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Trojan Horse method for nuclear astrophysics

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Over the past decades nuclear physicists have been trying to measure the rates of the most relevant nuclear reactions, which are responsible for the element nucleosynthesis, but there is still considerable uncertainty about their values.
This is because their reaction rates are extremely small, making it difficult for them to be measured directly in the laboratory. Indeed, although e.g. the stellar temperatures are of the order of hundred million degrees, they correspond to sub-Coulomb energies. As a consequence, the Coulomb barrier causes a strong suppression of the cross-section, which drops exponentially with decreasing energy.
In addition, the electron screening effect due to the electrons surrounding the interacting ions prevents one to measure the bare nucleus cross-section.
Typically, the standard way to determine the bare nucleus cross-section at the astrophysics relevant energies consists in a simple extrapolation of available higher energy data. This is done by means of the definition of the astrophysical S(E) factor, which essentially represents the cross-section free of Coulomb suppression. However, the extrapolation may introduce additional uncertainties due for instance to the presence of unexpected resonances or to high energy tails of sub-threshold resonances.
A valid alternative approach is represented by indirect methods developed to overcome some of the limits of measuring at astrophysical energies. A common feature shared by indirect methods is to replace the relevant two-body reaction at low energies by a high-energy reaction usually with a three-body final state.
In particular, the Trojan Horse Method (THM) is applied to charged particle reactions either resonant or non-resonant and allows to extract the energy-dependence of their S(E) factors. I will recall the basic ideas of THM and show a step-by-step analysis of a measurement relevant for the Big Bang Nucleosynthesis scenario and its use.

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