

Extragalactic Astrophysics: Question Sheet 6

1. **Velocity dispersion:** (i) For an elliptical galaxy, the wavelength of its H α line in the observed-frame is measured at 659.6 nm with a line width of 0.5 nm. The rest-frame wavelength of the line is at 656.3 nm. Assuming that the galaxy has no peculiar velocity, what is its distance and velocity dispersion? (Hint: Use Hubble's law and $H_0 = 73$ km/s/Mpc).

(ii) The galaxy has a spherical shape and a density profile that can be described as $\rho(R) = \rho_0 R^{-2}$. Show that the kinetic energy of the galaxy can be expressed as $K = 6\pi\rho_0\sigma_r^2 R_{\text{out}}$ and the potential energy as $U = -16G\pi^2\rho_0^2 R_{\text{out}}$.

2. **Sphere of influence:** Studies of stellar dynamics in the active galaxy NGC3115 have revealed a central black hole mass of $M_{\text{BH}} \sim 9.2 \cdot 10^8 M_\odot$ (Emsellem et al. 1999). Given that the velocity dispersion is 278 km/s, compute the radius of the sphere of influence of the central black hole. NGC3115 has a distance of 9.7 Mpc. What angle does the sphere of influence subtend here on Earth?

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