Homework 8

Due **October 29 by 10:45am via Canvas upload**

Please show all work, writing solutions/explanations clearly, or no credit will be given. You are encouraged to work together, but everyone must turn in independent solutions; do not copy from others or from any other sources.

1. You observe an interstellar cloud made of nearly pure molecular hydrogen (assume pure H_2, so the mean molecular mass $\mu = 2$), with a temperature of $T = 10$ K, an adiabatic index of $\gamma = 7/5$, and a mean mass density of $\rho_0 = 5 \times 10^{-12}$ $M_\odot$ AU^{-3}.
   (a) What is the speed of sound within this cloud?
   (b) What is the Jeans length of this cloud (in AU)?
   (c) What physical limit does the answer in part b) represent?
   (d) You observe your cloud to have a flattened, disk-like shape, with a disk radius of twice the Jeans length and a rotational speed of 42.7 m/s at the edges. Ignoring rotational pressure support, and assuming conservation of angular momentum, how fast will the disk edges be rotating if the cloud collapses to a radius of 30.1 AU (the semimajor axis of Neptune's orbit)?
   (e) How does this rotation speed compare to the speed of Neptune along its orbit?

2. You have taken the spectrum of a star with apparent mag $m_V = 14.3$ and color $(B-V) = 1.9$. Using this spectrum, you have calculated the star's temperature to be 4000 K and its surface gravity to be 380 m s^{-2}. (HINT: Tables A.5-A.6 in your textbook contain useful stellar info. Do <u>not</u> trust the $\log(g/g_\odot)$ values column).
   (a) What is the spectral type and luminosity class of this star?
   (b) What is the color excess $E(B-V)$ of this star (in magnitudes)?
   (c) What is the extinction A_V of this star (in magnitudes)? Assume the interstellar dust follows an $R_V = 3.1$ extinction law.
   (d) What is the distance to this star (in parsecs, pc)?
   (e) If you had ignored the presence of dust, what distance would you have calculated?

3. Of the five methods for detecting interstellar gas described in the textbook, which one is best-suited to mapping the vast amounts of neutral hydrogen gas spread throughout the Milky Way? Justify your answer thoroughly.