

PhD qualifying Exam: Galactic Astrophysics (2/2016)

- (1) Dark matter particles are collisionless. What is the evolution equation governing the collisionless particles? (10%) Stars are mostly collisionless. When so, can we distinguish stars from dark matter particles in the evolution equation? (5%) What is the condition for them to reach an equilibrium state? (10%)
- (2) In a collisionless equilibrium, the above evolution equation is governed by a much simpler equation, called the Jeans equation, when this equilibrium is spherically symmetric but the velocity dispersion can be anisotropic. What is the Jeans equation? (5%) How do you derive the Jeans equation from the evolution equation of problem (1)? (10%) The Plummer's model is an important example of a self-consistent solution of collisionless particles. Show that this model is self-consistent. (10%)
- (3) What is the Faber-Jackson relation and the Tully-Fisher relation? (10%) To what systems are they applied? (5%) Why can the Tully-Fisher relation be used to determine the distance? (10%)
- (4) What is the Jeans criterion for the gravitational instability? (5%) If we assume the local region of a disk galaxy undergoes uniform rotation, how do you derive a modified criterion for gravitational instability? (15%) What is the most unstable wavenumber of this instability? (5%)