

Indirect techniques in nuclear astrophysics

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In this review work we address three different commonly used indirect techniques to obtain the information about astrophysical reactions, the asymptotic normalization coefficient (ANC) method, the Trojan Horse method (THM), and the Coulomb Dissociation (CD) method. The ANC method focuses on determining the normalization of the tail of the overlap function. The ANC for a nuclear level determines the direct capture reaction rate associated with that level. For some reactions, this dominates over resonant capture. In other reactions, direct capture often interferes with resonant capture, which can be very important in determining the overall rate at stellar energies. Including both direct and resonant capture in a consistent framework can be done through an R -matrix analysis if the relevant information is available. The THM provides a way to determine the reaction rate for rearrangement reactions by obtaining the cross section for a binary process through the use of a surrogate "Trojan Horse" particle. The CD technique uses the virtual photon flux from the interaction of a high-energy ion with a very heavy target to dissociate the heavy-ion. The dissociation is an inverse process to a capture-gamma reaction that takes place in a stellar environment. Measurements of the dissociation cross section can be used to infer the reaction rate of radiative capture processes at stellar energies. All three of these methods provide information on stellar reaction rates at very low energy without requiring an extrapolation of data from higher energies. These three indirect techniques have in common an underlying connection to nuclear reaction theory. The review paper has been submitted to Journal of Physics G.