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The approach to equilibrium for idealized collisionless self-gravitating systems

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The evolution and equilibrium structure of dark matter halos has been well studied using N-body simulations. However, theoretical understanding, for example, based on statistical mechanics has been more challenging. A decade ago we showed that extremizing the number of microstates with a given energy per unit mass, under the constraints of conserved total energy and mass, leads to the maximum entropy state, known as DARKexp. Its differential energy distribution, and the resulting density structures provide very good fits to simulated dark matter halos. Here we define a non-equilibrium functional, which is maximized for DARKexp and increases monotonically during the evolution towards equilibrium of an idealized collisionless system, the Extended Spherical Infall Model.

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