Finding the radius of an H II region

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Strømgren Radius

$$R_{eq} = \left(\frac{3 N_{uv}}{4\pi n_p}\right)^{1/3} \left(\frac{1}{\sigma v_e n_e}\right)^{1/3}$$

$$= \left(\frac{3 N_{uv}}{4\pi}\right)^{1/3} \left(\frac{1}{\sigma v_e}\right)^{1/3} n_e^{-2/3}$$

$$= \left(\frac{3 N_{uv}}{4\pi}\right)^{1/3} \left(\frac{1}{\sigma}\right)^{1/3} \left(\frac{m_e}{3kT}\right)^{1/6} n_p^{-2/3}$$

From version in notes:

N_{uv}: ionizing photons / sec (10^{49})

($10^{9}\ m^{-3}$) n_e, n_p: density of electrons/protons (equal)

σ: effective particle cross-section ($5.9 \times 10^{-25}\ m^2$)

v_e: velocity of electrons $= \sqrt{\frac{3kT}{m_e}} = 6.7 \times 10^5\ m/s$ when $T = 10^4\ K$

Constants: $k = 1.38 \times 10^{-23}\ J/K$

$m_e = 9.1 \times 10^{-31}\ kg$

"constants": $\sigma = 5.9 \times 10^{-25}\ m^2$

$n_p = 10^7\ m^{-3}$

Options to change: R_{eq}

T

n_p

N_{uv}

Q: Let $T = 11000\ K$, $N_{uv} = 9 \times 10^{48}$, $\sigma = 5.9 \times 10^{-25}\ m^2$, $n_p = 10^7\ m^{-3}$. Find $R_{strømgren}$

A: find $v_e = \sqrt{\frac{3kT}{m_e}} = \sqrt{\frac{3(1.38 \times 10^{-23}\ J/K)(11000\ K)}{9.1 \times 10^{-31}\ kg}} \approx 7 \times 10^5\ m/s$

$$R = \left(\frac{3(9 \times 10^{48})}{4\pi}\right)^{1/3} \left(\frac{1}{(5.9 \times 10^{-25}\ m^2)(7 \times 10^5\ m/s)}\right)^{1/3} (10^7)^{-2/3} \approx 3.7 \times 10^{17}\ m$$

$1\ pc = 3.08 \times 10^{16}\ m \rightarrow$ **$R = 12.1\ pc$**