Astrophysics IV: Stellar and galactic dynamics

Exercises

Problem 1:

Derive the mean velocities and velocity dispersion tensor (in spherical coordinates) for a spherical system described by a distribution function that depends on the energy and angular momentum. When possible, write those quantities as a function of the tangential velocity.

Problem 2:

Derive the mean velocities and velocity dispersion tensor (in cylindrical coordinates) for an axi-symmetric system described by a distribution function that depends on the energy and z-component of the angular momentum.

Problem 3:

The distribution function of a spherical system is proportional to $L^\gamma f_1(\epsilon)$. Show that at all radii the anisotropy parameter is $\beta = -\frac{1}{2}\gamma$.

Problem 4:

A spherical mass distribution is immersed in a sea of collisionless test particles, which arrive with velocities $\mathbf{v} = (v, 0, 0)$ from the negative x-direction and are scattered by the gravitational field from the mass. Does the distribution function of the test particles satisfy the Jeans theorem? If so, write down the distribution function as a function of the integrals of motion; if not, explain why the Jeans theorem fails.