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Nuclear responses for double beta decay and muon capture

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To describe the double beta decay processes reliably one needs a possibility to test the involved virtual transitions against experimental data. Unfortunately, traditional EC or β^- -decay experiments only allow probing the lowest transitions. However, the available data on charge-exchange or OMC allows the examining of higher states.

In this work we manifest how to utilise the charge-exchange and OMC data in the study of $0\nu\beta\beta$ decay. We compute the nuclear matrix elements (NMEs)for the light Majorana-neutrino mode of $0\nu\beta\beta$ decay by exploiting the available data on isovector spin-dipole (IVSD) $J^\pi = 2^-$ giant resonances. We calculate the OMC giant resonance in ^{100}Nb and compare it with the experimental value, and compare the computed total capture rate value with the Primakoff estimate. We also compute the OMC rates to the daughter nuclei of some $0\nu\beta\beta$ decay triplets of immediate experimental interest.

In order to correctly describe the IVSD and OMC up to and beyond the giant-resonance region, we perform the present computations in extended no-core single-particle model spaces using the proton-neutron quasiparticle random-phase approximation (pnQRPA) with two-nucleon interactions based on the Bonn one-boson-exchange G matrix. We include the appropriate short-range correlations, nucleon form factors, higher-order nucleonic weak currents, and partial restoration of the isospin symmetry in the calculations.

Exploiting the IVSD $J = 2^-$ data offers a new way of fitting the g_{ph} value of pnQRPA which leads to improved reliability of the $0\nu\beta\beta$ matrix elements.
The calculated first OMC giant resonance in ^{100}Nb is in agreement with the experimental value. However, the total capture rate is higher than the Primakoff estimate which refers to quenched g_A value.
Eventually, the OMC process can be used to probe the structure of the intermediate states appearing in the double-beta-decay process. Future experiments can help fine-tune the nuclear-structure parameters for the double-beta-decay calculations.

Presenter: Ms JOKINIEMI, Lotta (University of Jyväskylä)

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