Role of Compositeness in 0ν ββ Decay of ^{76}Ge and ^{82}Se Isotopes

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Introduction

Neutrinos have mass is being established with the confirmation of neutrino flavor oscillation [1-2] while to ascertain its nature study of neutrinoless double beta (0νββ) decay plays a vital role. Left-right symmetry, super-symmetry, Majorons, sterile neutrinos, leptoquarks and compositeness are possible mechanisms for the occurrence of the 0ν ββ decay beyond Standard Model along with laboratory experiments, astrophysical and cosmological observations [3-5].

Mixing of a light sterile neutrino (<<1eV) with a much heavier sterile neutrino (>> 1 GeV) would result in observable signals in current ββ decay experiments [6] while the contribution of sterile neutrino ν_h to the 0νββ decay due to the exchange of Majorona neutrinos has been studied [7]. Alternative models involving compositeness wherein quarks and leptons are treated as bound states of preons. It is being shown that the compositeness scenario can give additional contribution to the 0ν ββ decay mediated by composite heavy Majorona neutrino [8].

In addition to theoretical front for the 0ν ββ decay in ^{76}Ge and ^{82}Se isotopes, experimental limits on half lives $T_{1/2}^{0\nu}$ have been extracted. Heidelberg-Moscow experiment [9] and IGEX [10] data when combined with GERDA experiment [11] imply $T_{1/2}^{0\nu} > 3.0 \times 10^{25}$ yr for ^{76}Ge while for ^{82}Se, NEMO3 collaboration [12] measured $T_{1/2}^{0\nu} > 3.6 \times 10^{23}$ yr.

Keeping an eye on these exciting developments in the experimental fronts for ^{76}Ge and ^{82}Se, our present concern is to calculate nuclear transition matrix elements (NTMEs) with high reliability. It offers a challenging task, as the observed onset of shape transitions of nuclei in the Ge region at N = 40 necessitates for a model which permits the interplay of pairing and deformation degrees of freedom on equal footing, to generate reliable nuclear wave functions. As the wave functions are model dependent, the employed model should be versatile enough to reproduce many observed properties of nuclei [13,14].

Calculational Framework

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 HFB1 and HFB2 are generated using two distinct effective two-body interactions, namely a realistic interaction KUO [15] and an empirical interaction JUN45 due to Honma et. al. [16] respectively.

To ascertain the reliability of the generated wave functions in both the cases, spectroscopic properties such as energies of yrast 2^+ state, occupation numbers for neutrons and protons, deformation parameter β_2 and g-factor g (2^+) are calculated for ^{76}Ge ^{76,82}Se and ^{82}Kr isotopes and found to be in good agreement with the experimentally observed data [17,18,19,20].

We have already presented our preliminary results on 0ν ββ decay with heavy and Majoron neutrino [21], employing same set of reliable HFB1 and HFB2 wave functions with two alternative forms of FNS namely FNS1 and FNS2 with three different parameterizations of SRC, the required set of 12 NTMEs $M^{(0f)}$ are calculated for the study of the 0νββ decay, and limit on compositeness parameter |*f*| is extracted from the observed half lives $T_{1/2}^{0\nu}$ of the 0ν ββ decay.

Conclusions

The study of the 0νββ decay of ^{76}Ge and ^{82}Se isotopes within composite scenario has been performed within the PHFB approach. Theoretical framework and detailed results of calculated NTMEs and extracted limit on compositeness parameter |*f*| will be presented in the symposium.

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