Study of SUSY accompanied neutrinoless double beta decay within PHFB model

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Introduction

The nuclear ββ decay in general and $(\beta\beta)_{0\nu}$ decay in particular is a convenient tool to test the physics beyond the standard model (SM) namely mass and charge conjugation properties of neutrinos. The $(\beta^-\beta^-)_{2\nu}$ decay has been already observed for about 10 nuclei and can be used to check the validity of nuclear models employed for the nuclear structure calculations. The study of $(\beta\beta)_{0\nu}$ decay mode has the following important ramifications vis-à-vis constraints on parameters of various gauge field theories beyond the SM (i) violation of lepton number conservation, (ii) the mass and charge conjugation properties of electron neutrino and (iii) possible right-handed admixtures in the weak leptonic current.

The $(\beta\beta)_{0\nu}$ decay mode is not only necessarily connected with the exchange of a virtual neutrino but may occur in any model violating conservation of lepton number namely (i) GUTs (Left-right symmetric SO(10) and E(6)), (ii) *R*-parity violating minimal supersymmetric standard model (R_p-MSSM). Out of several mechanisms responsible for $(\beta\beta)_{0\nu}$ decay we examine here the contributions of R_p-MSSM. In the R_p-violating MSSM [1], the gluinos, photinos etc. exchange contributions to the $(\beta\beta)_{0\nu}$ decay leads to a very stringent limit on the first generation Yukawa coupling and combination of the intergeneration Yukawa couplings. The *R*-parity conserving softly broken supersymmetry also contribute to the $(\beta\beta)_{0\nu}$ decay through B-L violating sneutrino mass term [2].

The relevant nuclear transition matrix elements necessary to extract SUSY parameters from $(\beta\beta)_{0\nu}$ decay of nuclei in the mass range 94–150 are calculated using Projected Hartree-Fock Bogoliubov (PHFB) model in conjunction with pairing plus quadrupole-quadrupole (*PQQ*) two body interaction. Finally the constraints on the combination of lepton number violating parameters are derived from the available half-life limits of $(\beta\beta)_{0\nu}$ decay.

Theoretical framework

The details about the model space, single particle energies, *PQQ* type of effective two-body interaction and the procedure to fix its parameters have been given in Refs. [3-6]. The Hamiltonian of the effective two-body interaction used in the present work is given as

$$H = H_{s.p.} + V(P) + V(QQ) \qquad (1)$$

where $H_{s.p.}$, $V(P)$, and $V(QQ)$ denote the single particle Hamiltonian, pairing and quadrupole-quadrupole parts of the effective two-body interaction. The detailed formalism and calculated results will be presented in the symposium.

References

[1] M. Hirsch, H.V. Klapdor-Kleingrothaus and S.G. Kovalenko, Phys. Rev. Lett. 75, 17 (1995); M. Hirsch, H.V. Klapdor-Kleingrothaus and S.G. Kovalenko, Phys. Lett. B 378, 17 (1996); Phys. Rev. D 53, 1329 (1996).

[2] M. Hirsch, H.V. Klapdor-Kleingrothaus, St. Kolb and S.G. Kovalenko, Phys. Lett. B 398, 311 (1997); Phys. Lett. B 403, 291 (1997); M. Hirsch, H.V. Klapdor-Kleingrothaus and S.G. Kovalenko, Phys. Rev. D 57, 1947 (1998).

[3] R. Chandra, J. Singh, P. K. Rath, P. K. Raina, and J. G. Hirsch, Eur. Phys. J. A **23**, 223 (2005).
[4] S. Singh, R. Chandra, P. K. Rath, P. K. Raina, and J. G. Hirsch, Eur. Phys. J. A **33**, 375 (2007).
[5] K. Chaturvedi, R. Chandra, P. K. Rath, P. K. Raina, and J. G. Hirsch, Phys. Rev. C. **78**, 054302 (2008).
[6] P. K. Rath, R. Chandra, K. Chaturvedi, P. K. Raina, and J. G. Hirsch, Phys. Rev. C. **82**, 064310 (2010).