

# 8<sup>th</sup> Indian National Astronomy Olympiad

May 1 to 20, 2006

Theory Test I,  
Juniors / Seniors

8<sup>th</sup> May 2006  
9:00 am to 11:00 am

Note: All questions carry equal marks.

1. Starship SS. Geromino is exploring the galactic neighborhood for habitable places. An onboard radar detects a planet likely to be habitable. The Ship automatically launches a satellite that goes into an orbit around the planet, whose plane is along the line of sight of the Ship. Once in orbit, the satellite continuously sends radio signals towards the Ship. Fig.1 shows an Intensity vs. Time plot for the received signal. Your task, as an Explorer-In-Charge is to interpret this signal and obtain:

- The ratio of the radii of the planet and the orbit of the satellite ( $r/R$ ). State clearly any assumptions you make.
- The density ( $\rho$ ) of the planet.

The ship is still very far away from the planet.

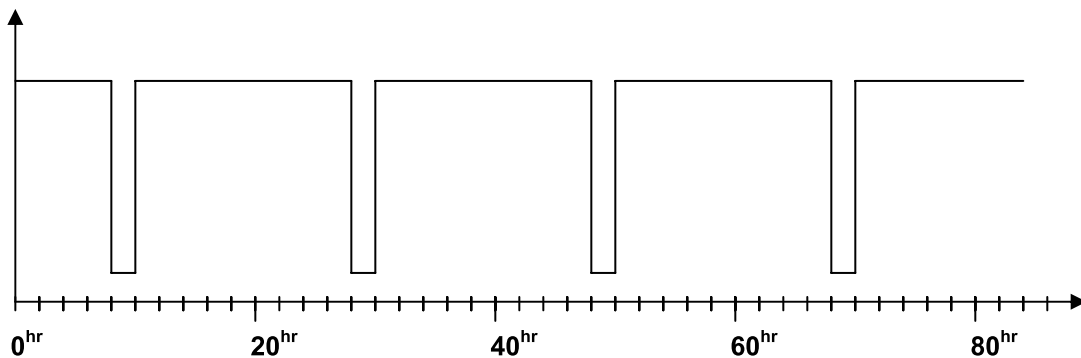


Fig. 1

2. The change in wavelength caused due to the loss in gravitational potential energy of a photon is called Gravitational redshift. A  $5M_{\odot}$  star of radius of  $2 \times 10^9$  m emits a radiation at  $\lambda = 5000\text{\AA}$ . Find the wavelength of this radiation as seen from infinity.

3. A velocity profile,  $v(r)$  (Fig.2) was obtained for a globular cluster SM171P in Eridanus. The curve in the Region B can be approximated by a straight line. Assuming that this system is gravitationally bounded, draw the mass profile  $M(r)$  in both the regions, where  $M(r)$  is the mass contained within a radius  $r$ .

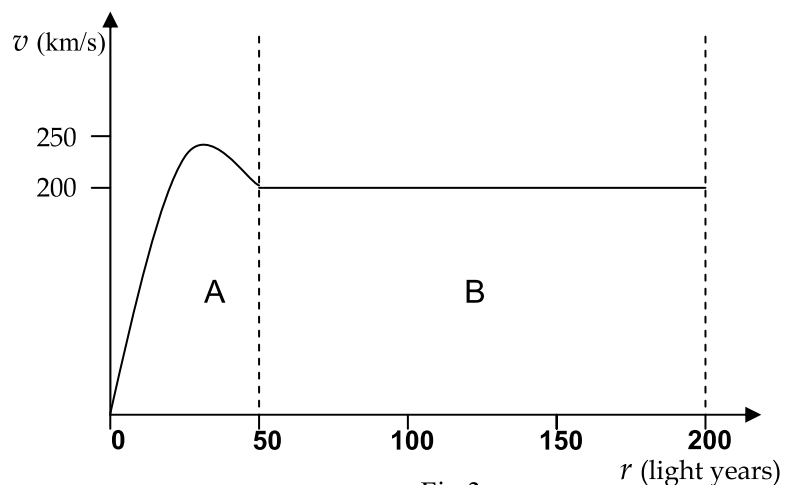


Fig.3.

4. Betelgeuse was the first star whose angular diameter was actually measured using interferometric techniques. The value was found to be  $0.019''$ . The radiation from Betelgeuse is seen to peak at  $\lambda = 8300\text{\AA}$ . Given the distance to Betelgeuse as 430 light years, predict its apparent magnitude. The real apparent magnitude of Betelgeuse, corrected for atmospheric effects, is  $0.43^m$ . Discuss the sources of error if any.
5. A satellite is revolving around a planet at an orbital radius of  $r$ , while the planet is separated from the central star (spectral type G2V) by distance  $R$ . The terminator of the satellite is the line separating bright side from the dark side. The view of the satellite and its terminator as seen from the planet is given in Fig.3. Find  $r$  if the apparent magnitude of the star as seen from the planet is  $-30.1^m$  and the angle of elongation (the Star-Planet-Satellite angle) is  $83^\circ$ .

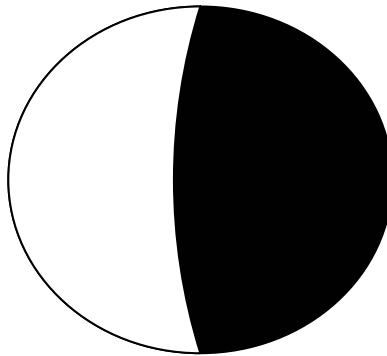


Fig.3