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Neutrino clusters

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The formation of a neutrino cluster due to an attractive interaction with a hypothetical light scalar boson is studied. The density distribution of the neutrino gas within the cluster is obtained for various system parameters. It is shown that, in addition to forming a cluster in space, the neutrino gas within it can form a superfluid condensate. An energy gap equation is derived for such a system, and the phase transition temperature and coherence length within the cluster are found. Constraints on the parameters of the interaction leading to neutrino superfluidity are derived. It is found that the superfluid condensate within the cluster consists of relic neutrinos. A neutrino cluster cooling channel based on the Cherenkov emission of neutrinos in matter is studied if the cluster forms in the early universe. A temperature range is obtained for which Cherenkov cooling of the cluster is effective. The possible contribution of neutrino clusters to dark matter is briefly discussed.

Primary author(s) : DVORNIKOV, Maxim (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation (IZMIRAN))

Presenter(s) : DVORNIKOV, Maxim (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation (IZMIRAN))

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