AST 300B – Spring 2019

In-class/Take-home Problems Due: Wed. Mar. 27

20. Assume you have a spherical, steady-state HII region (photoionization balances recombination and the HII region is optically thick to ionizing radiation E > 13.6 eV) powered by an O9V star. The HII region is constant density $n_H = 100$ cm^{-3} and temperature $T_k = 10^4$ K with radius R called the "Stromgren radius".

(a) Calculate the Stromgren radius of this HII region in pc.

(b) Imagine that the ionizing star suddenly turns off. Calculate how long it will take for the H atoms to recombine in years. This is the recombination timescale and it is equal to the corresponding ionization timescale for the reverse problem.

Fig. 1: HST image of NGC 604 in the Triangulum Galaxy, a HII region (40 times larger than the Orion Nebula) powered by over 200 O stars. 😳

21. In neutral hydrogen clouds (HI clouds), carbon may be ionized (CII) because it has an ionization potential of 11.26 eV which is less than the 13.6 eV needed to ionize Hydrogen. Calculate the fraction of neutral Carbon, f(CI) = n(CI) / (n(CI) + n(CII)), in a diffuse HI cloud with typical values of $T_k = 100$ K and $n(e^-) = 0.04$ cm^{-3}. Assume steady state (photoionization balances recombination) and that carbon can only be CI or CII. You will need Tables 13.1 and 14.6 of Draine's book to look up photoionization rates and recombination rates. **HINT:** Divide both sides of equation by n(CI) + n(CII) to get fractions.