ASTR 792 HW 12

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27.1a

Because the nebula is in thermal equilibrium, we assume $n_H = n(e^-)$ and

$$\Gamma_{pe} = \Lambda_{ff} + \Lambda_{rr}$$

The rate of heating becomes

$$\Gamma_{pe} = \alpha_B n_H n e \psi k T_c$$

where $\langle E_{eff} \rangle = 3/2kT$. The rate of free-free emission is

$$\Lambda_{ff} = -.54 n_e n_H \alpha_b k T$$

The rate of radiation recombination is

$$\Lambda_{rr} = n_e n(H^+) \langle E_{eff} \rangle = n_e n(H^+) \frac{3}{2} k T$$

Therefore

$$\alpha_B n_H n_e \psi k T_c = n_e n_H \frac{3}{2} k T + .54 n_e n_H \alpha_b k T$$
$$\rightarrow T = T_c \frac{2\psi}{4.08}$$

Let $Z = 1$ and $\psi = 1.38$. this becomes

$$\rightarrow T = 32000\ K \frac{2 * 1.38}{4.08}$$
$$\approx 21600\ K$$