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When to interfere with dark matter? The impact of wave dynamics on statistics

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Ultralight candidates for dark matter can present wavelike features on astrophysical scales. Full wave based simulations of such candidates are currently limited to box sizes of 1-10 Mpc/h on a side, limiting our understanding of the impact of wave dynamics on the scale of the cosmic web. We present a statistical analysis of density fields produced by perturbative forward models in boxes of 128 Mpc/h side length. Our wave-based perturbation theory maintains interference on all scales, and is compared to fluid dynamics of Lagrangian perturbation theory. The impact of suppressed power in the initial conditions and interference effects caused by wave dynamics can then be disentangled. We find that changing the initial conditions captures most of the change in one-point statistics such as the skewness of the density field. However, different environments of the cosmic web, quantified by critical points of the smoothed density, appear to be more sensitive to interference effects sourced by the quantum potential. This suggests that certain large-scale summary statistics may need additional care when studying cosmologies with wavelike dark matter.

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