

ASTR 3730: Astrophysics 1 – Problem Set #1
Due in class Friday 14th September

- 1) (a) Neutral hydrogen emits radio waves with a wavelength of 21cm. What is the frequency of this radiation?
- (b) What is the wavelength (in nm) of an X-ray photon with an energy of 6.4 keV?
- 2) (a) A binary star system in the star forming region of Taurus (at a distance of 150 pc) has a separation between the two stars of 50 au. Can we resolve the binary (i.e. detect the two stars individually) using a ground-based telescope with a resolution of 1 arcsecond?
- (b) Improved observations show that what was previously thought to be a single 16th magnitude star is actually a close binary consisting of two identical stars. What is the magnitude of each individual star?
- 3) An Active Galaxy (i.e. a supermassive black hole accreting gas from a surrounding galaxy) at a distance of 1 Gpc produces a luminosity in X-rays of $L_x = 10^{41}$ erg s⁻¹.
- (a) What is the X-ray flux at Earth from this source?
- (b) The *Chandra* X-ray observatory observed the source for 10⁶ s (one of the longest exposures made with *Chandra*). Assuming for simplicity that **all** the X-ray photons from the source have an energy of 5 keV, how many photons does *Chandra* collect during the exposure? (You will need to know that the effective area of the *Chandra* telescope for detecting 5 keV photons is 400 cm².)