Physics 108 Homework 11

1. A quasar is an entire galaxy, or at least the center of an entire galaxy. A pulsar is a single star - a neutron star, to be more exact. Both put out energy as radio waves, but a quasar puts out vastly more energy than a pulsar. The only pulsars we have detected are in the Milky Way or Large and Small Magellanic clouds, whereas the only quasars are far, far away, billions of light years away.

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Any of these contrasting properties is sufficient, and there could certainly be others

2. $v = H_0 d$ so $d = v/H_0$

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$$d = \frac{3000 \text{ km/s}}{75 \text{ (km/s)/Mpc}} = 40 \text{ Mpc}$$

3. The Hubble constant is the ratio of two things, recessional velocity v in km/s, and distance d, measured in Mpc. So it makes sense to use the ratio of units, even though km and Mpc are both measures of distance

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4. a) For z = 5.0 the distance is about 7750 Mpc

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b) For z = 5.0 the lookback age is 0.90 or 90% of the age of the Universe

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5. To convert the Hubble constant to the Hubble time we need to convert Mpc to km and cancel length units, using

$$1\ \text{Mpc} = 3.086 \times 10^{22}\ \text{m}$$

and convert seconds to years using

$$1\ \text{yr} = 3.156 \times 10^{7}\ \text{s}$$

5a)

$$T_0 = \frac{1\,\text{Mpc}}{71.0\,(\text{km/s})} \times \frac{3.086\times10^{22}\,\text{m}}{1\,\text{Mpc}} \times \frac{1\,\text{km}}{1000\,\text{m}} \times \frac{1\,\text{yr}}{3.156\times10^{7}\,\text{s}}$$

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$$= 1.38\times10^{10}\,\text{yr} = 13.8\times10^{9}\,\text{yr}$$

$= 13.8$ Gyr or

13.8 billion years

b) For $H_0 = 71.0 + 2.5 = 73.5$ (km/s)/Mpc

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$T_0 = 13.3$ Gyr

For $H_0 = 71.0 - 2.5 = 68.5$ (km/s)/Mpc

$T_0 = 14.3$ Gyr

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c) Report this as

40

$T_0 = 13.8 \pm 0.5$ Gyr

$= 13.8 \pm 0.5$ billion years