Register Number:
DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27

M.Sc. PHYSICS - IV SEMESTER

SEMESTER EXAMINATION: APRIL 2019

PHDE 0417 - ASTROPHYSICS

Time- 2 1/2 hrs. **Max Marks-70**

This question paper has 3 printed pages and 2 parts

PART A

Answer any FIVE full questions. (**5x10=50)**

1.
   (a) What are the various systems that make up the solar system? How far away is (are) the farthest object(s) from the Sun?
   (b) What type of a nebula is the Orion Nebula? Is it a planetary nebula? If yes, explain what is a planetary nebula; if not, explain how the Orion Nebula is different from a planetary nebula. (**5+5**)
2.
   (a) The all sky map of certain sources are as shown in Fig. 1:

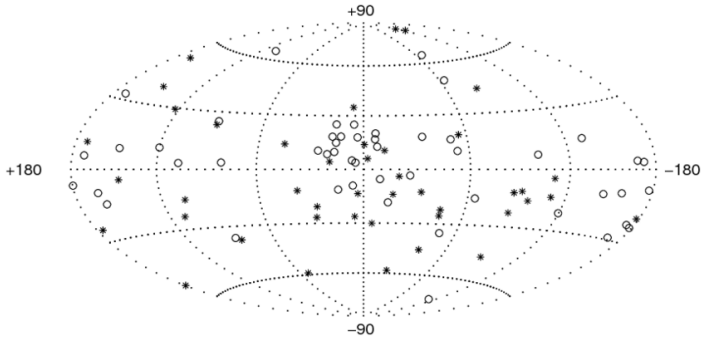

Fig. 1: All sky map of EGRET sources

Based on the figure, what can you say about the location of the sources?

(b) The SDSS archive gives a galaxy spectrum as shown in Fig. 2. The $H-\alpha$ emission line is observed to be located at 7519.69 Å . The lab wavelength of the line is: 6562.817 Å . Estimate the distance to the Galaxy. Assume the value of Hubble constant to be 70 $\text{km s}^{-1}\text{Mpc}^{-1}$. (**5+5**)

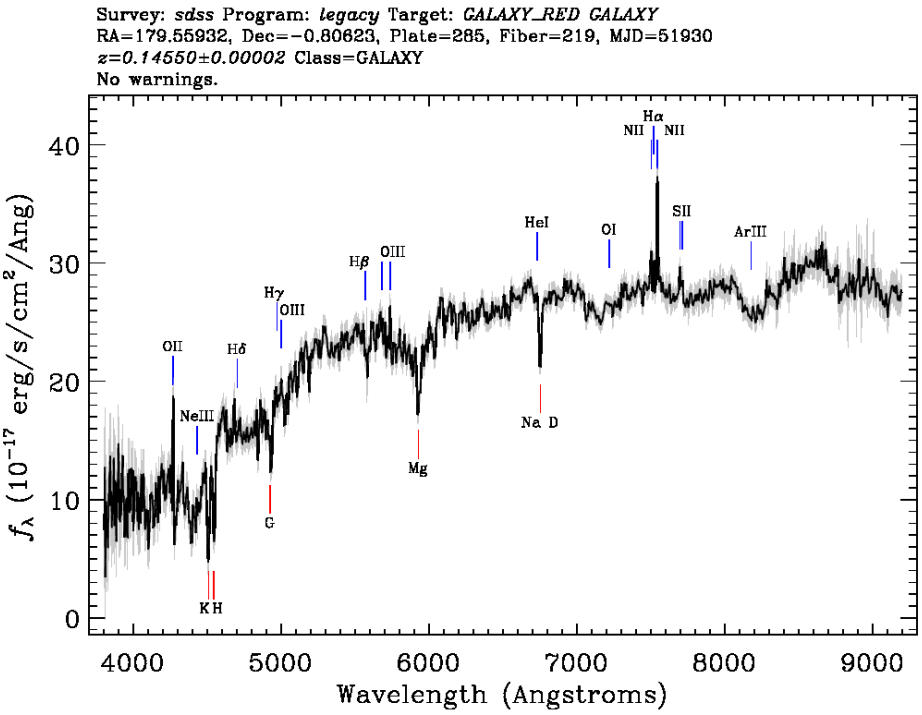

Fig. 2: Galaxy Spectrum

3. Using a sketch, explain expected rotation curves of galaxies assuming a gravitational source at the center and stars spread out in a disk. What was the result obtained by Vera Rubin and her group with regard to these rotation curves? How does the observational rotation curve vary from the expected one? (**4+3+3**)

4. What is the Hubble law? What type of observations helped Hubble arrive at this law? How did Hubble arrive at the distances to the objects he considered? (**2+4+4**)

5. What are afterglows in Gamma Ray Bursts (GRBs)? What is the importance of studying them? (**2+8**)

6. With a neat ray-diagram work out the Field of View of a telescope.

7. In an optically thick medium, the process of radiation propagation is very similar to conduction of electrons in a metal. We can define a mean free path for the photon. Show that for an optically thick medium, the mean optical depth tends to 1 .

PART B

Answer any <u>FOUR</u> full questions. (**<u>4x5=20</u>**)

[Constants: $h=6.6\times10^{-34}$ J s (Planck's constant), $1eV = 1.6\times10^{-19}$ J (electron volt to Joules), $c=2.99\times10^{8}$ m/s (speed of light), $1Å = 1\times10^{-10}$m (Angstrom to meters), $e = 1.6\times10^{-19}$ C (electronic charge), $m_{proton}=1.673\times10^{-27}$kg (mass of proton), $m_{electron}=9.109\times10^{-31}$kg (mass of electron), $G=6.674\times10^{-11}m^3kg^{-1}s^{-2}$ (Gravitational constant), $M_\odot=1.9891\times10^{30}$ kg (Solar mass), $R_\odot=6.9\times10^{8}$ m, $\sigma = 5.67\times10^{-8}$ W m^{-2} K^{-4} (Stefan-Boltzmann constant), $M_{Earth}=5.97\times10^{27}$kg (Mass of Earth), $D_{earth\text{-}sun}=1.49\times10^{11}$m (Earth-Sun distance), 1 inch = 2.54 cm, 1AU = 1.496×10^{11} m, 1 ly= 9.461×10^{15} m, 1 pc= 3.086×10^{16}m]

8. The center of Milkyway is about $8\,\mathrm{kpc}$ from the solar system. What would be the parallax of a star close to the center of Milkyway as seen from Earth?

9. In the paper by Vera Rubin (1972), it was observed that M31 (Andromeda Galaxy) had a rotational velocity of $275\ \mathrm{km\,s^{-1}}$ at about $1\ \mathrm{kpc}$. Assuming Kepler rotation rate at that point, what would the mass of the central object be?

10. Given that the solar constant on Earth is $1.361\,\mathrm{kW\,m^{-2}}$ and the distance of Jupiter from sun is $5.2\,\mathrm{AU}$, what is the solar constant as measured on Jupiter?

11. Microsecond variabilities are seen in GRBs. Assuming the sources of GRBs to be at distances of a few Gpc, what can you say about the size of the region of emission?

12. Shown in Fig. 3 is the view through a telescope. Assume that the object seen is the full moon against the night sky. Compute the Field of View of the telescope. If the exit pupil is measured as $4\ \mathrm{cm}$, what is the focal length of the objective?

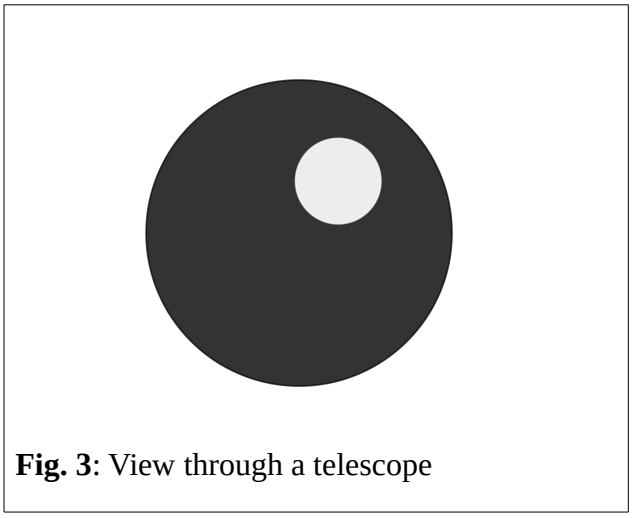

Fig. 3: View through a telescope

13. From basic parameters (like its mass and radius), estimate the dynamical timescale for the Sun.