Contribution ID: **117** Type: **Oral**

Neutron capture cross sections of radioactive nuclei: Inclusive breakup of two-cluster projectiles and two-cluster targets

Neutron capture reactions on radioactive nuclei especially near the drip nuclei of importance to the r-process, are not available. A possible way to obtain these cross sections is through indirect hybrid reactions. One such method is the Surrogate Method. The theory employed for this is the Inclusive Nonelastic Breakup (INEB) Reaction theory. In this talk we report on a recent work that extends the application of the NEB to the case of capture by a radioactive target or projectile. In our approach we consider first the three-body case of a non-cluster radioactive projectile interacting with a two-cluster target, such as the deuteron. In this case the reaction is a neutron pickup. Through the measurement of the inclusive proton spectrum one is able to extract the neutron capture cross section. This cross section is not the free capture cross section as several factors come into play owing to the fact that the neutron is bound in the deuteron. The second case we consider is the four-body one involving two-cluster projectile and two-projectile target. One such reaction involves the one proton halo nucleus ^{8}B, ^{8}B + d $\rightarrow$ p + ^{9}B or p + (^{7}Be + d). So the inclusive proton spectrum will exhibit two groups a low proton energy one associated with the incomplete fusion ^{7}Be + d and a higher proton energy group connected with the capture reaction. Our work reported here should be useful to assess the applicability of the NEB theory to isotopes such as ^{135}Xe whose lifetime is 9.8 hours, which is a notorious nuclear reactor poison as its thermal neutron capture cross section is huge, 2.5×10^{6} barns. Our aim is to use this nucleus as a benchmark to test to proton spectrum in a reaction of the type d + ^{135}Xe $\rightarrow$ p + ^{136}Xe.

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Session Classification: Session XIX (Parallel Session)