Homework 2 3

a) $\frac{Q_0}{V} = n_e n_p \alpha_B \Rightarrow Q_0 = n_e n_p \alpha_B V$

Optically thin $\Rightarrow F_\nu = \frac{j_\nu(T) V}{D^2} \Rightarrow V = \frac{F_\nu D^2}{j_\nu}$

$\Rightarrow Q_0 = \frac{n_e n_p D^2}{j_\nu} F_\nu \alpha_B$

$\Rightarrow Q_0 = \frac{n_e n_p D^2 F_\nu \cdot 2.54 \cdot 10^{-13} (T_4)^{-0.8163 - 0.0208 \ln(T_4)}}{5.444 \cdot 10^{-41} \cdot 6.155 \nu_g^{-0.118} T_4^{0.177} T_4^{-1/2} e^{-h\nu/kT} \cdot 1.1 n_p n_e}$ $(Z_i \sim 1)$

b) $D = 414 pc = 414 \cdot 3.1 \cdot 10^{18} cm$

$F_\nu = 495 \cdot 10^{-23} ergs^{-1} cm^{-2} Hz^{-1}$

$\nu = 1.4 \cdot 10^9 Hz \Rightarrow \nu_g = 1.4 GHz$

$T_e = 9000K \Rightarrow T_4 = 0.9 K$

$\Rightarrow Q_0 = \frac{(414 \cdot 3.1 \cdot 10^{18})^2 \cdot 495 \cdot 10^{-23} \cdot 2.54 \cdot 10^{-13} \cdot 0.9^{-0.8163 - 0.0208 \ln(0.9)}}{5.444 \cdot 10^{-41} \cdot 6.155 \cdot 1.4^{-0.118} \cdot 0.9^{0.177} \cdot 0.9^{-1/2} e^{-6.626 \cdot 10^{-27} \cdot 1.4 \cdot 10^9 / 1.3807 \cdot 10^{-16} \cdot 9000}} \cdot 1.1$

$\approx 6.04287 \cdot 10^{48}$ photons/sec

$\Rightarrow \log(Q_0) \approx 48.78 \Rightarrow$ O7V spectral type