

Astrophysical Dynamics — HS 08-09
Exercises Class 1 (23 Sept 2007)

Exercise 1

Kepler's third law states that, if P is the orbital period of a planet around a star, and a is the axis of its orbit, then $P^2 \propto a^3$. Show that this relation follows from virial equilibrium.

Exercise 2

Consider two molecular clouds, one with a mass of $5 \cdot 10^4 M_\odot$ and density 100 cm^{-3} , and one with a mass of only $10 M_\odot$ and density 10^4 cm^{-3} . Both clouds have a temperature $T = 15 \text{ K}$.

a) Which is more important in supporting, respectively, the first and the second cloud against gravitational collapse: their thermal energy or their kinetic energy? Determine the ratios between these two energies for each cloud. (*Hint: assume that Larson's law holds for both clouds.*)

b) Determine also the respective ratios between the magnetic energy and the gravitational binding energy of the clouds, assuming that they have an embedded magnetic field of $\sim 10 \mu\text{G}$.

Exercise 3

The Cold Neutral Medium component of the disk has a thickness of $\sim 100 \text{ pc}$, partially due to thermal pressure support and partially to turbulence (as shown in the first lecture).

a) The thickness of the Warm Neutral Medium (WNM) layer is comparable to that of the CNM. Knowing that its density is $n_{\text{WNM}} = 0.5 \text{ cm}^{-3}$ and assuming that turbulent motions are not important, compute the temperature T_{WNM} from hydrostatic equilibrium.

b) The Hot Intercloud Medium, on the other hand, has $n_{\text{HIM}} = 3 \cdot 10^{-3} \text{ cm}^{-3}$ and $T = 5 \cdot 10^4 \text{ K}$, and is usually associated with supernovae explosions and outflows. What thickness would it have if it was in hydrostatic equilibrium, again neglecting any turbulence?