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The Nuclear Symmetry Energy: constraints from Giant Resonances and Parity Violating Electron Scattering

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The nuclear symmetry energy is a basic ingredient of the nuclear equation of state: it accounts for the energy cost per particle of producing a neutron to proton asymmetry in the nuclear medium. The accurate determination of this quantity impacts on the size of the neutron distribution in nuclei [1] as well as on isovector nuclear collective excitations [2,3]. The latter are characterized by an out of phase oscillation of neutrons against protons, being the restoring force proportional to the nuclear symmetry potential and, therefore, directly related to the symmetry energy. Parity violating electron scattering can provide a direct and model independent measure of the parity violating asymmetry. Similarly to clean parity conserving electron scattering experiments where the electromagnetic distribution in nuclei is determined, the parity violating asymmetry provide information on the weak charge distribution in nuclei, basically carried by neutrons [4].

Experimental and theoretical efforts are being devoted to the study of such complementary observables that can shed light on the properties of the nuclear symmetry energy. We will briefly discuss the theoretical study on the Isovector Giant Dipole Resonance [2] and present our new results for the Isovector Giant Quadrupole Resonance [3], which has been the object of, new exclusive, experimental investigation. Then, we also present our theoretical analysis of the parity violating asymmetry at the kinematics of the Lead (^{208}Pb) Radius Experiment (PREx) [4] and how it can be related with the properties of the symmetry energy. PREx completed an initial run in 2010 and additional beam time has been requested and recently approved. In addition, the measurement of the weak charge distribution in other nuclei such as ^{48}Ca is thought to provide complementary information to that of PREx. Fostered by this fact, a proposal for a new experiment on this nucleus (CREx) has been recently submitted to the Jefferson Laboratory. We will also discuss some theoretical results relevant for CREx.

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