Selected Topics on Nuclear Structure in Electroweak Processes

E. Moya de Guerra[1], O. Moreno[1], P. Sarriguren[2]

[1] Depto. Física Atómica, Molecular y Nuclear, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, Ciudad Universitaria, E-28040 Madrid, Spain.

[2] Instituto de Estructura de la Materia, Consejo Superior de Investigaciones Científicas, Serrano 123, E-28006 Madrid, Spain.

We study electroweak processes in complex nuclei within the framework of self-consistent mean field theories including pairing and RPA correlations. We review the adiabatic time dependent Hartree-Fock theory and its ability to simultaneously handle large and small amplitude modes. We apply the formalism to the study of single and double beta decay as normal modes of the system, allowing for collective deformation, using Skyrme density dependent two body interactions. We also apply the formalism to the study of parity violating electron scattering.

We first discuss results on single beta decay half lives of several isotopic chains, including waiting point nuclei of astrophysical interest. Results on two neutrino double beta decay are also discussed along with Gamow Teller strengths of the single beta branches in parent and daughter nuclei. The dependence on deformation is analyzed and comparison with experiment and with other theoretical results is presented. Preliminary results on the double beta decay of 150 Nd matrix element for the zero neutrino case will also be discussed. We also give particular attention to the double-beta decay matrix elements in the A=76 system, where recently spectroscopic factors have been accurately measured. In the later case, we first review the Skyrme interaction as introduced by Vautherin and Brink in the Hartree-Fock formalism to construct the energy density functional and, more specifically, the two-body spin-orbit term. Keeping in mind that problems with this term were already pointed out by Skyrme, we discuss possible options that allow for more flexibility in the spin-orbit dependent terms of the energy density functional and of the self-consistent mean field potential. Focusing in particular on the recently measured spectroscopic factors in germanium and selenium isotopes, we show that using different neutron and proton spin-orbit coupling constants, together with pairing and deformation, greatly improves the agreement with experiment [1]. Results on spectroscopic factors, rms radii and other collective and single particle properties of germanium and selenium isotopes obtained with the new and old parametrizations of the constrained HF(Sk3)+BCS potential will be shown, in addition to results on the two-neutrino double-beta decay matrix element for 76 Ge going to 76 Se.

Concerning parity-violating elastic electron scattering [2] we discuss its potential as a tool for precise determination of neutron densities in nuclei. We study nuclear isovector and isoscalar densities for N>Z and for N=Z stable nuclei obtained within the self-consistent mean field approximation. We compare the values of the parity-violating asymmetry (PVA) at low and intermediate q-values for different N/Z and A values. Distorted wave calculations of PVA are shown and are compared to plane wave impulse approximation. We discuss how to extract the ratio between neutron and proton rms radii and monopole form factors from theoretical and experimental asymmetries. We focus on several N=Z cases to study the influence of nuclear isospin mixing in PVA. The effect of strangeness content of the nucleon on the PVA is also taken into account.

[1] O. Moreno, E. Moya de Guerra, P. Sarriguren and Amand Faessler, Phys. Rev. C 81, 041303(R) (2010).

[2] O. Moreno, P. Sarriguren, E. Moya de Guerra and J. M. Udias, J. Phys. G: Nucl. Part. Phys. 37, (2010) 064019; O. Moreno, P. Sarriguren, E. Moya de Guerra, J. M. Udias, T. W. Donnelly and I. Sick, Nucl. Phys. A 828 306 (2009).