Astro 7B: Worksheet 5

(Spring 2021)

1. Dust Extinction   (Adapted from C&O 12.1.1)
A certain star, located 0.8 kpc from Earth, is found to be dimmer than expected at $\lambda = 550$ nm by A_V = 2.2 mag, where A_V is the amount of extinction at visual wavelengths. Suppose the cross-section for absorption (roughly the size of the dust grains) is $\sigma_\lambda \sim 2 \times 10^{-13}$ m^2.

a) Roughly how many dust grains does a visual photon encounter before reaching Earth? What is the average mean free path of the photon traveling to Earth from the star?

b) What is the average number density of dust particles between Earth and the star?

2. Pesky coefficients   *Calculate the gravitational potential energy for a spherical galaxy of constant density.*

3. Many roads to Jeans   A cloud is Jeans unstable when the cloud collapses under its own weight – the self-gravity of the cloud wins out over thermal pressure, which is trying to keep the cloud up.

a) Derive the Jeans mass by equating the gravitational potential energy to the typical thermal energy. Neglect order-unity coefficients.

b) Derive the Jeans mass by equating the sound crossing time to the gravitational free-fall time. Neglect order-unity coefficients.

c) Examine the scaling relations in the Jeans Mass. When we increase T or ρ, what happens to M_J? Does this makes sense, physically?