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Two-neutrino double-beta decay to excited states of heavy nuclei

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$2\nu\beta\beta$ decay to excited states of heavy nuclei

In double-beta decay, two neutrons convert into two protons, accompanied by the emission of two electrons. According to the Standard Model (SM), this decay, called two-neutrino double-β decay ($2\nu\beta\beta$ decay), involves the emission of two antineutrinos, maintaining an equilibrium between matter and antimatter and preserving the principle of conserving lepton number. In models beyond the SM, this reaction is allowed without the emission of any neutrino. The neutrinoless decay, violates lepton-number conservation of the SM and creates matter ($2e^-$) but no antimatter ($0\overline{\nu}$) [1].
The empirical observation of such reactions would signify the confirmation of physics beyond the SM. The exploration of $0\nu\beta\beta$ decay serves as a driving force behind our investigation into the $2\nu\beta\beta$ decay. The initial and final nuclear states are common in both scenarios. Therefore, the methodologies applied in the investigation of $2\nu\beta\beta$-decay matrix elements are also applicable to the neutrinoless case.

In this study, we investigate the two-neutrino double-beta decay ($2\nu\beta\beta$) of ^{76}Ge, ^{82}Se, ^{130}Te to the first excited 0_2^+ state of ^{76}Se, ^{82}Kr, ^{130}Xe within the framework of the nuclear shell model [2]. This method describes well the $2\nu\beta\beta$ decay to the ground state of these nuclei [3,4]. We consider different interactions and we analyze the validity of these interactions in reproducing the experimental properties of the initial and final states of the decay. Subsequently, we calculate the matrix elements for the $2\nu\beta\beta$ decay. We compare our results with the predictions of other many-body methods and with the latest experimental limits.

Referencias

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session

I. Nuclear Structure and Reactions

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