

Coherent to incoherent structures in fuzzy dark matter (C)

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Bosonic dark matter particles with hypothetical ultralight mass down to the order of a trillionth of an electronvolt have a de Broglie wavelength in galactic length scales. The manifested quantum wave nature in astrophysical length scale suppresses and stabilizes the formation of small-scale structures with the uncertainty principle, and it is called fuzzy dark matter, which can be described by the Schrödinger-Poisson equation. Motivated by the concepts in atomic Bose-Einstein condensate, we examine the degree of spatial coherence of the field configuration in fuzzy dark matter halos. The compact soliton stabilized by the quantum pressure with a flat central density profile and full coherence sits at the centre of a halo and is surrounded by an incoherent field whose density follows the Navarro-Frenk-White profile and exhibits turbulent features. This spatial transition from coherence to incoherence can be well characterized by two parameters according to a generalized empirical core-halo profile, whose oscillations are found to be anti-correlated to the oscillation of the peak value of the power spectrum of the halo; their oscillation frequencies scale with the soliton core density. The outer halo reaches a quasi-steady state with a fixed distribution profile in the vortex energy spectrum, unveiling the vortical core structure, and the mean intervortex spacing is found to be correlated to the characteristic granule size.

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