BITS Pilani Dubai Campus

PHY F215 Introduction to Astronomy and Astrophysics

Compre examination, Maximum marks: 80 marks

Date: 07.06.2024 Time: 180 minutes

1. (i) Describe the basic composition of ISM.
   (ii) What is interstellar reddening? What does it tell us about the composition of interstellar matter?
   (iii) Discuss the evolution of an interstellar cloud into a pre-main sequence star.
   (iv) A collapsing cloud is made of neutral hydrogen (H I) only. If the temperature of the cloud is 100 K and its number density is 10^{10} m^{-3}, calculate its Jeans mass. ($m = 1mH (= 1.67 \times 10^{-27}$ kg), $\mu = 1$ for pure hydrogen, $k_B = 1.380649 \times 10^{-23}$ J/K, $G = 6.6743 \times 10^{-11}$ m^3 kg^{-1} s^{-2})
   (v) Write a short note on Hyashi line.

   [4 + 2 + 4+ 2 +3 =15 marks]

2. (i) What are Sunspots? Write a short note on sunspot cycle.
   How can sunspots help to determine the period of rotation of the Sun?
   (ii) What was the solar neutrino problem and how was it solved?
   (iii) Write a short note on p-p chain.
   (iv) Calculate the efficiency (in ergs/gram) of hydrogen fusion in p-p chain. (Mass of $H^1 = 1.66\times10^{-24}$ grams, mass of $He^4 = 6.6466 \times 10^{-24}$ grams) [4+3+4+4 = 15 marks]

3. (i) How does a main sequence star evolve if the mass of the star is ~ 1 MΘ?
   (ii) Why do fusion reactions stop at iron?
   (iii) Write a short note on Supernovae explosions.
   (iv) Suppose that a supernova explosion takes place at the distance of Proxima Centauri (~ 3 pc). If its luminosity equals the luminosity of our galaxy (~10^{12} LΘ), show that it would appear about as bright as the Sun. Take the absolute magnitude of the Sun as 5 and its apparent magnitude as − 27.

   [3 + 2 + 3 + 2 =10 marks]

4. (i) Explain the concept of degeneracy pressure of fermions and its role in compact stars.
   (ii) Write a short note on white dwarves and Chandrashekhar Limit.
   (iii) The masses and radii of a typical neutron star (NS), a typical white dwarf (WD) and a typical main sequence star (MS) are given below:

	Mass	Radius
NS	$1M_\Theta$	10 km
WD	$1M_\Theta$	10^4 km
MS	$1M_\Theta$	10^6 km

   Calculate the rotational time periods in all these cases and show that only neutron stars satisfy the pulse time periods observed for pulsars

   [2 + 5 + 3 =10 marks]

5. (i) What is a pulsar? Write a short note on Light-house model of pulsars.
   (ii) Suppose the Sun shrinks to the size of a neutron star of radius 10^6 cm. Calculate the magnetic field strength at the surface of the neutron star. Take the radius of the Sun to be 10^{11} cm and the magnetic field at its surface equal to 1 gauss.

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(iii) What is Schwarzschild radius? The mass of the supermassive black hole at the center of our Milky Way Galaxy, called Sgr A* , is estimated to be about 4.1 million solar masses. Calculate the Schwarzschild radius of Sgr A*. 1 solar mass = 1.98×10^{30} kg.
(iv) While most stars themselves may spin relatively slowly, black holes rotate at nearly the speed of light. Why?

[4 + 2 + 2 + 2 =10 marks]

6. (i) What are the evidences of big bang theory?
(ii) Write a short note on Cosmic Microwave Background Radiation.
(iii) What is Hubble's Law? Find the age of universe using this law.
(iv) Galaxy NGC 123 has a velocity away from us of 1,320 km/s and the Hubble Constant's value is 70 km/s/Mpc. How far away is the galaxy according to Hubble's Law?

[2 + 3 + 3+ 2 =10 marks]

$T_{\odot} = 5800$

7. (i) A bright star in Orion constellation, Betelgeuse, has a surface temperature of 3500K and is 10^5 times more luminous than the Sun. Calculate its radius in terms of RΘ , the radius of the Sun. What kind of star could it be on the basis of the H-R diagram?
(ii) Write a short note on equatorial coordinate system.
(iii) An astronomical object named Cygnus X-1, a strong X-ray source, is found to radiate like a black body with peak wavelength at 1.45 nm. Calculate its temperature. Assume that the constant for Wien's displacement law is equal to 2.9×10^{-3} mK.
(iv) After about 5 billion years the Sun is expected to swell to 200 times its present size. If its temperature becomes half of what it is today, find the change in its absolute magnitude.

[2 + 4+ 2+ 2 =10 marks]