ISP220 Addition to Homework #10

This will be added to the MasteringAstronomy score in the set due on April 1 and is worth 15 points.

Due in class April 4 , 2017

Refer to the slides from March 23 and the in-class calculation.

Figure 1 shows the optical spectrum from a quasar affectionately called 1044-0125 discovered by the Sloan Digital Sky Survey (SDSS) telescope at Apache Point, Arizona in 2000. The vertical axis is a measure of intensity and isn't important: stronger is higher. The horizontal axis is the wavelength measured by their spectrograph and is in units of Angstroms, Å. Perhaps you remember that 1Å $= 10^{-10}$m. You can see a handful of elements: *emission* (a line or prominence up) like Hydrogen (L indicates the "Lyman" band of hydrogen), Oxygen, O, and Silicon, Si; and *absorption* (dips), like Magnesium, Mg.

The most prominent is one of the tell-tale signatures of the element Hydrogen: its so-called Lyman α emission line. You're going to analyze this spectrum and learn about the history of this quasar. You'll hand in the next page.

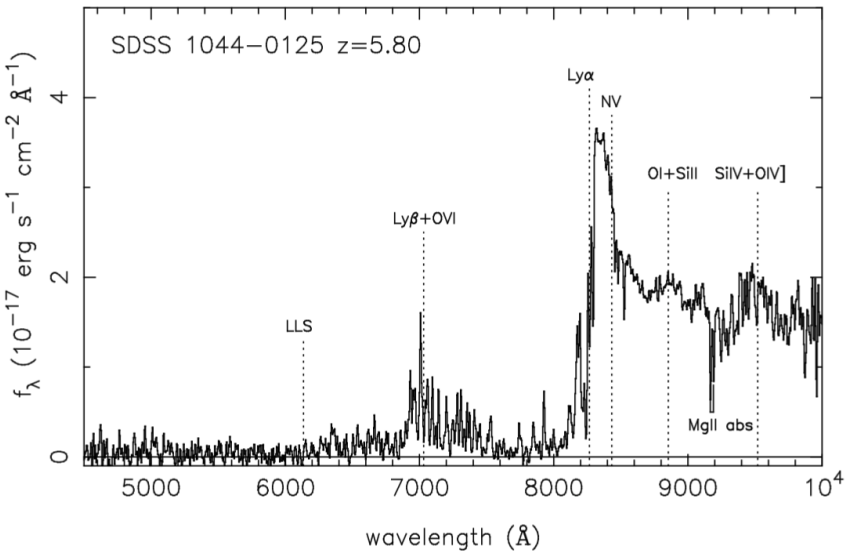

Figure 2. Optical spectrum of SDSS 1044–0125 observed with KeckII/ESI. The total exposure time is 3600s. The spectrum is smoothed to 4 Å/pixel. The spectral resolution is ~ 8 Å at $\lambda = 9000$Å.

Figure 1: Quasar 1044-0125 from https://arxiv.org/pdf/astro-ph/0005414.pdf

Your Name: _____

(1 pt) Look up lab value for the Lyman α wavelength and write it here (Wikipedia is fine):

Laboratory Lyman alpha wavelength, $\lambda_e =$ _____Å (it should be around 1200 Å)

(2 pts) Estimate the red-shifted Lyman α line from the SDSS spectrum and write it here (notice that the dashed line is not on the peak directly...use the dashed line mark):

SDSS measured Lyman alpha wavelength $\lambda_o =$ _____Å

What is the formula for the red shift In terms of the wavelengths, λ_e and λ_o?

(1 pts) _____ = _____

(2 pts) Calculate the red shift: $z =$ _____

Remember: the ratio of wavelengths is related to the stretch of space since the emission.

(2 pts) By what factor was the universe smaller when 1044-0125 emitted its light? _____

Go to http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/redshf.html and find the blank fields under "Measured Red Shifts" for red shift and speed. Type in your calculated red shift, hit return, and up will pop the recession speed as a function of the speed of light. Write β and v in m/s here:

(2 pts) $\beta =$ _____ (2 pts) $v =$ _____ m/s

Now use Hubble's Law and Hubble's Constant from the banner in the lecture slides to estimate how far away 1044-0125 was when it emitted its light.

(3 pts) $r =$ _____ m. (do your work below) For 2 points extra, how many Billion light years is this? http://www.metric-conversions.org/length/meters-to-lightyears.htm