ASTR 541; Week 1

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1a. ***Hydrogen density***

We can first calculate the density of the disc as

$$\rho = \frac{M}{\pi R_{\text{disc}}^2 H} \tag{1}$$

$$= 1.9 \times 10^{-24}\,\text{g}\,\text{cm}^{-3} \tag{2}$$

Now we need to convert the density to a number density as follows

$$\rho = m_{\text{H}} n_{\text{H}} + m_{\text{He}} n_{\text{He}} \tag{3}$$

$$= n_{\text{H}}\left(m_{\text{H}} + m_{\text{He}}\frac{n_{\text{He}}}{n_{\text{H}}}\right) \tag{4}$$

$$= n_{\text{H}}(m_{\text{H}} + 0.1 m_{\text{He}}) \tag{5}$$

$$= 1.4 n_{\text{H}} m_p \tag{6}$$

$$n_{\text{H}} = \frac{\rho}{1.4 m_p} \tag{7}$$

This gives that the average number density of hydrogen is

$$\boxed{n_{\text{H}} = 0.8\,\text{cm}^{-3}} \tag{8}$$

1b. ***Dust grain density***

???

1c. ***Molecular clouds - frequency and mass***

The typical mass can be found by multiplying the number density, mass of particles and volume.

$$M_{\text{MC}} = m_{\text{H}_2} n_{H_2} V_{\text{MC}} \tag{9}$$

$$= 2 m_p n_{H_2}\left(\frac{4}{3}\pi R_{\text{MC}}^3\right) \tag{10}$$

$$\boxed{M_{\text{MC}} = 10^5\,\text{M}_\odot} \tag{11}$$

The approximate number of clouds in the galaxy is then just

$$N_{\rm MC} = \frac{0.3 M_{\rm disc}}{M_{\rm MC}} \tag{12}$$

$$\boxed{N_{\rm MC} = 1.1 \times 10^4} \tag{13}$$

1d. ***Molecular clouds getting in the way***
