Report on the SATURNE project devoted to the measurement of neutrino electromagnetic properties

The project is unique for the following reasons:

1. The proposed TiT_2 neutrino source with an activity of 10 MCi has no known radioactive background and easily permits choosing an optimal source-detector geometry. The development and production of such a source seems currently possible only in Russia.

2. The first goal of the project is the detection of coherent elastic neutrino-atom scattering using a liquid helium target. This type of neutrino scattering process has not been observed so far and SATURNE is the first project aimed at its discovery. This process is interesting also because it is highly sensitive to neutrino electromagnetic characteristics such as, for example, the neutrino magnetic moment. The novelty of the project in this part is due to the fact that atomic recoil energies are extremely small and lie well below the detection threshold of existing types of nuclear detectors. Therefore, the authors of the project are planning to employ low-temperature bolometers for registering elementary excitations in superfluid He-4. This field of ultralow temperature and advanced nuclear physics can lead to unexpected discoveries. The only experiment analogous of this part of SATURNE is the recent US project HeRALD in which a detector with superfluid helium at ultralow temperature will be used to detect light dark matter particles of the WIMP type. However, this task is much simpler because the expected interaction products (recoil nuclei) are charged particles with an energy greater than the ionization energy of helium, so their registration is possible not only through elementary excitations.

The second goal of the project is to improve the limit on the neutrino magnetic moment with neutrino-electron scattering. The existing laboratory limits have been obtained by experiments (GEMMA, BOREXINO) using traditional detectors. From the dependence of the scattering cross section on the energy of the recoil electron it follows that for this problem the key parameter of the detector is the energy detection threshold. The developed low-temperature bolometers make it possible to significantly reduce the detection threshold, but only for small detectors in terms of mass (volume), while to observe rare processes it is necessary to increase the mass (volume). The authors of the project propose to overcome this difficulty by using the conversion of ionization losses into thermal ones with an energy gain of up to 1000 times due to the Neganov-Trofimov-Luke (NTL) effect. The NTL effect has been confirmed experimentally by many groups. Its use will make it possible to obtain with Si detectors at a temperature of 15-40 mK a very low energy threshold, as low as the energy gap of Si (about 1 eV). It is likely that the stated sensitivity to the neutrino magnetic moment at a level of about $2x10^{-12}$ μ_B can quite well be achieved.

To summarize, I recommend to support the SATURNE project and wish every success in its implementation.

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