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Theory of the Trojan-Horse Method - From the original idea to actual applications

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Breakup reactions were proposed in 1986 by Gerhard Baur as an indirect method to investigate low-energy charged-particle reactions relevant for nuclear astrophysics [1].

This so-called 'Trojan-Horse method' (THM) allows to extract cross sections of two-particle reactions from suitable transfer reactions with three particles in the final state using quasifree scattering conditions. A specific feature of the approach is the suppression of the Coulomb barrier effect that causes a strong reduction of the cross section of astrophysical reactions at low energies.

The THM is applicable to general rearrangement reactions in contrast to other indirect techniques such as the Coulomb dissociation (CD) method or asymptotic normalization coefficient (ANC) method, which aim at radiative capture reactions.

The analysis of dedicated laboratory experiments using the THM requires the application of nuclear reaction theory. In this contribution, the development of the theoretical description is presented starting from the early ideas with simple approximations, e.g., a modified plane-wave impulse approximation (PWIA) that allowed to factorize the THM cross section as a product of a kinematic factor, a momentum distribution and a half-off-shell two-body cross section. Different applications are considered, in particular, elastic scattering, non-resonant and resonant reactions. Suggestions for possible improvements in the future development of the theory are given.

[1] G. Baur, Phys. Lett. B 178, 135 (1986).

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