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Calculations of Nuclear Matrix Elements (NMEs) of Neutrinoless Double Beta Decay using Spin-Tensor decomposition method of Nuclear Shell Model

Neutrinoless double beta decay is a rare and important process to know whether neutrinos are Dirac or Majorana particles. It also gives hints of absolute neutrino masses. But this weak process is still unobserved even after 70 years of its predictions [1]. Problem is in the uncertainties in theoretical calculations of nuclear matrix element(NME) which is directly related to the decay rate of the process. The decay rate of light neutrino exchange mechanism of the process can be written as
$\Gamma^{0\nu} = G^{0\nu}(Q,Z)|m_{\beta\beta}|^2|M^{0\nu}|^2$
Nuclear matrix elements have Fermi, Gamow Teller, and Tensor part
$M^{0\nu} = M^{0\nu}_{GT} - \frac{g_V^2}{g_A^2}M^{0\nu}_F + M^{0\nu}_T$
Individual part of nuclear matrix elements can be written as [2].
$M^{0\nu}_\alpha = \sum_{j_{p1}j_{p2}j_{n1}j_{n2}J} TBTD(j_{p1},j_{p2},j_{n1},j_{n2},J) \times TBME(j_{p1},j_{p2},j_{n1},j_{n2},J)_A$

We did calculations for the decay

${}^{48}_{20}Ca \rightarrow^{48}_{22} Ti + e^- + e^-.$

In our calculations, we used spin-tensor decomposition method of nuclear shell model [3] to decompose interaction $gxpf1a$ for fp model space into various components (Central, Spin-Orbit, and Tensor) and showed the individual as well as combined contributions of various components to the calculation of TBTD. For our calculations, NushellX@MSU [4] shell model code was used to find the values of two-nucleon transfer amplitudes(TNA) which were used to calculate TBTD [5]. Final nuclear-matrix-elements (NME) were calculated with the calculations of two-body matrix elements (TBME) and TBTD using spin-tensor decomposition method of the nuclear shell model. We will show all the results in details at the conference.

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Primary author: Mr SARKAR, Shahariar (Indian Institute of Technology Ropar)

Co-authors: Mr KUMAR, Pawan (Indian Institute of Technology Ropar); Mr JHA, Kanhaiya (Indian Institute of Technology Ropar); Prof. RAINA, P.K. (Indian Institute of Technology Ropar)

Presenter: Mr SARKAR, Shahariar (Indian Institute of Technology Ropar)

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