Collisional Evolution of Nuclei

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[1] Collisionless nuclei: the nuclei in which the relaxation time T_r —the time required for random gravitational encounters between stars to deflect them from their otherwise fixed orbits—is long compared with the age of the universe. The allowed equilibrium states of collisionless galaxies are very diverse, including models with essentially any radial distribution of matter around the supermassive black hole (SBH), as well as many different morphologies (spherical, axisymmetric, triaxial) and velocity distributions (isotropic, highly rotating, chaotic). The only a priori requirement that can be placed on the stellar distribution function f of a collisionless galaxy is that it satisfies Jeanss theorem in the combined gravitational potential, Φ, of the stars and the SBH. But this requirement turned out to place only very weak constraints on f and Φ. The degeneracy in f in collisionless nuclei is the biggest impediment to inferring SBH masses from kinematical data, since in only a handful of galaxies is the sphere of influence well-enough resolved that a Keplerian rise in velocities near the center is seen. A collisionless stellar system is like a gas in which the molecules have not yet experienced a single collision: the particle positions and velocities still reflect in large measure the "initial conditions".

Collisional nuclei: the nuclei that are older than one relaxation time. The phase-space densities are determined by just a handful of parameters: the "temperature" (i.e., the velocity dispersion), the mean density, the distribution of stellar masses.

References

[1] D. Merritt. *Dynamics and Evolution of Galactic Nuclei*. July 2013.