ASTR 3520, Fall 2002
Homework Set #3:
Radio astronomy basics
Due, Tuesday, 12 Nov 2002

(1) Radio telescopes: Consider a radio telescope with a diameter of 10 meters.
[a] What wavelengths do the following frequencies have in the vacuum? 1 GHz, 10 GHz, 100 GHz, and 1 THz?
[b] What is the size of the beam (and the angular resolution) at the above frequencies?
[c] Which frequencies would you expect to be able to observe from a humid site such as New York?

Which frequencies would you expect to be able to observe from a dry site such as Mauna Kea?

Which frequencies can you not observe from the ground (and would have to go to space to detect?

(2) Radar: Assume you are using the above telescope.
[a] You are bouncing a radar beam from an asteroid passing the Earth with a relative velocity of 1 km/s with respect to the telescope. For a 10 GHz transmitted frequency, what is the difference between the transmitted frequency and the received reflected frequency?
[b] Suppose the asteroid is 1 km in diameter and spinning at a rate of one full rotation per minute. What is the frequency range of the reflected signal?

(3) Resolution of an interferometer: Predict what the best angular resolution you could get with the VLA radio telescope. Assume that the maximum separation between the most distant dishes is 27 km and that you are using a frequency of 10 GHz.

(4) Ionization Equilibrium:
[a] Consider a spherical planetary nebula that is 0.5 pc in diameter, and has an average electron density, $n_e = 10^4\ cm^{-3}$. Assuming that all of the UV radiation is absorbed in the nebula, what is the Lyman continuum luminosity of its central star?

[a] Use the formula you used above to give a general expression for the mass of an HII region as a function of the mean electron density and the Lyman continuum luminosity of its central star.