Neutron-proton asymmetry in nuclear matter and finite nuclei

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The equation of state for *asymmetric* nuclear matter (NM) is determined essentially by the *isospin dependence* of the NN interaction which is originated from the neutron-proton asymmetry in the medium. To explore the isospin effects, asymmetric NM has been studied within the Hartree Fock formalism using a complex density dependent CDM3Y6 interaction with the isospin dependence carefully fine-tuned against the data of charge-exchange (p,n) reactions. In finite nuclei, the neutron-proton asymmetry is largest at the surface of neutron-rich nuclei which can significantly affect the shell evolution of valence neutrons. To show these effects, a coupled-channel (CC) analysis of the ^{18,20,22}O(p,p') data has been performed to determine the neutron transition strengths of 2^+_1 states in ^{18,20,22}O, using the microscopic folded optical potential and inelastic form factor given by the same CDM3Y6 interaction. Based on the isoscalar (δ_0) and isovector (δ_1) deformation lengths of 2^+_1 states in Oxygen isotopes extracted from the CC analysis of (p,p') data, a specific N dependence of δ_0 and δ_1 has been established which can be linked to the neutron shell closure occurring at $N \to 16$. The ratios of the neutron/proton transition matrix elements (M_n/M_p) determined for the 2^+_1 states in ^{18,20}O have been compared to those deduced from the mirror symmetry, using the measured $B(E2)$ values of 2^+_1 states in the proton rich ^{18}Ne and ^{20}Mg nuclei, and a significant deviation from the mirror symmetry has been found which indicates the isospin impurity in the 2^+_1 excitation of the $A = 18, T = 1$ and $A = 20, T = 2$ isobars. A further experiment at RIKEN to probe this interesting effect in the (inverse kinematics) inelastic proton scattering on ^{20}Mg and ^{20}O is suggested.