ASTR 792 HW 3

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Due: September 28 2023

Draine 1.3

$n_H = .22\ cm^{-3}$
$v_{rel} = 26 \pm 1\ km\ s^{-1}$
$\frac{He}{H} = .1$
$F_{dust} = .005 m_{gas}$
$a = .1\mu m = 10^{-5}\ cm$
$\rho_{dust} = 2\ g\ cm^{-3}$

First, let's compute the mass of a single particle of dust

$$\begin{aligned} m_{part} &= 2\ g\ cm^{-3} \cdot \frac{4}{3}\pi(10^{-5}\ cm)^3 \\ &= 8.38 \cdot 10^{-15}\ g \end{aligned}$$

Next, let us calculate the density of the gas

$$\begin{aligned} \rho_{gas} &= n_H m_H + n_{He} m_{He} \\ .22\ cm^{-3} \cdot 1.67 \cdot 10^{-24}\ g + .022\ cm^{-3} \cdot 4 \cdot 1.67 \cdot 10^{-24}\ g \\ &= 5.14 \cdot 10^{-25}\ g\ cm^{-3} \end{aligned}$$

The density of the dust is therefore

$$\begin{aligned} \rho_{dust} &= .005 \cdot \rho_{gas} \\ &= .005 \cdot 5.14 \cdot 10^{-25}\ g\ cm^{-3} \\ &= 2.57 \cdot 10^{-27}\ g\ cm^{-3} \end{aligned}$$

The number density for the dust then becomes

$$\begin{aligned} n_{dust} &= \frac{2.57 \cdot 10^{-27}\ g\ cm^{-3}}{8.38 \cdot 10^{-15}\ g} \\ &= 3.05 \cdot 10^{-13}\ cm^{-3} \end{aligned}$$

Therefore we can calculate the area by

$$1/hr = n_{dust} A v_{rel}$$
$$\frac{1}{3600\ s} = 3.05 \cdot 10^{-13}\ cm^{-3} \cdot \frac{2.6 \cdot 10^{6}\ cm}{s} A$$
$$= 350\ cm^{2}$$