

Trojan Horse as indirect technique in nuclear astrophysics.

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The Trojan Horse method (THM) is a unique indirect method in nuclear astrophysics because it allows one to determine the astrophysical factors for reactions with bare nuclei down to zero energy. To determine the astrophysical factor for the $x+A \rightarrow b+B$ reaction in the THM one measures the $2 \rightarrow 3$ process $a+A \rightarrow y+b+B$, where $a=(yx)$. The kinematics of the THM is chosen so that particle y can be treated as a spectator. The Trojan Horse process contains the reaction $x+A \rightarrow b+B$ as a sub-process where particle x is virtual (off-the-energy-shell). As a result of this there is no Coulomb barrier between x and A . Hence using proper chosen kinematics one can go down in xA energy below the Gamow window having still significant cross section. In the THM only the energy dependence of the cross section $x+A \rightarrow b+B$ is being measured. Its absolute value is determined by normalization to the direct measurements available at higher energies. If direct measurements are available down to energies where the electron screening becomes important, the THM allows one to determine the electron screening potential. It is still difficult or impossible to calculate the screening potential accurately from the microscopic approach. Another advantage of THM is that allows one to observe the subthreshold states at negative energies.

In this talk I will explain why there is no Coulomb barrier for the off-shell particle x in the initial channel of the sub-reaction $x+A \rightarrow b+B$. I will address also two most important issues for application of the Trojan Horse: the impact of the off-shell effects and initial and final state interactions on the extracted from the THM astrophysical factors.

As demonstration I will present the latest results for the astrophysical factor for the resonant $^{15}\text{N} + p \rightarrow \alpha + ^{12}\text{C}$ reaction determined from the Trojan Horse

process $^{15}\text{N} + d \rightarrow \alpha + ^{12}\text{C} + n$. The measurements have been done at Texas A&M University in collaboration with Catania National Lab- Texas A&M University.