

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, 3%

part b, 3%

part c, 6%

(a) In what ways are BL Lac objects typical active galactic nuclei (AGNs)? List, and explain in a few words, each typical feature.

(b) In what ways are BL Lac objects unlike typical AGNs? List, and explain in a few words, each atypical feature.

(c) A BL Lac object shows variability on a timescale of 8 hours.

(i) Calculate (in metres) the limit on the size of the emitting region.

(ii) If the BL Lac has a redshift of 0.25 and $H_0 = 75 \text{ km s}^{-1} \text{ Mpc}^{-1}$, calculate its distance in megaparsecs.

(iii) Calculate the angle (in radians) that the limit on the size of the BL Lac subtends at the Earth. State whether this is resolvable with the best telescopes currently available.

NO BLR

$$ct = 2R$$

$$3 \times 10^8 \times 8 \times 3600 = 2R$$

$$= 4.32 \times 10^{12} \text{ m}$$

$$1000 \text{ Mpc}$$

$$z = H_0 d$$

$$\phi = d/r = 1/\text{arcsec}$$

$$ct = 2R \quad 3 \times 10^8 \times 8 \times 3600 = 2 \times R$$

$$2R = 8.64 \times 10^{12} \text{ m}$$

$$z = H_0 d \quad \theta \approx d = \frac{zc}{H_0} = \frac{0.25 \times 3 \times 10^5}{75} = 10^3 \text{ Mpc}$$

$$10^3 \text{ Mpc} = 10^3 \times 10^6 \times 3.09 \times 10^{16} = 3.09 \times 10^{25} \text{ m}$$

$$\phi = \frac{8.64 \times 10^{12}}{3.09 \times 10^{25}} = 2.8 \times 10^{-13} \text{ rad}$$

best telescopes radio resolution 10^{-3} arcsec
 $= 10^{-3} \times \frac{2\pi}{60 \times 60 \times 360} = 5 \times 10^{-9} \text{ rad}$