

Question 8

part a, 4%

part b, 4%

part c, 4%

A satellite-based infrared telescope identifies a far infrared source at a position which is coincident with a known spiral galaxy at a redshift of $z = 0.015$. The spatial resolution of the infrared telescope is not good enough to allow the spatial extent of the infrared emission to be determined, but the far infrared flux density is measured as $7.1 \times 10^{-13} \text{ W m}^{-2}$.

(a) (i) Using a value of $H_0 = 75 \text{ km s}^{-1} \text{ Mpc}^{-1}$, calculate the distance of the galaxy, expressing your answer in metres.

(ii) Hence calculate the far infrared luminosity of the galaxy. Express your answer in terms of the solar luminosity.

(b) Given that the galaxy shows far infrared emission that is in excess of that which is expected for a normal spiral galaxy, suggest two types of galaxy that it might be. (If either of your types is an active galaxy, you should specify what sort of active galaxy.) You should justify your choice, including why you have ruled out certain types of galaxy.

(c) Discuss how the following observations would help in classifying this galaxy:

(i) high resolution images, and emission line spectra at optical wavelengths;

(ii) strength of X-ray emission, and any variation of X-ray emission with time.

Question 9

part a, 7%

part b, 5%

(a) (i) What is meant by the statement that 'the Universe is expanding'?

(ii) With the aid of a sketch, explain how it can be that clusters of galaxies are all moving away from us, and yet this does *not* mean that we are in a special place in the Universe.

(b) (i) What is meant by the term 'the scale factor of the Universe'?

(ii) Draw a graph showing how the scale factor of the Universe varies with time in each of the following cases:

- if there is no deceleration
- if there is deceleration in an open universe
- in a closed universe.

You should continue your curves to a time when the differences between them are clear.

[END OF QUESTION PAPER]