Contribution ID: **18** Type: **ORAL**

Quantum field theory of scalar dark matter: a simple model

Thursday, 24 October 2024 15:40 (25 minutes)

We build up a simple Lorentz invariant model of dark matter consisting of a massive, real, scalar field coupled to its massless, real scalar mediator field. From a mathematical point of view the model belongs to the Klein-Gordon-Wave family of models. The dynamics is ruled by a single parameter, containing the mass of the dark particles and their initial number. It is shown that if the latter number is set to one, then the stationary states of the model exist only for values of the particle mass that are quantized, the minimum possible value being at the Planck scale, whereas no upper bound exists. Such states can be tentatively interpreted, within all the limits of the theory, as primordial black holes. On the other hand, allowing for a very large number of particles and plugging into the model a value of the dark particle mass of the order of $10^{-24}eV$, we get, by a perturbative procedure, the Schroedinger-Wave model. The spherically symmetric, stationary states of the latter model are those first interpreted by Sin (1994) as "cold" BEC clumps of galactic size. Thus, the simple model considered here allows for two components of dark matter (primordial black holes and ultralight scalars) whose mass ranges are completely far apart. The important issue concerning the stability of the two families of stationary states is also discussed.

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Session Classification: Cosmology - Talks on specific topics

Track Classification: Cosmology