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Isospin dependence of Spin-Orbit splitting in relativistic and non-relativistic density functionals.

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One of the most important advantages of relativistic mean-field (RMF) models in nuclear physics is the fact that the large spin-orbit (SO) potential emerges automatically from the inclusion of Lorentz-scalar and -vector potentials in the Dirac equation [1]. It is therefore of great importance to compare the results of such models with those of non-relativistic models and with experimental data. In a recent experiment by Burgunder et al. [2] the isospin dependence of the level splitting between spin-orbit partners has been studied by (d,p) transfer reactions in several isotones with neutron number N=21. Inspired by this work we carried out an investigation following the self consistent approach of relativistic and non-relativistic energy density functionals describing these nuclei, in particular 40Ca, 36S and 34Si. Concentrating on the first 7/2-, 3/2-, 1/2- and 5/2- neutron states, we calculate the SO splittings of the 2p and the 1f orbitals and compare them with the respective experimental results. Our first approach is to calculate the single particle energies using a Relativistic Hartree Bogolyubov code based on several modern nonlinear and density dependent covariant density functionals with various pairing schemes. In the second step we use several non-relativistic Skyrme and Gogny functionals to investigate the energy splitting for the same levels. Finally we study the influence of tensor forces and of particle vibrational couplings on these spin-orbit splittings.

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