AST 250 – Spring 2019
<u>Homework Due: Wednesday April 10</u>

33. (a) Consider light being emitted by a galaxy from Hydrogen atoms in the Lyman alpha transition (denoted Ly α, meaning that the electron jumps from principle quantum number n = 2 to 1). The wavelength of Ly α measured in laboratories on Earth is 121.6 nm. The Large Binocular Telescope (LBT) on Mount Graham has spectrographs (MODS and LUCI) that can observe from 320 nm to 2.44 μm. What range of redshifts can Ly α emission be theoretically observed from galaxies by the LBT? See Figure on back.

(b) Hydrogen atoms in the ground electronic state (n = 1) can also be observed in the radio from emission at 1.420 GHz due to the flip of the spin of the electron relative to the spin of the proton. In order to detect H emission from z $\sim$ 7 to 30 when the intergalactic medium was predominantly neutral (before "reionization"), over what frequency range should you design your radio telescope experiment? Give your answer in MHz. Hint: first derive the redshift equation in terms of frequency.

34. The relativistic Doppler shift gives an expression between 1+z and a function of the radial velocity of the source divided by the speed of light (v/c):

$$1 + z = [1 + (v/c)]^{1/2} \; [1 - (v/c)]^{-1/2}$$

In the limit that v <<c, we can Taylor expand the two square root terms on the right side. Ignore terms that are quadratic in v and higher powers (i.e. ignore terms with v^2, v^3, etc.) and simplify the expression to show that redshift is directly proportional to recessional velocity when v << c.

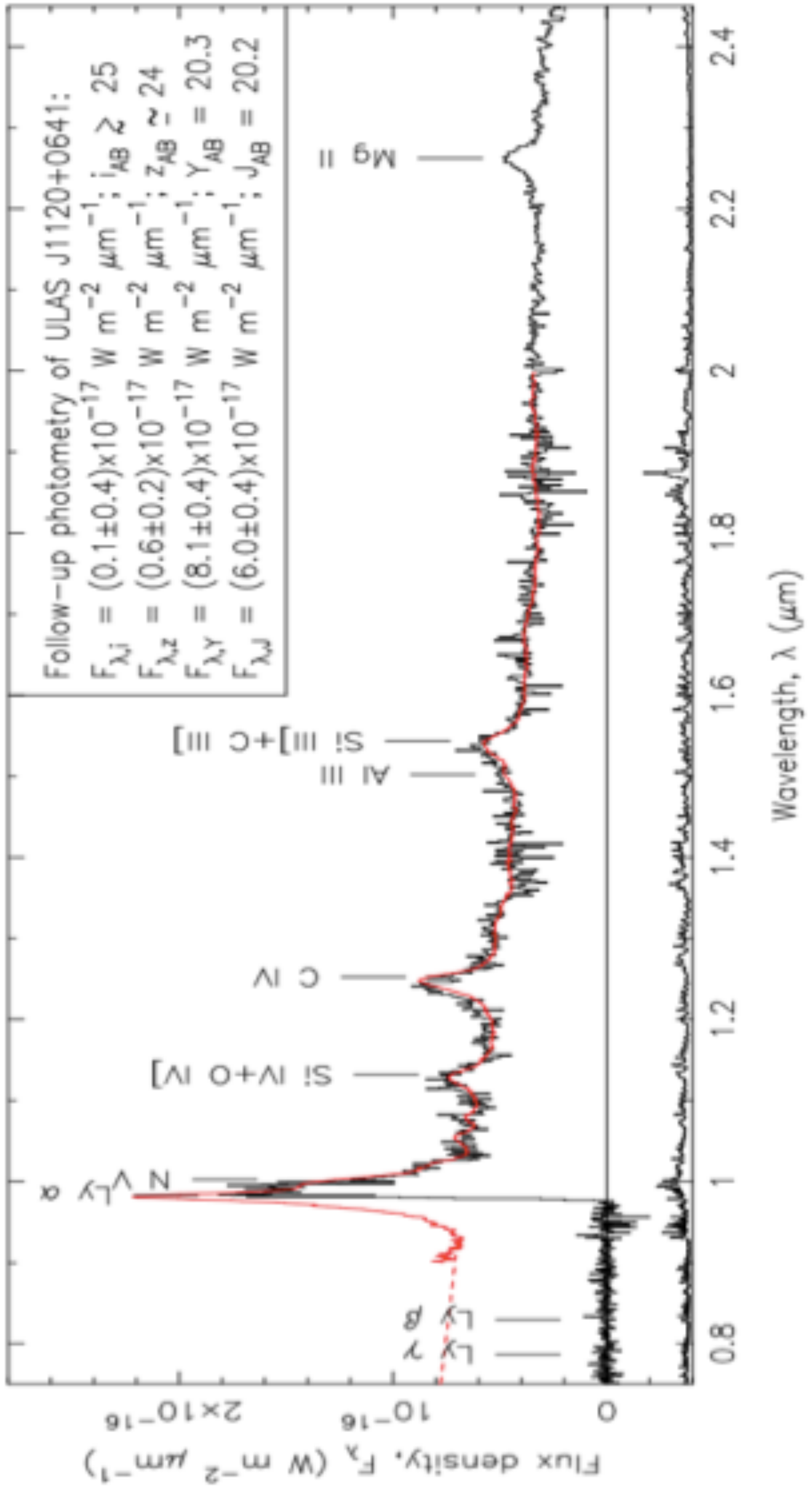

Figure 1: Spectrum of a high redshift quasar (Mortlock et al. 2011, Nature, 474, 616).