

Tutor Marked Assignment

Make sure you know how to complete and send in your TMA and PT3 form: detailed instructions are given in your student handbook (or supplement).

Covering: **Block 3 and**

Block 4 Chapter 1

Cut-off date:

Friday 12 September 1997

In all calculations

- show details of your working;
- include units with all physical quantities;
- work to an appropriate number of significant figures.

Question 1

This question relates to Block 3 Chapter 1, and parts of Block 1 are also relevant. It carries 23% of the marks for this TMA.

(a) (5 marks) In a sentence explain what a Doppler shift is. To study the rotation of the Galaxy using Doppler shifts, what types of object in the Galaxy should we observe and what measurements on those objects should we make? Exactly what information do we get from these measurements? (100–150 words should suffice.)

(c) (4 marks) Rank in order (with largest first) the speed with which the material at these points is moving. Give a reason for your ranking.

(d) (4 marks) Consider how much of this motion is along the line SD. Suppose there are hydrogen clouds at each of A, F, B, C and D. For which cloud is the maximum Doppler shift observed from S? Explain your answer in a sentence or two.

(e) (6 marks) Recalling that the Sun itself is moving, do you think any of these gas clouds have a net component of their motion towards the Sun? Explain your answer in a few sentences.

Question 2

This question relates to Block 3, Chapter 1 and Sections 2.1 to 2.4 of Chapter 2, and parts of Block 1 are also relevant. It carries 26% of the marks for this TMA.

RR Lyrae stars (see Book 1, pp. 126–127) are similar to Cepheid variable stars in that each has a variable light output of constant period. The period of RR Lyrae stars is less than 1 day and all have the same peak luminosity.

(a) (4 marks) Explain what is meant by a 'standard candle', and outline how observations of RR Lyrae stars in a globular cluster can be used to determine the distance to that cluster.

(b) (4 marks) From measurements of distances to various globular clusters, explain how the distance to the centre of our Galaxy can be determined.

(c) (3 marks) How does the peak luminosity of a typical Cepheid compare with the peak luminosity of an RR Lyrae star?

(d) (5 marks) Cepheid variables are sufficiently luminous to be used to determine distances of galaxies out to a maximum distance d_C of about 10 Mpc. Beyond this the flux density received from them falls below the minimum detectable value F_{min} . Assuming that the same F_{min} applies to RR Lyrae stars at a maximum distance d_{RR} , show that the luminosities are related as follows:

$$\frac{L_C}{d_C^2} = \frac{L_{RR}}{d_{RR}^2}$$

where the subscripts C and RR refer to Cepheid and RR Lyrae stars respectively.

(e) (5 marks) Using $d_C = 10$ Mpc and the luminosity ratio you found in part (c), estimate the maximum

Figure 1

(b) (4 marks) In Figure 1, O is the centre of the Galaxy, and S is the position of the Sun. SD is a line through the Galactic plane along which observations are being made. The material in the Galaxy is moving around O in circular paths in a clockwise sense, and the speed of the material decreases with increasing distance from O. Draw a sketch with arrows, making clear the direction of motion of the material at each of S, A, F, B, C and D. (Note that A and B are equidistant from F.)