Trojan Horse particle invariance: an extensive study

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In the last decades Trojan Horse method (THM) has played a crucial role for the measurement of several particle (both neutron and charged one) induced cross sections for reactions of astrophysical interest. The main features of THM allow to measure the bare nucleus cross section, without the effects of Coulomb penetration as well as without the problems connected to the electron screening.

To better understand its cornerstones and its applications to physical cases, many tests were performed to verify all its properties and the possible future perspectives. The Trojan Horse nucleus invariance [1] proves the relatively simple approach allowed by the pole approximation and shed light in the reaction mechanisms involved. This will be the objective of the present, complete, work for the binary ^{2}H(d,p)^{3}H, $^6Li(d,\alpha)^4He$, $^6Li(p,\alpha)^3He$, $^7Li(p,\alpha)^4He$ reactions, by using the quasi free reactions after break-ups of different nuclides. Results are compared assuming the ^{6}Li and ^3He break-up in the case of the d(d,p)t, $^6Li(d,\alpha)^4He$, $^6Li(p,\alpha)^3He$ reactions and considering the ^{2}H and ^{3}He break-up for $^6Li(p,\alpha)^3He$, $^7Li(p,\alpha)^4He$ reactions.

The astrophysical S(E)-factor for the binary processes was then extracted in the framework of the Plane Wave Impulse Approximation (PWIA) applied to the two different break-up schemes. The obtained results are compared with direct data as well as with previous indirect investigations [2]. The very good agreement, regardless of the trojan horse particle or the break-up scheme, confirms the applicability of the (PWIA) and suggests the independence of binary indirect cross section on the chosen Trojan Horse nuclei for a whole spectra of different cases. This gives a strong basis for the understanding of the quasi-free mechanism which is the foundation on which the THM lies. Moreover the astrophysical implications of the results will be discussed in details.

[1] R.G. Pizzone et al., Phys. Rev. C 83 045801 (2011);

[2] R.G. Pizzone et al., Phys. Rev. C 87 025805 (2013).

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