Astronomy 160b — spring 2007

Problem Set #8 — due April 19 in class

I (6 points). Suppose that 1 billion years ago the scale factor of the Universe was 90% of its current value, and that you can observe light emitted by a supernovae at that time.

a) Assuming the absolute magnitude of the supernova was $M = -19$, calculate the observed apparent magnitude.

b) The $H\alpha$ spectral line (caused by the 3-2 transition of a hydrogen atom) has a wavelength measured in the lab of 0.65 microns. Calculate the wavelength at which this spectral line is observed from the supernova.

II (6 points). Suppose you observe an object with a redshift of $z = 1.5$ and a distance modulus of $m - M = 42.5$. Does this object suggest that the Universe is accelerating or decelerating? Explain your answer. For purposes of this problem you can assume that the current age of the Universe is 12.5 billion years. (Hint: convert the observed quantities into a point on the a vs. t plot, and then compare the position of the point to the line representing an empty universe).

III (8 points). One possible explanation of the Type Ia supernova observations would be that SNIa events were intrinsically fainter in the past than they are now.

a) Explain why this hypothesis could mean that Dark Energy is not required.

b) How much fainter would the SNIa events at redshift $z = 1$ have to be if the Universe really had $\Omega_M = 1$ and no Dark Energy? You'll need to consult the data plot shown in class on Thursday, which has been posted in the problem set folder in the classesv2 resources area. You can assume that the observations of supernovae follow the solid line in that plot. In this case you can do the logs and/or exponents on a calculator.