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Wave Interference in Self-Interacting Fuzzy Dark Matter

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In the Fuzzy Dark Matter (FDM) scenario, the dark matter is composed of an ultra-light scalar field with coherence length and wave interference on astrophysical scales. Scalar fields generically have quartic self-interactions that modify their dispersion relation and the associated evolution of density perturbations. In this talk, I will present the first dedicated analysis of the relationship between wave interference and the evolution due to self-interactions, where we first develop a perturbative treatment applicable at early times and then compare against a suite of benchmark simulations. We vary the dark matter density, interaction strength, and fiducial momentum scale, focusing on the regime where the momentum is relatively high compared to the simulation volume. This is relevant for cases where the dark matter is initially "warm"from post-inflationary production or in virialized halos and other "thermalized"cases with initially cold production. We find that in such scenarios, density perturbations are unable to grow on the expected self-interaction time scale because of interference effects, instead saturating on the much shorter de Broglie crossing time, with a dependence on the sign of the interaction. Finally, I will discuss the implications of our findings for astrophysical systems such as high-density ultra-faint dwarf galaxies, where wave interference plays a significant role.

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