The Trojan Horse Method: a versatile tool for nuclear astrophysics

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The low energy behavior of reactions of astrophysical interest is one of the most important inputs to calculate the reaction rates of astrophysical importance and therefore to evaluate their impact on several astrophysical environments. Direct measurements in the last decades have given an important contribution to understanding several astrophysical phenomena although they have highlighted an " unexpected" problem related to the lowering of the Coulomb barrier between the interacting nuclei due to the presence of the "electron screening" in the laboratory measurements. It was systematically observed that the presence of the electronic cloud around the interacting ions in measurements of nuclear reactions cross sections at astrophysical energies gives rise to an enhancement of the astrophysical S(E)-factor as lower and lower energies are explored. Moreover, at present such an effect is not well understood as the value of the potential for screening extracted from these measurements is higher than the upper limit of theoretical predictions (adiabatic limit). On the other hand, the electron screening potential in laboratory measurement is different from that occurring in stellar plasmas thus the quantity of interest in astrophysics is the so-called "bare nucleus cross section". This quantity can only be extrapolated in direct measurements.
These are the reasons that led to a considerable growth on interest in indirect measurement techniques and in particular the Trojan Horse Method (THM).
Moreover explosive nucleosynthesis, which is dominated by unstable nuclei interacting with p, alpha and n, has helped to trigger the development of radioactive beams facilities worldwide. Notwithstanding the huge experimental difficulties connected to directly measuring cross-section for reactions induced by RIBs at astrophysical energies, this has given more and more credit to indirect methods.
An overview of the available indirect methods will be given, with a special attention to the Trojan Horse Method. The basic principles of the Method will be introduced with special attention to its advantages and limits as well as the application to some problems of big astrophysical relevance and the related results.