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Coulomb breakup of 37Mg and its ground state structure

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Coulomb breakup of nuclei away from the valley of stability have been one of the most successful probes to unravel their structure. However, it is only recently that one is venturing into medium mass nuclei like ^{23}O [1] and ^{31}Ne[2], especially in and around the so called "island of inversion". This is a very new and exciting development which has expanded the field of light exotic nuclei to the deformed medium mass region.

In this contribution we report new results [3] on the Coulomb breakup of neutron rich ^{37}Mg nucleus on a Pb target at the beam energy of 244 MeV/nucleon within the framework of a finite range distorted wave Born approximation theory that is extended to include the projectile deformation effects. In this theory, the breakup amplitude involves the full wave function of the projectile ground state. Calculations have been carried out for the total one-neutron removal cross section (σ_{-1n}), the neutron-core relative energy spectrum, the parallel momentum distribution of the core fragment, the valence neutron angular, and energy-angular distributions.

The calculated σ_{-1n} has been compared with the recently measured data to put constraints on the spin parity, and the one-neutron separation energy (S_{-1n}) of the ^{37}Mg ground state (^{37}Mg$_{gs}$). The dependence of σ_{-1n} on the deformation of this state has also been investigated. Our study suggests that ^{37}Mg$_{gs}$ is most likely to have a spin parity assignment of $3/2^-$. Using the shell model value for the spectroscopic factor for this configuration and without considering the projectile deformation effects, a S_{-1n} of 0.10 ± 0.02 MeV is extracted. Inclusion of the deformation effects increases the value of the deduced S_{-1n}. The narrow parallel momentum distribution of the core fragment and the strong forward peaking of the valence neutron angular distribution suggest a one-neutron halo configuration in the $2p_{3/2}$ ground state of ^{37}Mg.

We shall also show how our calculated neutron-core relative energy spectrum
in the breakup of ^{37}Mg on a Pb target could be used to extract the
^{36}Mg$(n,\gamma)^{37}$Mg radiative capture cross section. To the best
of our knowledge this would be the first
application of a fully quantum mechanical theory of Coulomb breakup \textit{with
deformed projectiles} as an indirect method in nuclear astrophysics. The ^{36}Mg$(n,\gamma)^{37}$Mg reaction is thought to compete with the
^{36}Mg$(\alpha,n)^{39}$Si reaction and could affect a new \textit{r}-process
path proposed in Ref. [4], initiated from light elements.

Our study is thus expected to provide motivation for future experiments on breakup reactions of the neutron rich medium mass nuclei, given that we have identified the observables that are more critically dependent on the ground state structure of the projectile.

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