AST 393F Assignment 5

Due Friday Nov. 6

1. Soon after an O5 star has formed in a molecular cloud, it has ionized an H II region around it with an electron density of 10^5 cm⁻³. Assume the H II region is spherical and has a uniform density. For parts a-e, neglect the absorption of ionizing photons by dust. a) What is the radius of the H II region? What is the average value of its ionization parameter (U)?

b) If the density is set by the molecular cloud density (the H II region hasn't begun to expand), and the star turned on abruptly, about how long did it take the star to ionize the gas in the H II region?

c) Because of the high pressure inside of the H II region, it will expand. Assume its density remains uniform (spatially) as it expands, and assume that at all times it is in ionization-recombination equilibrium. When it has expanded to 10 times its original radius, how has its density changed? How has its ionization parameter changed? Qualitatively, how would the change in U change the emitted spectrum?

d) When the H II region expanded, how did its H β luminosity change? How did its [O III] (λ 5007) luminosity change? How did its [O III] (88 μ m) luminosity change? e) Roughly, how did the heating, cooling, and gas temperature change? (You can assume that the [O III] lines are representative coolants.)

f) If dust is present in the H II region, and the gas/dust ratio didn't change while the H II region was evolving, how did the dust optical depth change? How did the fraction of the ionizing photons absorbed by dust change? How would dust affect your answers to parts a-e (qualitatively)?