

Neutrino scattering on superfluid helium with account for neutrino electromagnetic properties and collective effects

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Superfluid He-4 can serve as a tool for neutrino [1] and dark matter detection [2]. Low-energy neutrino interaction with superfluid He-4 can take place in the form of coherent elastic neutrino-atom scattering (CEvAS) [3] - a process that has not been observed so far. The first experimental study of CEvAS is under preparation in the National Center for Physics and Mathematics in Sarov [4]. Using a high-intensity tritium neutrino source and a superfluid He-4 detector, it will have a rich potential to test the neutrino physics of Standard Model and beyond it at unprecedentedly low energies. For example, one of the observable effects of beyond-Standard-Model physics in CEvAS can be neutrino millicharge and magnetic moment [5]. In our work we develop a theoretical approach for studying neutrino interaction with a superfluid He-4 by taking into account single quasiparticle production in a superfluid He-4 target upon tritium neutrino scattering. In particular, we show that such collective effects drastically influence the neutrino scattering cross section at energy transfer of the order of 1 meV and less.

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