Assignment #6: due June 19

1. **Dust Extinction**

   (a) The $R_{\rm V}$ of the diffuse ISM in our Galaxy is generally taken to be 3.1. Assuming that the extinction can be represented as a power law with wavelength, $A_\lambda \propto \lambda^\beta$, what is the value of β that will give $R_{\rm V} = 3.1$.

   (b) If I measure an $A_{\rm V}$ of 1 along a sight line, by how much does the B band extinction change if the $R_{\rm V} = 5.5$ instead of the typical 3.1?

   (c) Bohlin et al. (1978) found a direct relation between the reddening and column density of gas, with:

   $$N_{\rm H}/(A_B - A_V) = 5.8 \times 10^{21}\,{\rm cm}^{-2}{\rm mag}^{-1}. \quad (1)$$

   What would be the difference in column density be between the sight lines with $R_{\rm V} = 5.5$ and $R_{\rm V} = 3.1$ mentioned above in question 1(b)?

2. **Dust Emission**

   (a) At 850 μm, the absorption cross-section per unit mass of galactic dust is estimated to be $\kappa_{850} \sim 0.47$ cm^2 g^{-1}. If we assume this arises from a MRN power-law grain size distribution ($d{\rm N}/da \propto a^{-3.5}$ with $0.01 < a < 1.0$ μm), and that $Q_{\rm abs,850} \propto a^{0.8}$, what would be the value of κ_{850} if the grain size distribution was flattened to $d{\rm N}/da \propto a^{-3.3}$?

   (b) Using the SPIRE instrument on the Herschel space telescope we measure a 500 μm flux of 51 MJy / steradian (5.1×10^{-19} W m^{-2} Hz^{-1} sr^{-1}) in the centre of the Whirlpool galaxy (M51, distance=7.6 Mpc). The temperature of dust in this region is 25 K. Determine what the surface density of dust is given the values of κ_{850} from question 2(a) (assume the emissivity $Q_{abs}(\lambda) \propto \lambda^{-2}$, and use M$_\odot$ pc^{-2}).