ASTRONOMY 1102 – 1

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Answers to HW7, Fall 1999

1) *Metallicity and HR diagrams of clusters*

Start by finding which is the youngest and the oldest of these clusters. Cluster 2 has the longest MS or the bluest turnoff, so it is the youngest. Therefore it has formed most recently out of an ISM which has been chemically enriched for the longest time. It follows that the metal abundances should be highest in the youngest cluster. Cluster 3 has the shortest MS or the reddest turnoff, so it is the oldest. Therefore it formed long ago when the very little enrichment had taken place. It should have the lowest metal abundances.

2) *Pressure balance in the ISM*

The gas pressure is given by $P = NkT$ where N is the number density and T is the temperature of the gas. For the first 4 states listed, the product NT is the same $NT = 10^4$ K/cm^3, so they hare in pressure balance with one another. In star forming cores however the pressure must be higher to balance the increasing gravity of the contracting cloud.

3) *Stellar Orbits*

Pop. I stars formed in the disk which is rotating in a plane (the galactic plane) around the galactic center while Pop II stars formed mostly during the collapse of the halo.

4) By measuring the rotation velocity of the galactic disk as a function of the distance to the center. This is the *rotation curve* of the Galaxy. Since it remains flat out to large distances, it requires a lot of mass at these large distances, which we do not see.

5) Spiral arms, open clusters, the M2V star (because of its orbit), and OB associations (recently formed) are Pop I. Globular clusters, high velocity stars and the bulge are Pop. II.

6) The light of S and SB galaxies is dominated by the arms containing young blue massive and luminous stars. In fact the bulges do look orange like elliptical galaxies which also lack young blue stars.

7) From Fig. 19.13 such a Cepheid would have a luminosity of $10^4 L_\odot$. So one should be able to detect them 100 times (inverse square law) farther than a G2V star. So 100 Mpc is the approximate answer.

8) Since $v = H_0 d$, it follows that $d = v/H_0 = 10^4$km/s / 100 km/s/Mpc = 100 Mpc

9) The age of the Universe is estimated to be on the order of the so–called Hubble time $t_0 = 1/H_0$. We have shown in class that for $t_0 = 15$ Billion yr for $H_0 = 65$ km/s/Mpc. We may now write in general that

$$t_0 = 15 \text{ Byr} \frac{65 \text{ km/s/Mpc}}{H_0}$$

and therefore $H_0 = 100$ km/s/Mpc yields $t_0 = 10$ Byr.

10) Galaxies may indeed exist at such distances but we shall not be able to detect them for about 90 billion years.