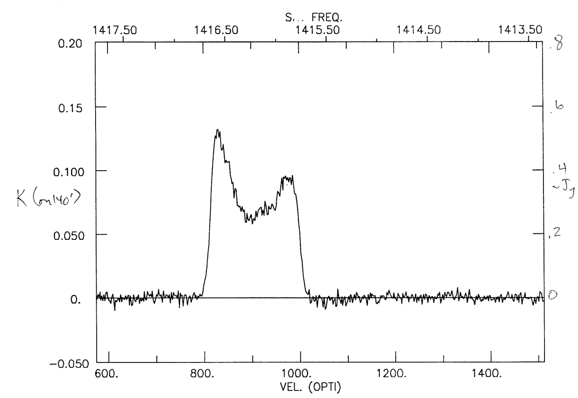
ASTR705 ISM
HW #3
Due 2/10 at beginning of class.

1) Let's talk about rotation curves! Proportionalities are fine for these. (2 pt each)
a) Assuming the rotation curve is flat and orbits are circular, derive the mass, velocity, and angular velocity distributions as a function of Galactocentric radius.
b) Do the same for a Keplarian curve, and
c) the same for a solid body curve where the velocity is proportional to Galactocentric radius.

2) Below is an HI profile for an unresolved edge-on galaxy:



a) (1 pt) Tell me about the optical depth of the HI line, and how you came to that conclusion.
b) (2 pt) Derive the mass of the Galaxy using the difference between the peaks of the profile. Assume the Galaxy is 25 kpc in radius. [Hint: Equate centripital and gravitational accelerations.]
c) (3 pt) From the area under the curve, find the H I mass of the galaxy. For the distance, assume the galaxy is moving along with the Hubble flow, $v = H_0 d$, with $H_0 = 67$ km s^{-1} Mpc^{-1}.
d) (1 pt) If your assumptions are valid, why is there a discrepancy between these two numbers?

3) Suppose H I gas is in a plane-parallel slab geometry, with full thickness 6×10^{20} cm^{-2}, and take the velocity distribution to be Gaussian with a one-dimensional velocity dispersion $\sigma_V = 10$ km s^{-1}. Neglect the effects of Galactic rotation.
(a) (2 pt) If the spin temperature is $T_s = 100$ K, for what Galactic latitudes is the line-center optical depth $\tau_\nu < 0.5$, as seen from a point in the mid-plane?
(b) (2 pt) If the full-thickness of the H I disk is 300 pc, out to what radius (in the plane, at $b = 0$) can it be observed with line-center optical depth $\tau_\nu < 0.5$.
(c) (1 pt) What is the maximum N(H I) that can be observed with $\tau_\nu < 0.5$ at all radial

velocities?

4) (2 pt) Compare the area under the curve of a 1-D Gaussian to the FWHM times the peak height.