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Large-scale shell-model study of two-neutrino double beta decay in 82Se

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Double-beta ($\beta\beta$) decay is one of the rarest second-order weak interaction processes with two major decay modes: two-neutrino (2ν) and neutrinoless (0ν). Mayer [1] first introduced the $2\nu\beta\beta$ decay process as a nuclear disintegration with the simultaneous emission of two electrons and two antineutrinos. This process is allowed by lepton number conservation. The study of $2\nu\beta\beta$ decay provides an important test for the standard model and insights into the properties of neutrinos, which are currently a subject of intense research in nuclear and particle physics.

The half-life for the $2\nu\beta\beta$ decay can be given as, $t_{1/2}^{2\nu} = \frac{1}{G^{2\nu} g_A^4 |M_{2\nu}|^2}$. Here, $G^{2\nu}$ denotes the phase-space factor [2]; g_A is the axial-vector coupling strength [3]; $M_{2\nu}$ is the nuclear matrix element (NME) for $2\nu\beta\beta$ decay. There are several candidates for $2\nu\beta\beta$ decay in the nuclear chart, and among them, ^{82}Se is an important candidate for this process. We have performed systematic shell-model calculations for studying the $2\nu\beta\beta$ decay process in ^{82}Se. The jun45 effective interaction [4] is used to calculate the nuclear matrix element (NME) for $2\nu\beta\beta$ decay, having the $0f_{5/2}1p0g_{9/2}$ proton and neutron orbitals. For the calculation of NME, we have calculated 1000 intermediate 1^+ states in ^{82}Br up to the excitation energy of 7.427 MeV. Here, the experimental value for the energy of the lowest 1^+ state in ^{82}Br is taken at 0.075 MeV. Using the shell-model calculated value of NME, we have extracted the half-life of ^{82}Se for $2\nu\beta\beta$ decay as 0.68×10^{20} yr. This value is very close to the average value $0.87^{+0.02}_{-0.01} \times 10^{20}$ yr given in Ref. [5].

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Presentation type

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