Role of Sterile Neutrino in the Neutrinoless Double Beta Decay of ^{76}Ge and ^{82}Se Isotopes

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Introduction

The confirmation of neutrino flavor oscillation [1-2] has established the fact that neutrinos have mass. However, the nature of neutrinos can be ascertained through the study of neutrinoless double beta ($0\nu\beta\beta$) decay. The occurrence of the 0ν $\beta\beta$ decay is possible within mechanisms involving left-right symmetry, super-symmetry, Majorons, sterile neutrinos, leptoquarks and compositeness.

The existence of more than three massive neutrinos and the mixing of a light sterile neutrino (mass<<1eV) with a much heavier sterile neutrino (mass>> 1 GeV) would result in observable signals in current $\beta\beta$ decay experiments [3]. In the case of $0\nu\beta\beta$ decay involving sterile neutrinos, the extracted limits on $\nu_h - \nu_e$ mixing matrix element get extended over a wider region of mass m_h than those of laboratory experiments, astrophysical and cosmological observations [4-6].

Remarkable limits on half lives $T_{1/2}^{0\nu}$ of the 0ν $\beta\beta$ decay have been extracted for ^{76}Ge and ^{82}Se isotopes. Combined data of GERDA experiment [7] with Heidelberg-Moscow experiment [8] and IGEX [9] imply $T_{1/2}^{0\nu}$ > 3.0×10^{25} yr for ^{76}Ge and $T_{1/2}^{0\nu} > 3.6 \times 10^{23}$ yr while for ^{82}Se, as measured by NEMO3 collaboration [10].

These exciting developments in the experimental fronts offer a challenging task for calculating nuclear transition matrix elements (NTMEs) with high reliability, which can be obtained only with reliable nuclear wave functions.

Calculational Framework

The observed onset of shape transitions of nuclei in the Ge region at N = 40 necessitates the adaptation of a calculational framework, which permits the interplay of pairing and deformation degrees of freedom on equal footing [11,12].

The present calculation is performed employing the Projected HFB (PHFB) approach in a valance space spanned by the $1p_{1/2}$, $1p_{3/2}$, $0f_{5/2}$ and $0g_{9/2}$ orbits treating the doubly even ^{56}Ni as an inert core.. Two different sets of wave functions are generated using two distinct effective two-body interactions, namely a realistic interaction KUO [13] and an empirical interaction JUN45 due to Honma et. al. [14].

To ascertain the reliability of the generated wave functions in both the cases, some spectroscopic properties are calculated for ^{76}Ge ^{76,82}Se and ^{82}Kr isotopes and found to be in good agreement with the experimentally observed data [15,16,17,18]. Employing these reliable wave functions, the required NTMEs are calculated for the study of the $0\nu\beta\beta$ decay, and limit on $\nu_h - \nu_e$ mixing matrix is extracted from the observed half lives $T_{1/2}^{0\nu}$ of the 0ν $\beta\beta$ decay.

Conclusions

The study of the $0\nu\beta\beta$ decay of ^{76}Ge and ^{82}Se isotopes involving sterile neutrinos has been performed within the PHFB approach. Detailed results on extracted limit on $\nu_h - \nu_e$ mixing matrix will be presented in the symposium.

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