

distance d_{RR} at which RR Lyrae stars can be observed. Comment on the usefulness of RR Lyrae stars for measuring distances of extragalactic objects.

(f) (5 marks) Assuming that globular clusters are like miniature elliptical galaxies, how might the masses of globular clusters be obtained? (100 words should suffice.)

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Question 3

This question relates to Block 3, Chapter 3, and carries 21% of the marks for this TMA.

(a) (3 marks) The X-ray emission from an AGN varies on a timescale of 20 minutes. What is the upper limit (in parsecs) to the size of the X-ray emitting region?

(b) (2 marks) The infrared emission from the same AGN varies on a timescale of 2 hours. What is the upper limit (in parsecs) to the size of the infrared emitting region?

(c) (2 marks) Given the model of an AGN described in Book 3, do you expect the infrared emitting region to be larger or smaller than the X-ray emitting region? Explain your answer. (A few sentences should suffice.)

(d) (3 marks) The X-ray and infrared emission must both be from outside the Schwarzschild radius of the central object. From your size calculations above, what limit(s) (in kilograms) can you place on the mass of the central object?

(e) (4 marks) Double images of an AGN can be obtained when there is a galaxy or other massive object close to the line of sight. For the (asymmetric) case shown in Figure 2, indicate in which directions the two images of the AGN are seen.



Figure 2

(f) (4 marks) The two ray paths from the AGN to the observer in Figure 2 have different lengths. If the real AGN varies, then the image AGNs also vary, but not simultaneously. Which image, the northern or the southern, shows the variation first?

(g) (3 marks) If the difference in path length of the two rays is 100 pc, what is the time delay (in years, between the observed variation of the northern and southern images?

Question 4

This question relates to Book 4, Chapter 1, and carries 30% of the marks for this assignment.

Your local newspaper has an 'Ask a Scientist' column in which readers write in with questions on scientific topics. One day the editor phones to say that next month's column will be devoted to cosmology and asks if you would answer the questions. You agree, of course! Here are the questions that the readers have sent in.

(a) Astronomers claim the Universe is millions and millions of years old. But how do they know?

(b) What will happen to the Universe? Will it come to an end or will it last forever?

(c) My mum says the Big Bang is only a theory and that scientists are always changing their minds. Is there really any proof of the Big Bang?

• Write the 'Ask a Scientist' reply column with answers to each of the three questions.

• Remember that your readers are not scientists, and you will have to judge carefully what to say, how much to say and how to say it.

• You must answer each question separately, but the editor will be annoyed if you repeat yourself, so you will have to plan your answers carefully. You can answer them in any order you like.

• The editor does *not* want any illustrations.

• The length of each answer is up to you, but the total length of your answers should be around 500 words and must be in the range 450–550 words. Write the number of words on the top of the first page.

• Your name will be on the column, so your scientific reputation is at stake!

Marks are available as follows:

• 9 marks for the scientific accuracy of your answers

• 21 marks for their effectiveness in communicating scientific ideas within the constraints of a newspaper column.