Abstract

This thesis describes the study of $2\nu\ \beta^-\beta^-$ transition as well as $2\nu\ \beta^+\beta^+$/ β^+EC/ ECEC transitions of some nuclei in the mass range $A = 76$ to $A = 150$ within a self-consistent mean field model namely, Deformed Hartree-Fock (DHF) model. Our aim is to study the double beta decay not isolatedly but together with the other observed nuclear phenomena. This is in accordance with the basic philosophy of nuclear many body theory, which is to explain all observed property of nuclei in a coherent manner.

We begin with the presentation of the necessary ingredients of the theoretical model used in detail and its formalism to calculate spectroscopic properties and nuclear transition matrix elements for double beta decay. The present model is based on deformed Hartree-Fock (HF) procedure and angular momentum projection technique. The residual interaction is included self-consistently in building the deformed basis. This model is known to take into account the configuration mixing in the active shell model space. The DHF model, with the residual interaction built into the HF states, is very close to the shell model.

Next, we study the nuclear structure of some nuclei involved in double beta decay processes, in the mass range A=76 to A=150. We have studied nuclear structure properties such as energy spectra, reduced transition probability B(E2), electric quadrupole moments Q and magnetic dipole moments μ, for even-even parent and daughter nuclei as well as odd-odd intermediate nuclei. Here, our aim is to obtain reliable nuclear wave functions which will later be employed to calculate double beta decay observable. We test the quality of the wave functions obtained in our calculations by comparing the shapes and deformations of the nuclei and spectroscopic properties with available experimental results.

Subsequently, we use the above wave functions to calculate the Nuclear Transition Matrix Elements (NTMEs) of $2\nu\beta^-\beta^-$ decay for $0^+ \rightarrow 0^+$ transition in two nucleon (2n) mechanism for the nuclei ^{76}Ge, ^{82}Se, ^{100}Mo, ^{110}Pd, ^{116}Cd, ^{124}Sn, ^{130}Te and ^{150}Nd. The predicted half-lives are compared with the available experimental results as well as with other theoretical model calculations.

Lastly, we employed the above DHF formalism to calculate NTMEs and hence to predict the half-lives for $2\nu\ \beta^+\beta^+$/ β^+EC/ ECEC transitions of ^{78}Kr, ^{96}Ru and ^{106}Cd nuclei.

Finally, we conclude with discussion on possible improvements in the model and future scope of the present work.

Keywords: Deformed Hartree-Fock model, nuclear structure, double beta decay, nuclear transition matrix elements, electromagnetic moments.