

PART IV

Attempt **TWO** questions in this Part, which carries 24% of the marks for the examination. All of these questions carry equal marks. You are advised to spend about **40 minutes** on this Part. Write your answers to this Part in the **SEPARATE ANSWER BOOK** provided.

Remember to write your name, personal identifier and examination number on your answer book.

Question 7

part a, 4%

part b, 2%

part c, 6%

(a) Describe, using labelled sketches the differences between S0, Sa, Sb and Sc galaxies, showing the differences in the central part of the galaxy as well as the differences in the spiral arms.

(b) What is the 'winding dilemma' in a spiral galaxy? Explain this in one or two sentences. (Do not explain how the dilemma is resolved.)

(c) Suppose a galaxy begins life with a nuclear bulge of radius 3 kpc and four straight arms, which reach out to 30 kpc, at 90° to each other, as in the lower part of Figure 3. The rotation curve of the galaxy is given in the upper part of the figure.

(i) Describe in a few words how the bulge rotates and how the material outside the bulge rotates.

(ii) How long does it take for the material at 3 kpc to complete one revolution? Express your answer in years.

(iii) Suppose that this is a strange galaxy in which the arms contain the same population of stars throughout the lifetime of the galaxy. Consider a later time than that in Figure 3, when the material at 3 kpc has completed half of one revolution. At this time, calculate the fraction of a revolution completed by the material in an arm at radii of 9 kpc and 15 kpc. Hence sketch the shape of an arm, showing the direction of rotation.

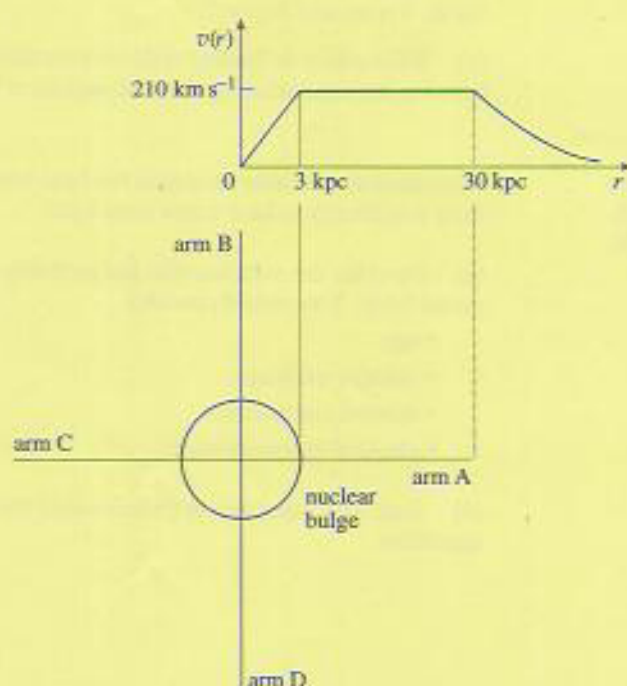


Figure 3 The positions of four arms of a galaxy, and the associated rotation curve (Note that this diagram is NOT to scale).