Eddie? / Herry?

PROBLEM 4

a) (3 points) Imagine a large cloud of pure interstellar hydrogen having density n atoms/cm^3. Φ is the number of photons emitted by a star per second which are capable of photoionizing neutral hydrogen ($\lambda < 912$Å), while αn^2 is the number of recombinations per second per cm^3. If each photon results in a photoionization and the rate of photoionization equals the rate of recombination, find an expression for the Strömgren sphere R_s, i.e. the radius of the ionized gas cloud, in terms of n, Φ, and α.

b) (2 points) Find R_s in parsecs for an O star if Φ=10^{49}photons/s, n = 10 atoms/cm^3, and $\alpha = 2 \times 10^{-13}$.

c) (2 points) Find R_s in parsecs for the sun if $\Phi = 5 \times 10^{23}$ photons/s, while n and α remain the same.

d) (3 points) Could the cloud around the sun be seen by an astronomer on α-Centauri (distance=1.31pc) using a telescope which can just barely resolve objects which are 1" in angular size?

Constants:

1 parsec=3.086x10^{18}cm

1 radian = 206265 arcsec

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Astro #4

a) $[n] = \frac{\text{atoms}}{cm^3}$

$[\Phi] = \frac{\text{photons}}{s}$

* Assuming # of ionizations and recombinations are the same over a 1s interval

$\Phi = \int \alpha n^2 dV$

$\Phi = \alpha n^2 \frac{4}{3}\pi r^3$

$\left(\frac{3\Phi}{4\alpha n^2 \pi}\right)^{1/3} = r$

b) $r = \left(\frac{3 \cdot 10^{49} \frac{1}{s}}{\pi \cdot 4 \cdot 2 \cdot 10^{-13} (10)^2 \frac{1}{cm^3}}\right)^{1/3}$

$= 4.92 \cdot 10^{19}$ cm

≈ 15.96 pc

c) $r = \left(\frac{5 \cdot 10^{23}}{\pi \cdot 4 \cdot 2 \cdot 10^{-13} \cdot 10^2 \frac{1}{cm^3}}\right)^{1/3}$

$= 1.258 \cdot 10^{11}$ cm

$= 4.08 \cdot 10^{-8}$ pc