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Extension of the ratio method to low energy and charged hal\oe s

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The ratio method is a recent observable that has been proposed for the study of halo nuclei [1]. It consists of the ratio of breakup angular distribution and the summed angular distribution (which includes elastic, inelastic and breakup). This removes the reaction process dependence, making it model independent. Originally, this method was developed for high and intermediate energies. Studies of the reactions of ^{11}Be neutron-halo nucleus on ^{12}C and ^{208}Pb targets at 70 MeV/u have shown this observable to provide precise information about the halo structure [2].

Given the potential interest in applying this method at lower energy, we explore its validity at beam energies of 20MeV/u in this work. We use the Continuum Discretized Coupled Channel method (CDCC) and the Coulomb-corrected Dynamical Eikonal Approximation (CC-DEA) for the study of the reactions of ^{11}Be on ^{12}C, ^{40}Ca and ^{208}Pb at 20MeV/u. We analyse the influence of the projectile theoretical description on this observable and we explore the dependence of our results on the core-target interaction. Our study demonstrates that the ratio method is still valid at these lower beam energies [3]. This could open up the way to its experimental testing in ISOL-type laboratories.

Moreover, we explore the validity of the method in the case of proton hal\oe s. We use CC-DEA to study the reaction of ^{8}B proton-halo nucleus on ^{12}C and ^{208}Pb at 44MeV/u. Surprisingly, the ratio observable remains valid for charged hal\oe s. This result could open the method to any loosely-bound quantal system (nucleus, atom, molecule), whether charged or not.

[1] P. Capel, R. C. Johnson, and F. M. Nunes, Phys. Lett. B705, 112 (2011).

[2] P. Capel, R. C. Johnson, and F. M. Nunes, Phys. Rev. C 88, 044602 (2013).

[3] F. Colomer, P. Capel, F. M. Nunes and R. C. Johnson, submitted to Phys. Rev. C. in Dec. 2015.

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