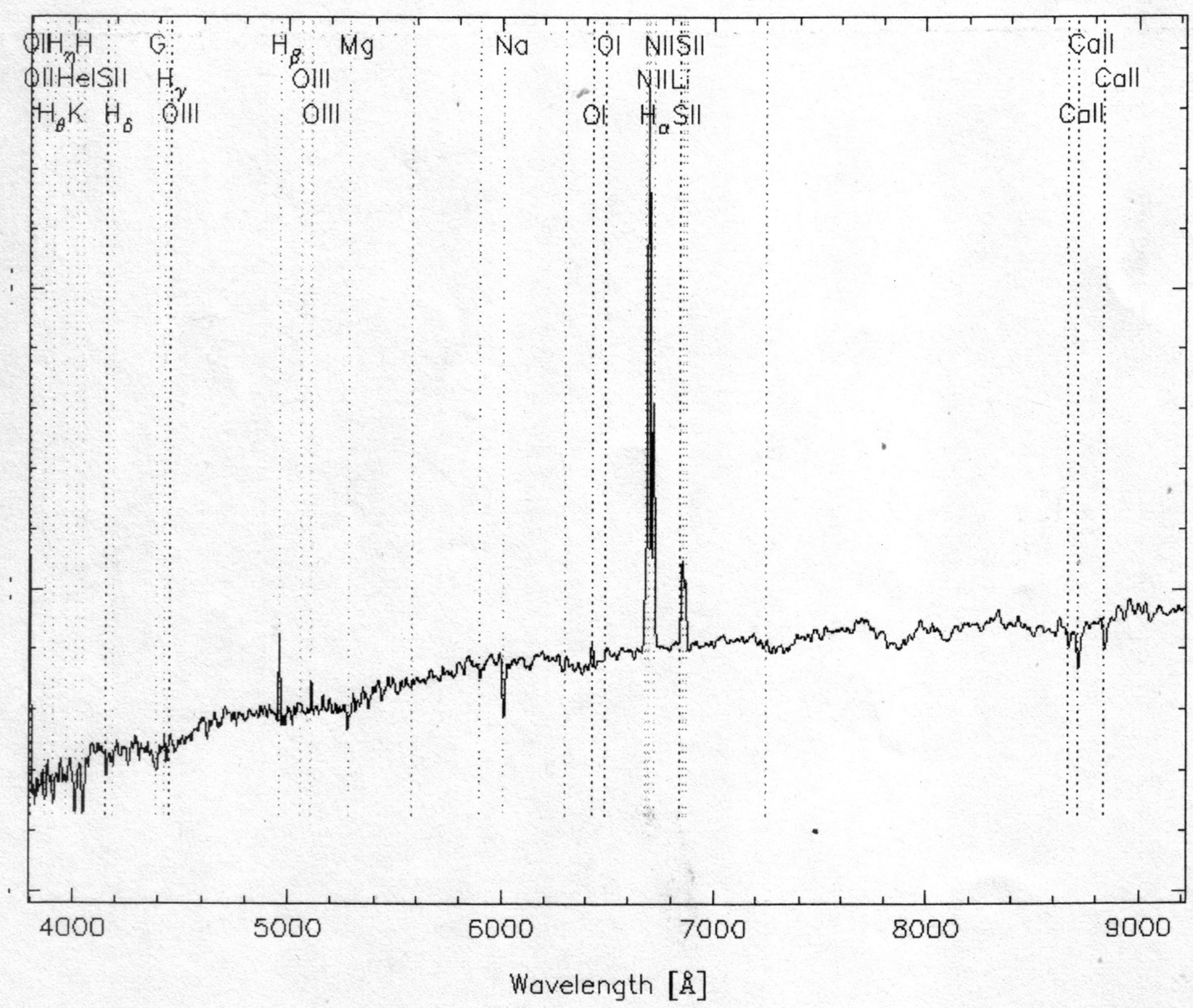
Задача 5. Рисунки. Таблица

Problem 5. Figures. Table





№		
№ фильтра	максимум пропускания (%)	пик по красному смещению для Hα (км/с)
№ of filter	maximum transmission (%)	peak value of redshift for Hα (km/s)
C1	80	0
C2	78	2150
C3	89	3600
C4	78	6720
C5	82	9006
C6	81	11290
C7	87	13570
C8	78	15400
C9	84	18600
C10	84	20890

Элементы орбит.
Физические характеристики некоторых планет, Луны, Солнца и Эриды

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

Небесное тело, планета	Среднее расстояние от центрального тела		Сидерический (или аналогичный) 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	$1{,}6\cdot10^9$	$2{,}5\cdot10^{11}$	$2{,}2\cdot10^8$	$8\cdot10^{10}$		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		0,06
Венера Venus	0,723	108,2	0,615	224,70	0,007	12 104	4,8690	5,24	8,87		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
Эрида Eris	68,01			204 862	0,434	2 600	0,0167		0,8		0,86

**) Для Луны – в среднем противостоянии.
**) For Moon – in mean opposition.

АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО

EURO-ASIAN ASTRONOMICAL SOCIETY

Round **Theo**

Group **α** **β**

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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)	
Постоянная Хаббла, H_0 (км/с/МПк)	среднее значение диапазон значений	70 50-100	mean value diapason of values	Hubble constant, 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/K)		8.314	Universal gas constant, R (J/mol/K)	
Постоянная Больцмана, k (Дж/K)		$1.381·10^{-23}$	Boltzmann constant, k (J/K)	
Стандартная атмосфера (Па)		101325	Standard atmosphere (Pa)	
Постоянная Стефана-Больцмана, σ ($Вт/м^2/K^4$)		$5.670·10^{-8}$	Stefan-Boltzmann constant, σ ($W/m^2/K^4$)	
Константа смещения Вина, b (м·K)		0.002897	Wien's displacement constant, b (m·K)	
Лабораторная длина волны Hα (Å)		6563	Laboratory wavelength of Hα (Å)	
Показатель преломления воды при 20°C, n		1.334	Refractive index of water for 20°C, n	
Площадь сферы		$S = 4\pi R^2$	Area of sphere	
π		3.14159265	π	

Данные о некоторых звёздах

Data of some stars

			RA	DEC	m	SC
Арктур	Arcturus	α Boo	$14^h\ 15^m\ 40^s$	19° 10' 57"	-0.05	K1
Вега	Vega	α Lyr	$18^h\ 36^m\ 56^s$	38° 47' 01"	0.03	A0
Денеб	Deneb	α Cyg	$20^h\ 41^m\ 26^s$	45° 16' 49"	1.25	A2
Полярная	Polaris	α UMi	$02^h\ 31^m\ 51^s$	89° 15' 51"	2.02	F7
Сириус	Sirius	α CMa	$06^h\ 45^m\ 09^s$	-16° 42' 58"	-1.46	A1