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Nuclear reaction theory for the era of multi-messenger observations: capture cross sections from indirect measurements

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Obtaining cross sections for neutron-induced reactions on unstable isotopes is challenging, but critical for astrophysics simulations. Various indirect methods have been proposed to address this problem. The 'surrogate reaction method'[1] uses inelastic scattering or transfer ('surrogate') reactions to produce the compound nucleus of interest and measure its subsequent decay. When combined with a proper theoretical description of the surrogate reaction mechanism, this data provides constraints for the models describing the decay of the compound nucleus, which dominate the uncertainties of the cross section calculations. I will present applications of the method to recent measurements of the (p,d) and (d,p) transfer reaction in the Zr-Y-Mo region. The procedure for obtaining constraints for unknown capture cross sections is illustrated and results for both known (benchmark) and unknown capture reactions are presented [2,3]. The method makes no use of auxiliary constraining quantities, such as neutron resonance data, or average radiative widths, which are not available for short-lived isotopes; thus it can be applied to isotopes away from stability, including those of relevance to astrophysics simulations.

[1] Escher et al, Rev. Mod. Phys. 84, 353 (2012).
[2] Escher et al, PRL 121, 052501 (2018).
[3] Ratkiewicz et al, PRL 122, 052502 (2019).

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