

ASTRONOMY 020

Problem Set #20

Due: March 19, 2004

1. An astronomer finds that 80% of all G2V stars have an apparent flux f greater than a value f_0 . At what flux value f_1 (in units of the value f_0) will she expect to find that 50% of stars have $f > f_1$, assuming that all G2V stars have the same intrinsic luminosity and uniformly populate space.
2. An atomic hydrogen gas cloud of number density $n = 10 \text{ cm}^{-3}$ surrounds an O star which emits 10^{49} photons/s at wavelengths shorter than 91.2 nm. The recombination coefficient for protons and electrons is $\alpha = 2.0 \times 10^{-19} \text{ m}^3/\text{s}$.
 - (a) Determine the Stromgen radius of the resultant H II region.
 - (b) Explain why an actual emission nebula is not likely to be spherical.
3. Calculate the Jeans length and Jeans mass for the following conditions.
 - (a) An average piece of a molecular cloud, of number density $n \approx 10^3 \text{ cm}^{-3}$ and temperature $T \approx 50 \text{ K}$. (Hint: the cloud is composed primarily of molecular hydrogen, so $\mu \approx 2$)
 - (b) A smaller high density region within an average cloud, known as a core, which has $n \approx 3 \times 10^5 \text{ cm}^{-3}$ and $T \approx 10 \text{ K}$.
 - (c) Explain why the formation of the Sun more probably took place in a core rather than under average conditions of a molecular cloud.

Practice problems:

1. Write a paragraph explaining how Trumpler demonstrated the existence of interstellar dust.
Answer: see class notes.
2. Explain briefly why
 - (a) Dark nebulae are dark.
 - (b) Reflection nebulae appear blue.
 - (c) Emission nebulae often appear red.Answer: see class notes or textbook.
3. Zeilik & Gregory, Chapter 15, problem 10.
Answers: $\lambda = 3.61 \text{ cm}$, $\nu = 8.32 \text{ GHz}$. HII regions emit at this frequency as well as the optically visible $\text{H}\alpha$ line ($\lambda = 656.3 \text{ nm}$) due to the recombination cascade.
4. Zeilik & Gregory, Chapter 15, problem 16.
Answer: $\theta = 0.33''$. This is right at the limit of resolution from the best sites on Earth, but is resolvable by the Hubble Space Telescope.