AY 145: HW 7

Due Wednesday, April 13th

1. **Sound Speed**

   (a) Consider the Earth's atmosphere, which consists of approximately 75% by mass of N_2 and 25% by mass of O_2. Calculate the speed of sound in air (both the isothermal speed and the adiabatic speed) at a temperature of 300 K.

   (b) Do the same for a cold HI cloud with $n = 10$ cm^{-3} and $T = 80$ K.

   (c) Do the same for an HII region with $n = 1000$ cm^{-3} and $T = 8000$ K.

2. **Fluid Mechanics**

   Consider a fluid flow in which the density, velocity, and pressure are independent of time and are given in Cartesian coordinates by:

$$\rho(x, y, z) = \rho_0 \exp(-R/R_0), \tag{1}$$

$$\vec{\mathbf{v}} = v_0(-y/R, x/R, 0), \tag{2}$$

$$P(x, y, z) = 0, \tag{3}$$

   where R is the cylindrical radius $\sqrt{x^2 + y^2}$ and ρ_0, R_0, and v_0 are constants.

   (a) Show that the flow satisfies the continuity equation.

   (b) Substitute in the momentum equation and calculate $\vec{\mathbf{g}}(x, y, z)$, the acceleration due to gravity.

   (c) Give a simple physical interpretation of the results.