Referee Report to the joint meeting Jan. 21, 2021 of N.P. & P.P. PAC at JINR

concerning 3.2 Project SuperNEMO

"Investigations of the 2β-decay processes of ^{82}Se with the SuperNEMO detector"

Searches for neutrino-less double beta decays (0νββ) belong to the most fundamental experiments in nuclear and particle physics, testing the nature of neutrinos and ultimately also its mass hierarchy. A discovery of (0νββ)-decays would establish the Majorana type of neutrinos and signify physics beyond the standard model. Several experiments in underground laboratories have studied a number of candidate isotopes, where only 2β decays are energetically possible. Some lower limits of half-lifes have now already reached or are approaching 10^{26} years, though without any clear signal yet. Obviously more efforts with higher sensitivities and improved background suppression must be undertaken.

One of the most promising approaches has been proposed by the NEMO collaboration working in the Mondane underground laboratory (LSM) at France. With the NEMO-3 detector the collaboration has achieved excellent results in the study of (2νββ) and (0νββ) decays of isotopes ^{100}Mo, ^{48}Ca, ^{116}Cd and ^{150}Nd, which are now being published. The NEMO experiments use the tracker-calorimeter technique allowing clear kinematic reconstruction of 2β-events. Since all experiments have so far only led to lower limits of half-lifes $T(0\nu\beta\beta)_{1/2}$, new efforts with much higher sensitivities are required.

A new generation of (0ν2β)-decay experiments, the **SuperNEMO detector**, has been proposed, of which a first unit, the **"SuperNEMO Demonstrator"** using 7 kg of the ^{82}Se isotope is now in its testing and commissioning phase at LSM. The design of the SuperNEMO Demonstrator looks very promising. Start of data collection is expected by the end of 2021. The goal is, after 2.5 years of production, to reach a lower limit $T(0\nu\beta\beta)_{1/2} > 6x10^{24}$ years. The full SuperNEMO detector, composed of 20 Demonstrator units, should reach $T(0\nu\beta\beta)_{1/2} > 10^{26}$ years.

Exactly the same document as of now has already been presented to the PACs in Nov. 2017 and Jan. 2018 – except that the time schedules changed by 2-3 years. So, no progress report is available of the last 3 years! The Dubna group should explain in a new progress report why the SuperNEMO Demonstrator project got delayed and what progress was achieved since 2018.

The Dubna group from DLNP is strongly involved in NEMO projects for many years by the development and testing of detector components (scintillators, PMs, electronics) and isotopes (chemical purification), software developments, etc. In 2018 the PAC recommended that the current output in the form of talks and international conferences and PhD theses should be improved, and that more young physicists should be involved in the data analysis. This should also be documented by the Dubna group.

In conclusion, if the Dubna team can make a convincing case of their future involvement, I strongly recommend that JINR continues with full support of the SuperNEMO project.

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