Homework 9

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Task 2

(a) In order to find the cloud's diameter consider the column density:

$$N = \int n \, \mathrm{d}z \overset{\text{here}}{=} n \int_0^d \mathrm{d}z = nD$$
$$\iff d = \frac{N}{n} = 1.5 \times 10^{16} \, \mathrm{m} = 0.49 \, \mathrm{pc}$$

(b) To find the total number of particles:

$$\text{Number of particles} = nV, \quad V = \frac{\pi d^3}{6}$$
$$\implies \text{Number of particles} = \frac{\pi d^3 n}{6} = 1.77 \times 10^{56}$$

(c) Therewith one can estimate the cloud's total mass:

$$M = \text{Number of particles} \times m_\mathrm{H} \overset{m_\mathrm{H} \approx m_\mathrm{P}}{=} 2.96 \times 10^{29} \, \mathrm{kg} = 0.15 \, \mathrm{M}_\odot$$

(d) The Luminosity of 21cm photons with given rate of photons Q:

$$L = Q \times h\nu = 1.47 \times 10^{18} \, \mathrm{W} = 3.8 \times 10^{-9} \, \mathrm{L}_\odot$$

where $\nu = \frac{c}{\lambda} = 1.4 \times 10^9 \, \mathrm{Hz}$.

(e) And finally the flux of 21cm photons as seen on earth:

$$F_\nu = \frac{L}{A\nu} = \frac{L}{\pi D^2 \nu} = 3.48 \times 10^{-29} \, \mathrm{W \, m^{-2} \, Hz^{-1}} = 3.48 \times 10^{-3} \, \mathrm{Jy}$$

where $D = 100 \, \mathrm{pc} \approx 3.1 \times 10^{18} \, \mathrm{m}$.