# Homework 11

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1. Volume of a sphere: $V = \frac{4}{3}\pi r^3$. Then,

$$V = \frac{4}{3}\pi(\frac{100000}{2} * \frac{9.46 * 10^{17}}{1})^3$$
$$V = 4.434 * 10^{68}\text{cm}^3.$$

   Therefore, there are $4.434 * 10^{68}$ hydrogen atoms in the interstellar gas of our galaxy. Then the mass, $4.434 * 10^{68} * (1.67 * 10^{-27}\text{kg}) = 7.422 * 10^{41}\text{kg}$. This then means that there are $\frac{7.422*10^{41}}{1.989*10^{30}} = 3.732 * 10^{11}$ solar masses of hydrogen in our galaxy.

2. Stefan-Boltzmann Equation: $\frac{L_2}{L_1} = (\frac{R_2}{R_1})^2(\frac{T_2}{T_1})^4$. Then,

$$1400 = (R_2)^2(\frac{480}{5800})^4$$
$$R_2 = \sqrt{\frac{1400}{(\frac{480}{5800})^4}}$$
$$R_2 = 5463\ \text{R}_\odot.$$

   This star has a radius of about 5463 $\text{R}_\odot$.

3. Jean's Length: $R_J = \sqrt{\frac{15*k*T}{4*\pi*G*\mu*m_H*\rho_0}}$. Then,

$$R_j = \sqrt{\frac{15(1.38 * 10^{-23})(110)}{4\pi(6.67 * 10^{-11})(1)(1.67 * 10^{-27})((1.67 * 10^{-27})(1.22 * 10^6))}}$$
$$R_j = \frac{2.83 * 10^{18}}{1.496 * 10^{14}}$$
$$R_j = 18917\ \text{AU}.$$

Freefall Time: $T_{ff} = \sqrt{\frac{3\pi}{32G\rho_0}}$. Then,

$$T_{ff} = \sqrt{\frac{3\pi}{32(6.67 * 10^{-11})(1.67 * 10^{-27})(1.22 * 10^{6})}}$$
$$T_{ff} = \frac{1.47 * 10^{15}}{31557600}$$
$$T_{ff} = 4.658 * 10^{7} \text{ years}$$