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How can inclusive Coulomb break-up measurements help in determining astrophysical radiative capture reaction rates?

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A direct link between the Coulomb inclusive break-up probability and the radiative capture reaction rate for weakly bound systems can be established [1]. This link provides an indirect method to estimate reaction rates of astrophysical interest. This procedure can also assess the validity of different theoretical approaches that have been used to calculate reaction rates. In particular, this procedure is useful for systems in which the relevant reaction cross section cannot be measured directly, or it is experimentally unfeasible at present, such as three-body reactions [2] or short-lived initial nuclei [3].
Results will be presented for the three-body radiative capture reaction rates ^{4}He$(2n,\gamma)^{6}$He and ^{9}Li$(2n,\gamma)^{11}$Li, for which inclusive break-up experimental data exist [4-6] and theoretical three-body models are developed [6,7]. For ^{6}He case, the available experimental data provide a reaction rate that is considerably larger than the theoretical estimation. For that reason, a new experiment has been carried out recently at TRISOL facility (NSL, University of Notre Dame) for the reaction of ^{6}He+^{208}Pb at an energy around the Coulomb barrier (approx. 21 MeV), paying attention to the possible overestimation of alpha production at forward angles. The analysis of this experiment is still ongoing.
Other systems of interest for possible applications will be discussed.
[1] Phys. Rev. C 93 (2016) 041602(R).
[2] Nucl. Phys. A 709 (2022) 467.
[3] Rep. Prog. Phys. 62 (1999) 395.
[4] Phys. Rev. C 84 (2011) 044604.
[5] Phys. Rev. C 87 (2013) 064603.
[6] Phys. Rev. Lett. 110 (2013) 142701.
[7] Phys. Rev. C 88 (2013) 014327.

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