

## Questions 5

1. In a spectrum of a galaxy the H $\beta$  Balmer line of hydrogen that has a rest wavelength of 486 nm is observed to be close to the wavelength of H $\alpha$  at 656 nm instead.

- a) What is the redshift and radial velocity of the galaxy?
- b) What is the distance according to Hubble's law ( $H=68 \text{ km s}^{-1} \text{ Mpc}^{-1}$ )
- c) What is the lookback time of the galaxy, i.e. how long has it taken the light to travel from the galaxy to us?
- d) If the galaxy was a member of a cluster with total mass of  $10^{14}$  solar masses and a diameter of 2 Mpc estimate the typical peculiar velocity in the cluster in  $\text{km s}^{-1}$  due to the gravitational pull of the cluster. What size error could this cause in the distance for this galaxy and comment on your answer.

2. Estimate how many times the Sun has orbited around the centre of the Galaxy.

3. Assume the spiral pattern in our Galaxy rotates at half the speed of the stars. Taking the typical width of a spiral arm to be 1 kpc, estimate the time that the Sun spends inside an arm during a single passage through an arm.