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Low Threshold Detectors for Neutrino-Nucleus Elastic Scattering and the Studies of its Quantum-Mechanical Coherency Effects

Elastic scattering of the neutrino with nucleus (νA_{el}) offers a unique laboratory to study Quantum Mechanical superpositions in electroweak interactions, towards which several experimental programs are being actively pursued. In the TEXONO experiment, we are currently focused to measure the νA_{el} cross-section for low energy reactor neutrinos (E_ν<10 MeV) at Kuo-Sheng Reactor Neutrino Laboratory[1]. We are using the state-of-art point contact Germanium detector technology with the advance pulse-tube electro-cool mechanism to probe low energy interactions. We will report our status and plan for achieving low threshold & background for νA_{el} search. In parallel, we identified a new parameter (α) to describe the degree of coherency which depends on incoming neutrino energy, detector threshold, and target nucleus [2]. There could be three possible formulations to measure α based on (a) Nuclear Physics (b) Quantum Mechanical description and (c) Data driven description [3]. It can be seen that coherency is mostly complete (α>95%) for νA_{el} with reactor and solar neutrinos for Xe/CsI, Ge and Ar targets, whereas coherency is only partial for DAR-π and weak for atmospheric neutrinos. Accordingly, studies of νA_{el} with different neutrino sources provide complementary information and cover the transitions from completely coherent to decoherent states. We will also highlight our studies on departure of coherency under various scenarios of discovering νA_{el} by comparing it with form factor and N^2 deviation in cross-section.

[1] H. T. Wong et al., J. Conf. Ser. 39, 266 (2006).
[2] S. Kerman et al., Phys. Rev. D93, 113006 (2016).
[3] V. Sharma et al., arXiv:2010.06810v1(2020).

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