

Galactic Astrophysics (2013 PhD Qualifying Exam)

- (1) What variables does the photon specific intensity I depend on, and what does the specific intensity mean? (5%) What is the radiative transfer equation that describes the evolution of I along the photon path? (5%) From this equation, how do you use the diffusion approximation to derive the Rosseland mean opacity? (10%)
- (2) In a steady state where the specific intensity does not change along the photon path, the absorption must balance the emission. Three processes are involved in the balance, and what are they? (5%) You can take the thermodynamics limit to derive the coefficients (Einstein coefficients) of these processes. What are these coefficients? (10%) In such a steady state, what is the photon polarization? (5%)
- (3) For an infinitely extended thin mass sheet of **uniform** surface density σ in a vacuum, what is the equation describing the gravitational potential ϕ produced by the sheet? (5%) What is the solution ϕ yielded by this equation? (5%) Suppose that there is a surface density perturbation δ on the sheet, and it assumes the spatial dependence $\delta = \alpha \cos(kx)$, where α is a constant, what is the perturbed gravitational potential produced by this density perturbation? (10%)
- (4) What is the difference between the distribution function of gas particles and the distribution function of collisionless particles. (5%) What is the evolution equation of collisionless particles? (5%) What is the evolution equation for gas particles? (10%)
- (5) The light profile of a typical elliptical galaxy can be described by de Vaucouleur's law. What is it? (5%) On the other hand what is the light profile of a typical disk galaxy? (5%) From the disk galaxy light profile and rotation curve, how do you show that there must be a dark matter halo around the galaxy? (10%)