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Maris polarization in deuteron knockout reactions

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While the independent particle picture that nucleons (protons and neutrons) move almost independently inside nuclei is well established, it is also known that several nucleons form a cluster and behave as a single entity in them. Nuclear clustering is a phenomenon that breaks the uniformity of nuclei and can be a key to elucidating the mechanism of alpha decay, determining the equation-of-state of neutron stars, etc. Therefore, experimental and theoretical studies have been intensively conducted [1] to answer such questions as ''What kind of clusters can exist?" ''What kind of motion do they have in nuclei?" ''Are they universal on the nuclear chart?" and ''What mechanism does nuclear clustering realize?"

The proton-induced knockout reaction is one of the experimental methods to observe the presence of clusters and their motion in nuclei [2-9]. In this reaction, a proton collides with a nucleus at an energy of several hundred MeV per nucleon and knocks out a particle from the nucleus. The advantage of using this reaction is that because the incident energy is high, the proton does not perturb the nucleus very much, and we can approximately describe the reaction as the scattering of the proton and the cluster [10]. It allows us to extract information about the cluster in the nucleus with a relatively small uncertainty than other nuclear reactions.

From experimental data of knockout reactions, we can determine the orbital on which the cluster moved, i.e., the radial quantum number n, the orbital angular momentum l, and the total angular momentum j. One topic strongly related to the determination of j is the Maris polarization [11, 12]. The Maris polarization is a phenomenon in which the sign of the analyzing power A_y is reversed in a nucleon knockout reaction depending on whether the knocked-out nucleon moved on the $j = l + 1/2$ or $j = l - 1/2$ orbitals with the appropriate kinematic conditions (mainly the kinetic energies of the particles). The Maris polarization can also occur in cluster knockout reactions, but we can find only a few examples discussed except in nucleon knockout reactions. In this talk, I will introduce the Maris polarization and show how A_y behaves for the three orbitals $j = l + 1$, l, and $l - 1$ when the spin is 1, using the deuteron knockout reaction as an example.

References:

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Collaboration

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