

## 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  $\text{N}_2$  and 25% by mass of  $\text{O}_2$ . 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  $n = 10 \text{ cm}^{-3}$  and  $T = 80 \text{ K}$ .
- (c) Do the same for an HII region with  $n = 1000 \text{ cm}^{-3}$  and  $T = 8000 \text{ K}$ .

### 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:

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

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

$$P(x, y, z) = 0, \quad (3)$$

where  $R$  is the cylindrical radius  $\sqrt{x^2 + y^2}$  and  $\rho_0$ ,  $R_0$ , and  $v_0$  are constants.

- (a) Show that the flow satisfies the continuity equation.
- (b) Substitute in the momentum equation and calculate  $\vec{g}(x, y, z)$ , the acceleration due to gravity.
- (c) Give a simple physical interpretation of the results.