2. Übung zu: Astronomie & Astrophysik II

(Due: Thu., 29.4.2004)

Problem 2.1:

The Jeans instability criterion for the collapse of ISM gas can be exactly derived from pertubation theory or estimated in a simple way by means of the virial theorem. Show that the virialansatz yields

$$M_J \simeq 5.46 \left(\frac{k_B T}{Gm} \right)^{3/2} \rho^{-1/2}$$

for the Jeans mass. Here m is the molecular weight. In that process give an expression also for the Jeans length. Assume as in Problem 1.1 a nondegenerate monoatomic gas and as in Problem 1.2 that the density of the region (sphere) is constant.

Problem 2.2:

Compute the Jeans length and mass for a) an ISM with a density $\rho = 30\,\mathrm{H/cm}^3$, a temperature $T = 200\,\mathrm{K}$ and only composed of hydrogen as gas, and b) for a gas of density, temperature, and compostion as the earth's atmosphere at sea level (~100% nitrogen, 1018 hPa, 15° C; assume the above formula is also valid for N_2). c) Interpret the mass- and lengthscales in both cases in the corresponding context (interstellar space and earth's surface, respectively).