Registration Number:

Date & session:

ST.JOSEPH'S UNIVERSITY, BENGALURU -27

M.Sc (PHYSICS) – IV SEMESTER
SEMESTER EXAMINATION: APRIL 2024
(Examination conducted in May - June 2024)
PHDE 0420 – ASTROPHYSICS
(For current batch students only)

Time: 2 Hours **Max Marks: 50**

This paper contains 3 printed pages and 2 parts

PART A

Answer any FIVE full questions. **(5x7=35)**

1. Explain the methodology of determining the color index of stars (please provide the physical basis on which we arrive at the color indexing).
2. (a) What is the cause for the phases of the moon? Draw a neat diagram showing all the phases of the moon: from full to new.
   (b) How do stars form? Explain the various stages of star formation. [4+3]
3. Should infra-red astronomy be done in space or can we do it effectively on ground? Explain your reasoning in detail.
4. The semi-major axis of Io (satellite of Jupiter) is $0.002819\,\mathrm{AU}$. Jupiter's mass is $1.898\times10^{27}\,\mathrm{kg}$. Obtain the period of Io in Earth days (you may make use of constants provided before Part B of this question paper).
5. Show that the brightness of an extended object is the same as that of the image in an imaging system. Discuss the effect of the eye-piece on the apparent brightness of the object.
6. From the definitions of specific intensity I_ν , mean intensity J_ν and the momentum flux for a reflective enclosure: $p_\nu=\frac{2}{c}\int I_\nu \cos^2\theta \; d\Omega$ and its energy density u_ν , show that the mean radiation pressure of radiation enclosed within reflective chambers is one third of the mean energy density.
7. An H_β absorption feature having a wavelength of $4861.332\,\text{Å}$ in the laboratory is observed in a star to be at a wavelength of $4853.88\,\text{Å}$. How fast is this star moving; is it moving towards or away from you?

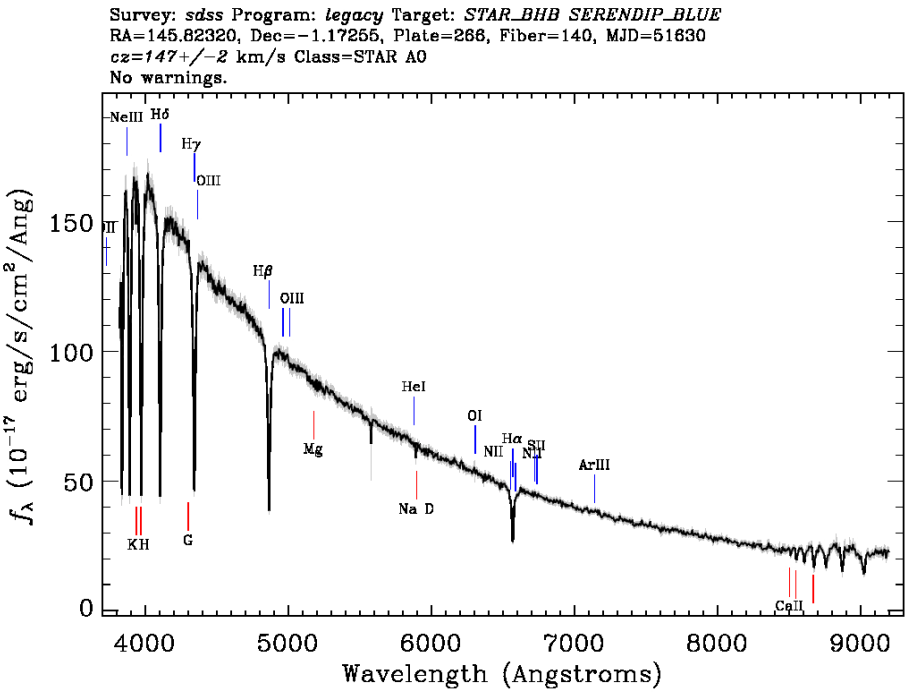

Fig. 1: Spectrum of a star from SDSS – related to question 7.

PART-B

Answer any THREE full questions **(3x5=15)**

[Constants: h=6.6x10^{-34} J s (Planck's constant), 1eV = 1.6x10^{-19} J (electron volt to Joules), c=2.99x10^{8} m/s (speed of light), 1Å = 1x10^{-10}m (Angstrom to meters), k_B = 1.380649x10^{-23} JK^{-1} (Boltzmann constant), N_A= 6.022 × 10^{23} mole^{-1} (Avogadro Number), e = 1.6x10^{-19} C (electronic charge), m_{proton}=1.673x10^{-27}kg (mass of proton), $m_{electron}$=9.109x10^{-31}kg (mass of electron), G=6.674x10^{-11}m^{3}kg^{-1}s^{-2} (Gravitational constant), $M_\odot$=1.9891x10^{30} kg (Solar mass), $R_\odot$=6.9x10^{8} m, σ=5.67x10^{-8}Wm^{-2}K^{-4}(Stefan-Boltzmann constant), M_{Earth}=5.97x10^{27}kg (Mass of Earth), $D_{earth-sun}$=1.49x10^{11}m (Earth-Sun distance), 1 inch = 2.54 cm, 1AU= 1.496x10^{11} m, 1 ly= 9.461x10^{15} m, 1 pc= 3.086x10^{16}m]

8. The mass of Vikram (lander with a rover onboard it on the Chandrayaan-2 mission) was $1471\,\text{kg}$. The lander was on a low lunar orbit and was at a height of $30\,\text{km}$ from the surface of the moon when it crash-landed. Assuming that the lander did not have any radial (downward) velocity at the time it started to fall, what would be the speed at which it would hit the Moon's surface? You can take the Moon's mass to be: $7.346\times 10\,22\,\text{kg}$ and its radius to be: $1737\,\text{km}$.

9. Compute the angular diameter of Mars as viewed from Earth. Data: $225\,\text{million km}$, Radius of Mars: $3389.5\,\text{km}$.
10. The central engines in Quasars are observed to show variabilities in their radio flux in times of the order of days. Estimate the maximum size of the object in meters. Compare this to the Earth-Sun distance (i.e. what fraction of the Earth-Sun distance would the maximum size of the central objects of Quasars be?).
11. An amateur astronomer has a dark adapted pupil diameter of $8\,\text{mm}$. She uses a $10\,\text{inch}$ telescope. What are the allowed focal length of eyepieces she can use?