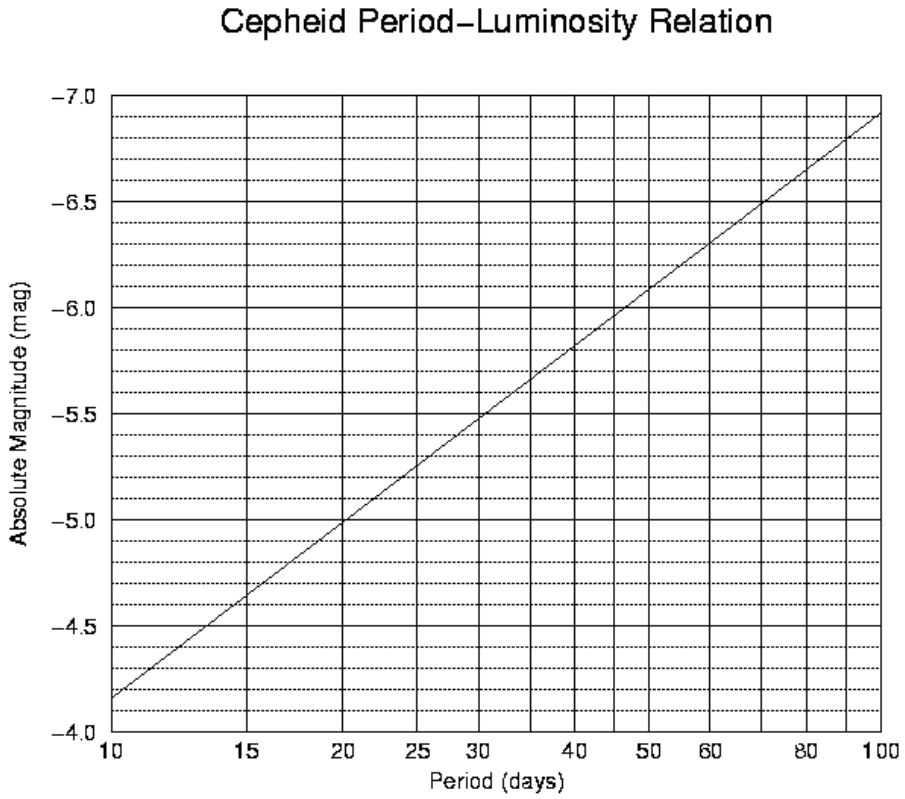
ASTRONOMY 12

Problem Set 2 – due Tuesday, Feb. 9, 2010

1) A nearby star has a parallax angle of 10 milli-arcseconds, i.e., p = 0.01". If that star has an apparent magnitude of m = 5.0, what is its absolute magnitude? Is it more or less luminous than the sun? (Ignore bolometric corrections.)

2) a) Given below is an approximate period luminosity relation for *Type I* Cepheid Variables. If a Cepheid of this type is observed in another galaxy with a period of 40 days and if that Cepheid has an apparent magnitude m = 21.0, what is the distance to that Galaxy in parsecs?

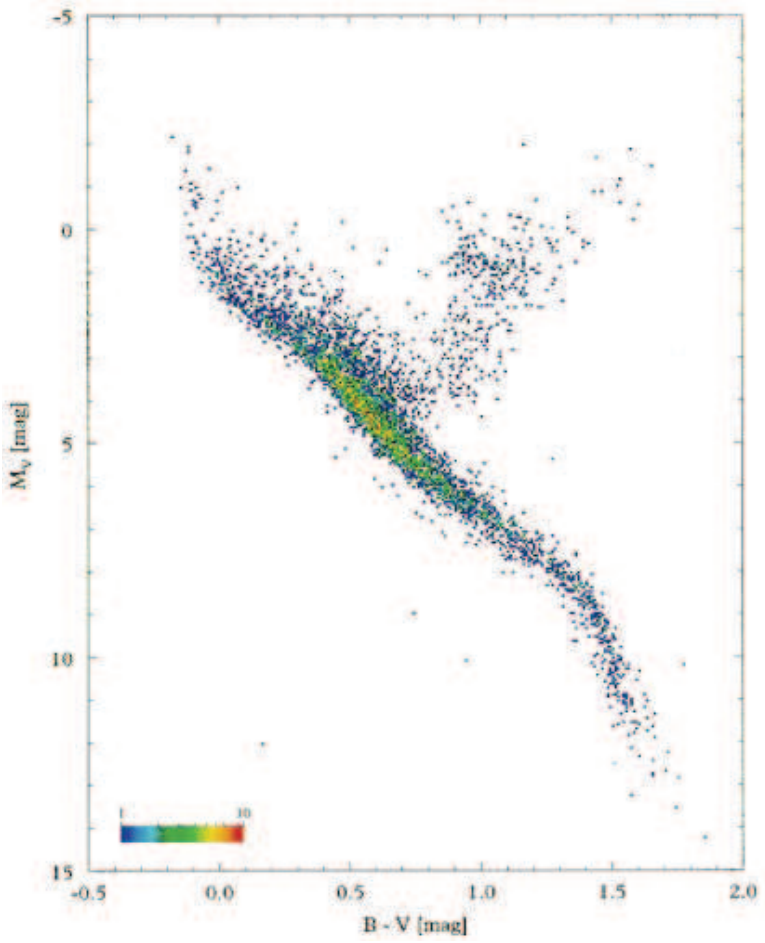
b) Suppose a Cepheid with m = 21.0 had that same period, but was actually *Type II* and thus had an *absolute* magnitude 1.5 magnitudes larger (i.e., less negative and therefore fainter) than plotted here, [or alternatively the diagram had been miscalibrated by 1.5 magnitudes due to the neglect of dust and reddening], what would be the revised distance? By what factor does your answer in b) differ from that in a)?



3) Below is a HR-diagram prepared from data taken by the Hipparcos satellite using 4477 stars whose parallax distance is accurately determined. Consider a *main sequence* star with color index B-V = 0.65. What would be its absolute magnitude (as accurately as you can read the graph)? If another main sequence star much farther away had the same color index (i.e., B - V = 0.65) and was observed to have an apparent magnitude of 15.0, what would be the distance to that star in parsecs?

b) The (B-V) for the star Wolf-28 is 0.55 and its absolute visual magnitude is 14.19. Locate this point on the graph. What is special about this star compared to all the others? For example, how would its radius compare to the sun (qualitatively, no calculation necessary).

c) Betelgeuse, obviously one of the brighter stars in the sky has (B-V) = 1.85 and absolute visual magnitude -5.9, just off scale here. Again, how would its radius compare with that of the sun - qualitatively, not a number?



4) A Type Ia supernova has a peak visual *absolute* magnitude of -19.3. If the white dwarf companion of Sirius, Sirius B, located at 2.64 pc, became a Type Ia supernova (very unlikely - the two stars are not exchanging mass), what would be its apparent visual magnitude at peak? Could you see it without a telescope?

5) Calculate the radius of a hypothetical star having 10,000 times the luminosity of the sun and a blackbody spectrum that *peaks* at 1.75 times the wavelength that the sun peaks at (what does this say about the temperature?). It will be easiest to do your calculation in terms of solar radii using ratios rather than trying to convert things to cgs units. First solve for the temperature in terms of solar temperature and then for the radius, in solar radii, using blackbody theory. If done correctly, this should be a short question.

6) The average temperature of the earth worldwide, night plus day, is 288 degrees K (15 degrees C). Assume that the earth radiates like a perfect blackbody and ignore the Earth's atmosphere. a) At what wavelength would most of the energy come out? Is this wavelength in the optical, radio, uv, microwave band or what? b) The radius of the earth is 6.38 x 10^8 cm (6380 km). What is the luminosity of the earth in erg s^{-1}? What is the ratio of that luminosity to that of the sun? (This does not include the sunlight reflected by the earth which comes out at a different wavelength).

7) From the tables in the notes, what is the approximate luminosity of a K5 main sequence star expressed in solar luminosities? At what radius in AU from such a star should the Starship Enterprise search for planets which a terrestrial life form might most comfortably inhabit? That is to say, at what distance would planets have a surface temperature comparable to that of the Earth. [Hint: Assume that a planet that receives the same flux from its parent star will have the same temperature (not always true because of albedo and greenhouse effects)].

8) A star moving *away* from you at 400 km s^{-1} has a spectrum containing the Balmer series of hydrogen. The Balmer-alpha (H_α) line in the laboratory from hydrogen at rest is found at a wavelength of 6564 Angstroms. What transition in the hydrogen atom does Balmer-alpha correspond to, i.e., n = ? goes to n =?. At what wavelength would that line appear in the star's spectrum as observed from the earth (because of the Doppler shift)?

9) What are the spectral types and approximate luminosities relative to the sun of *main sequence* stars whose spectra show the following characteristics?

a) He I lines predominate. He II absent. H I lines weak.

b) Ca II lines strong. H I lines very weak. TiO lines not present. CH strong.

c) Strong lines of TiO (titanium oxide) and VO (vanadium oxide).

d) The star alpha-Lyra, also known as Vega, whose spectrum is given on the next page.