Problem 1.

(a) Determine how the observed surface brightness (i.e., flux per square arcsecond on the sky) of a disk galaxy seen face-on depends on the optical depth due to interstellar dust in the galaxy. Consider two limiting cases:

- Case 1: The stars are distributed uniformly throughout a thin layer of thickness D with a layer of absorbing material of optical depth $\tau_\lambda$ between the stars and the observer ($\tau_\lambda$ is the total optical depth at wavelength $\lambda$ integrated along our line-of-sight).

- Case 2: Same as Case 1, but now the absorbing medium is distributed uniformly with the stars.

In both cases, assume that D is negligible compared to the distance to the observer. Express your answers in terms of the observed surface brightness, $I_\lambda$, of the galaxy, the surface brightness the galaxy would have without any dust extinction, $I_\lambda(0)$, and the total integrated optical depth, $\tau_\lambda$.

(b) Plot $I_\lambda/I_\lambda(0)$ versus $\tau_\lambda$ in both cases. Discuss the results.

Note: The calculation is only academic since real dust grains have an albedo of about 50%, so they scatter much of the light rather than absorb it.

Problem 2.

Binney & Merrifield, Prob. 10.10.

Problem 3.

Binney & Merrifield, Prob. 10.13.

Problem 4.

Binney & Merrifield, Prob. 10.16.