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Ordinary muon capture as a probe of $\beta\beta$ decays

A reliable description of the double-beta-decay processes needs a possibility to test the involved virtual transitions against experimental data. Unfortunately, only the virtual transitions trough lowest J^π states can be probed by the traditional electron capture or β^--decay experiments. The ordinary muon capture (OMC) offers a versatile tool to analyze the nuclear structure of the intermediate states involved in double-beta-decay processes. In the present work the OMC rates for muon captures on the nuclei ^{24}Mg, ^{32}S and ^{56}Fe populating the low-lying states of the nuclei ^{24}Na, ^{32}P and ^{56}Mn are calculated.

The nuclear states for isobaric doublets ^{24}Mg, ^{24}Na, ^{32}S, ^{32}P and ^{56}Fe, ^{56}Mn are computed by the nuclear shell-model code NuShellX@MSU. The $A = 24$ and 32 states are computed in the sd-shell and $A = 56$ states in the pf-shell using different interactions without any configuration restrictions. The nuclear matrix elements and partial capture rates to the lowest J^π states of the daughter nuclei are computed using the one-body transition densities (OBTDs) given by the shell-model code.

It has been found that the two lowest 1^+ intermediate states play a significant role in the OMC processes. Also, the lowest 2^+ state has a strong impact on the transition rates. The OMC process can be used to probe the structure of the intermediate states appearing in the double-beta-decay process since the associated momentum exchange is of the order of 100 MeV, i.e. the same amount which is carried by the virtual Majorana neutrino in the neutrinoless double beta decay. Experimental measurements in the near future can help fine-tune the nuclear-structure parameters for the double-beta-decay calculations, but also give access to the effective values of the axial-vector coupling g_A and the induced pseudoscalar coupling g_P.

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