Nucleon-Nucleus Scattering and Dirac Phenomenology: What We Have Learned and What Remains

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A new method for extracting neutron densities from intermediate energy elastic proton-nucleus scattering observables uses a global Dirac phenomenological (DP) approach which is based on the Relativistic Impulse Approximation (RIA). This analysis provides energy independent values for the RMS neutron radius, R_n and the neutron skin thickness, S_n, in contrast to the energy dependent values obtained by previous studies. The vector point proton density distribution, ρ_v^p, is determined from the empirical charge density after unfolding the proton form factor. The other densities, ρ_v^n, ρ_s^p, ρ_s^n, are parametrized. We have obtained values of S_n and R_n for ^{40}Ca, ^{48}Ca, ^{208}Pb and other targets which agree with nonrelativistic Skyrme models and relativistic Hartree-Bogoliubov model extended to include density dependent meson-nucleon couplings. Our results are generally not in agreement with relativistic mean-field models. We have found that substantial progress in extracting the neutron densities from proton-nucleus elastic scattering is made by using a global approach focusing on the energy region where the RIA is capable of reproducing experiment well.

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