Astro 402 Problem Set #4
March 25 2003. Due April 8 2003

1. An observation is made of the 21 cm HI line profile in the direction $l = 30^o, b = 0^o$. Assume that the HI density is constant at 1 cm^{-3} and that the spin temperature is 150 K everywhere. Calculate the HI line profile $T_b(V)$ as a function of velocity (between -50 and +200 km s^{-1}) assuming the Galaxy to have a flat rotation curve with a speed of 220 km s^{-1} everywhere. You can calculate T_b every 10 km s^{-1}. What is the total column density of HI you are observing? Check the answer using your calculated HI profile.

2. Calculate the cooling rate (in ergs s^{-1}, for example) due to emission in the 21 cm line of HI for a cloud of radius 5 pc, temperature 200 K and HI density 1 cm^{-2}. Estimate the cooling time for the cloud. Is this cooling likely to be significant?

3. You observe an HI profile towards galactic latitude 90°, i.e. the north galactic pole. It has two distinct components; a broad line, of width 25 km/s and brightness temperature 1 K, and a narrow component, width 2 km/s and brightness temperature 10 K. There is a continuum source in this direction of brightness temperature 100 K in whose spectrum you observe a narrow absorption component of depth -20 K, while you detect no absorption from the broad component. A map of the region shows that the cloud diameter is 40 arcmin, while the broad component is very extended. What is the mass of the cloud? Are the cloud and intercloud HI in pressure equilibrium? Note that you have to make several assumptions about distances etc, just like in real life. Discuss your assumptions carefully!