Investigation of neutrino properties with the low-background germanium spectrometer vGEN

Referee's comment on the project vGEN

The goal of the vGEN project is to investigate fundamental parameters of neutrino. Within the initial formulation of the Standard Model, neutrinos are massless particles. However, already now it is known that the Standard Model should be extended to some more general theory in particular because of neutrinos which are the only particles exhibiting experimentally well-confirmed properties beyond the Standard Model. In many extensions of the Standard Model, which accounts for neutrino masses and mixings, neutrinos acquire nontrivial electromagnetic properties that hence allow direct electromagnetic interactions of neutrinos with electromagnetic fields and charged particles or with particles which have magnetic moments. Unfortunately, in the easiest extension of the Standard Model a tiny value for the neutrino magnetic moment at the level less than ~ 10^{-19} Bohr magneton is predicted. In addition, in spite of reasonable efforts in studies of neutrino electromagnetic properties, up to now there is no experimental confirmation, neither from terrestrial laboratories studies nor from astrophysical observations, in favour of non-vanishing neutrino electromagnetic characteristics. However, many experimentalists and theoreticians really believe that the neutrino magnetic moments have much greater values and are eagerly searching for them. Therefore, neutrino magnetic moments, once being experimentally confirmed, will open a window to new physics beyond the easiest extension of the Standard Model.

As the primary result of the GEMMA-I phase of the project the best world terrestrial experiment upper limit on the neutrino effective magnetic moment 2.9×10^{-11} Bohr magneton has been obtained. The discussed next phase of the GEMMA project (vGEN) is aimed at the further increase in sensitivity to the neutrino magnetic moment and will reach the level of about ~ (5-9) $\times10^{-12}$ Bohr magneton. This seems quite a reasonable and attainable goal for the vGEN collaboration. The claimed limit on the neutrino magnetic moment will be reached because of reasonable improvements in characteristics of the vGEN experimental setup in respect to those of GEMMA-I. The most important, in particular, are the following:

- a factor of 2 increase in the total neutrino flux at the detector because of much closer location of the detector to the reactor core,
- a factor of 3.7 increase in the total mass of the detector,
- the energy threshold would be improved from 2.8 keV to 200 eV.

Furthermore, the experimental setup is located in the new room with much better (by an order of magnitude) γ-background conditions and on a moveable platform. The

later gives an opportunity to vary on-line the neutrino flux and thus suppress systematic errors.

Due to new low-threshold germanium detectors it would become possible to investigate another interesting effect – coherent elastic neutrino-nucleus scattering (CEvNS). This process is predicted by the Standard Model and recently was observed from accelerator by the COHERENT collaboration. It was never observed from the reactor neutrinos, so it would be interesting to compare obtained results. It opens a way to search for new physics via non-standard neutrino interactions. Some other interesting investigations including sterile neutrino search or reactor monitoring are possible within this project. Due to a very good resolution of new detectors produced by CANBERRA it would be possible to reach an energy threshold of 200 eV which makes such detection possible. The important advantage of vGEN setup compare to other projects is the highest available neutrino flux and significant overburden suppressing cosmic radiation.

The JINR team of the vGEN project has an ample experience in setting up first-rate experiments in physics of low-energy weak interactions and there is no doubt that the proposed project can be successfully implemented and thus deserves all possible support.

Prof. Alexander I. Studenikin
Department of Theoretical Physics
Moscow State University
119991 Moscow, Russia

phone: (007-495) 939-16-17
fax: (007-495) 932-88-20
e-mail: studenik@srd.sinp.msu.ru