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Bosonic dark-matter: How to mix Particle Physics, Cosmology and Cold Atoms

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We present from first principles, under the Schwinger-Keldysh path integral formalism, equations for bosonic, non-relativistic and self-interacting dark matter which can include both a condensed, low momentum “fuzzy” component and one with higher momenta that may be approximated as a collection of particles. The equations can describe both CDM and Fuzzy Dark Matter in a unified way. We show that self-interaction could play an important role in the dynamics of the two components, for example in the initial generation and growth of the condensate through the presence of stochastic noises and dissipative terms.

We also present the linear regime of this mixed model and we show how the existence of these two components and the interaction between the condensate and particles could bypass Lyman alpha forest bounds for the typical Fuzzy Dark Matter.

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