

Homework 11

Please write all your work and answers on separate paper. (You can turn in this page with the questions or not, as you wish). Show all your work on calculations and explain your reasoning whenever you can.

1. **Mind the P's and Q's:** What is the difference between a Quasar and a Pulsar?

2. **Hubble Law:** The red shift of a distance galaxy indicates that it is moving away from the Milky Way galaxy at a speed of 3000 km/s. Using a value of the Hubble Constant of 75 (km/s)/Mpc, what is the estimated distance to that galaxy, in Mpc?

3. **Hubble Units:** The Hubble Constant has units of (km/s)/Mpc. Explain why this strange combination makes sense.

4. **QSO:** The Quasar QSO J6338+0021 has a red shift of $z = 5.0$. Using the graphs in Fig. 24.3 and Fig. 24.4,
 - a. How far away is the Quasar, in Mpc?

 - b. What is the lookback time of the Quasar, as a percentage of the age of the Universe?

5. **WMAP and the Hubble Constant:** Data from 7 years of observations from WMAP, the Wilkinson Microwave Anisotropy Probe, produce a value for the Hubble Constant of $H_0 = 71.0 \pm 2.5$ (km/s)/Mpc.
 - a. Compute the Hubble Time for this value of H_0 .

 - b. The “error bars” ± 2.5 say that the actual value could be as high as $71.0 + 2.5$ or as low as $71.0 - 2.5$. Repeat the calculation of the Hubble Time for those two extremes.

 - c. Express your results for the Hubble Time using the “ \pm ” notation, to the same number of significant figures as the initial input value.