

## Extragalactic Astrophysics: Question Sheet 3

1. **Magnetic fields:** Galaxy M82 is pervaded by a magnetic field of  $10 \mu\text{G}$ .  
(i) Modelling the galaxy as a disc of radius 10 kpc and thickness 100 pc, compute the total energy in the magnetic field (in ergs).

(ii) What is the wavelength (in cm) of the peak synchrotron emission for 5 GeV electrons?

2. **Stars around BHs:** Consider a star of radius  $R$  at a distance  $d$  from a supermassive black hole of mass  $M_{\text{BH}}$ .

(i) Calculate the difference in the gravitational force from the black hole at distance  $d$  and  $d + R$ . This difference is called the tidal force. By equating the tidal force to the force that gas on the stellar surface feels due to the star's own self-gravity, show that the tidal force will be able to overcome the star's own self-gravity and rip the star apart if the mean density of the star is

$$\bar{\rho} < \frac{\alpha M_{\text{BH}}}{d^3}. \quad (1)$$

Determine  $\alpha$  assuming  $d \gg R$ .

(ii) Hence calculate the minimum distance that a solar-type star could approach the black hole at the Galactic centre before torn apart. Express this distance in units of Schwarzschild radii.

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