Contribution ID: **57**　　　　　　　　　　　　　　　　　　Type: **Plenary/Parallel talk**

Unified description of corpuscular and fuzzy scalar dark matter

Monday, 22 August 2022 16:30 (20 minutes)

We present a finite temperature model for dark matter. In this work, we show 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 two distinct but equivalent approaches: firstly via the Schwinger-Keldysh path integral and secondly using the operator evolution equation of the density matrix, also known as the ZNG formalism in the cold atom community. 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.

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Session Classification:　Parallel Session Main Cupula: DM

Track Classification:　Dark matter, neutrinos & astroparticle physics