Stars and Galaxies

Coursework Sheet 8

1. The broad width of the emission lines seen in the spectra of active galactic nuclei correspond to velocities of about 10 000 km s^{-1} if interpreted as due to the Doppler shift. Assume that this arises from material in Keplerian rotation in circular orbits around a super-massive black hole of mass 10^9 M$_\odot$, i.e. the centripetal acceleration to move in a circle is provided by the gravitational acceleration such that $\dfrac{v^2}{r} = \dfrac{GM(r)}{r^2}$. What is the orbital radius required to explain such speeds? What is the shortest timescale for significant variations in the total emission from a region of this size?

(4 marks)

2. Estimate how many solar masses of material must fall onto such a black hole per year if its observed luminosity is 10^{42} W.

(4 marks)

3. A Cepheid variable is seen in a galaxy with a period of 15 days. Its average apparent visual magnitude is 17.6. Using the graph below and ignoring extinction, calculate how far away is the Galaxy assuming it is a Type I Cepheid, i.e. it belongs to Population I?

(2 marks)