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Unified description of corpuscular and fuzzy scalar dark matter

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We derive coupled equations for self-interacting scalar dark matter, which can include both a condensed, low momentum ‘‘fuzzy” component and one with higher momenta that may be described as a collection of classical particles. We do this from first principles, using the Schwinger-Keldysh path integral and the corresponding Feynman diagrams in a perturbative expansion. The resulting coupled equations consist of a modified Gross-Pitaevskii equation describing the condensate, a kinetic equation describing the higher momentum modes (the ‘‘particles”), and the Poisson equation for the gravitational potential sourced by the two components. We show that this model contains known models of dark matter and cold atom physics in some limits.

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