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Two-phase structure of ultralight dark matter with ψ^6 self-interaction.

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The ultralight dark matter (ULDM) model (also known as fuzzy dark matter or Bose-Einstein condensate dark matter) is one of alternatives to the cold dark matter (CDM) paradigm. It suggests that the dark matter particles are ultralight bosons with a tiny mass order of 10^{-22} eV, so that their de Broglie wavelength is of kiloparsec scale, that helps to resolve CDM tensions on the small scales. We consider ultralight scalar bosons condensate with ψ^6 self-interaction, which has a noticeable effect on the dark matter density distribution in highly dense regions, such as a central core of galactic dark matter halo or overlap of dark matter halo during the galaxies collision. At the same time, a contribution of tree-particles interaction is negligible in an outer part of the galactic dark matter halo and intergalactic medium. Thus all ULDM predictions on the large scales remain valid for the ψ^6 model, which, in turn, coincide with CDM predictions on these scales and are in agreement with observations. From the detailed analysis of thermodynamic characteristics of ULDM with ψ^6 self-interaction, we find the existence of two phases of dark matter separated by instability region in the (high density) core of dark matter halo.

Primary authors: Prof. GAVRILIK, A. M.; KHELASHVILI, M. V. (Bogolubov Institute for Theoretical Physics); NAZARENKO, A. V.

Presenter: KHELASHVILI, M. V. (Bogolubov Institute for Theoretical Physics)

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