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Dynamical Friction from Ultralight Dark Matter

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We simulate the gravitational dynamics of a massive object interacting with ultralight/fuzzy dark matter (ULDM/FDM), nonrelativistic quantum matter described by the Schrödinger-Poisson equation.

We first consider a point mass moving in a uniform background, and then a supermassive black hole (SMBH) moving within a ULDM soliton. After replicating simple dynamical friction scenarios to verify our numerical strategies, we demonstrate that the wake induced by a moving mass in a uniform medium may undergo gravitational collapse that dramatically increases the drag force, albeit in a scenario unlikely to be encountered astrophysically. We broadly confirm simple estimates of dynamical friction timescales for a black hole at the center of a halo but see that a large moving point mass excites coherent "breathing modes"in a ULDM soliton. These can lead to "stone skipping"trajectories for point masses which do not sink uniformly toward the center of the soliton, as well as stochastic motion near the center itself. These effects will add complexity to SMBH-ULDM interactions and to SMBH mergers in a ULDM universe.

This talk will also discuss ongoing work in the quantitative analysis of nonlinear oscillations of a range of systems made up of ULDM solitons and point particles.

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