Determining the proton and neutron transition matrix elements from Coulomb-nuclear interference in hadron inelastic scattering

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Experimental determination of nuclear transition strengths provides sensitive test on nuclear structure calculations. Measurements of the lifetimes and electromagnetic excitations of nuclear states lead to quite accurate values for the proton multipole matrix element M_p, which is related to the reduced electric transition probability by $B(EL) = M_p^2$. Excitations of nuclear states by hadron inelastic scattering allows us to study the isospin character of the transition and deduce the neutron multipole matrrix element $M_{n,}$ as well as M_p. This is done by varying the experimental parameters, so that a significant interference between the nuclear and Coulomb excitations occurs, and studying the effect of the nuclear-Coulomb interference on the angular distribution of the excitation cross section. We note that the Coulomb interaction between the probe and the target nucleus contributes to both the isoscalar and isovector transitions. Similarly, for a probe with isospin $T > 0$, such as a proton, the nuclear interaction also contributes to both isoscalar and isovector transitions. Using an isoscalar probe (with $T = 0$), such as deuteron (d), alpha particle (α) and ^{6}Li, to investigate isoscalar transitions, one exploits the destructive interference between the nuclear and the Coulomb amplitudes and thereby extract the values of M_p and M_n and their ratio $M_n/M_{p.}$ Note that for a target nucleus with different neutron and proton density distributions, the nuclear interaction due to an isoscalar probe also contributes to an isovector transition.

In this work we consider the excitation of low lying isoscalar multipole states, such as the 2^+ and 3^-, excited by the isoscalar probes d, α and the ^{6}Li nucleus. In particular, we take a closer look at the recent analysis of experimental data on the excitation cross sections of the isoscalar low lying 2^+ and 3^- in the isotopes of Ge, Mo, Ru, and Pd within the distorted wave Born approximation (DWBA). The analyses of these cross sections were carried out by employing the deformed potential (DP) model resulting with values of M_n/M_p which are significantly smaller than the corresponding N/Z expected from the simplified collective model. We reanalyze [1] these data within the deformed potential (DP) model and within the implicit folding model (IFM) employing realistic neutron and proton density radial moments and discuss the sensitivity of the results to model assumptions. We note that the folding model approach [FM] to the evaluation of optical potentials and transition potentials is quite successful in describing hadron (h)-nucleus scattering. The main advantage of this approach is that it provides a direct link to the description of h particle scattering reactions based on ground state nucleon density and transition density.

[1] S. Shlomo, M.R. Anders, and M.R. D. Rodrigues, in preparation