Surrogate reaction methods for neutron induced cross-sections

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Compound nuclear cross sections for reactions of neutrons and light charged particles with target nuclei across the isotopic chart, taking place at energies from several KeV to tens of MeV, are required for nuclear astrophysics, national security, and nuclear-energy applications [1]. The trans-uranium nuclide produced in the nuclear fuel cycles by successive neutron capture, play prominent role in modeling processes that are relevant to generate energy. The fast-neutron induced reactions have also been proposed for the incineration of actinide materials, notably minor actinide isotopes which are produced in Th-U or U-Pu fuel cycles. Unfortunately, for a large number of reactions the relevant data cannot be directly measured in the laboratory, since the relevant nuclei are often too difficult to produce with currently available experimental techniques or too short-lived to serve as target in present day setups. The Surrogate reaction methods provide access to such nuclear data indirectly.

In recent years, the surrogate reaction methods in various forms have been employed to get indirect estimate of the neutron induced fission reaction cross sections of many compound nuclear systems in actinide region, which are not accessible for direct experimental measurements. We have developed a new experimental technique known as hybrid surrogate ratio method[2] and successfully employed to determine ^{233}Pa(*n,f*), ^{234}Pa(*n,f*), ^{239}Np(*n,f*), and ^{240}Np(*n,f*) compound nuclear cross sections in the equivalent neutron energy range 10.0 to 16.0 MeV by measuring the ratio of fission decay probabilities in [^{232}Th(^{6}Li,α)^{234}Pa/ ^{232}Th(^{6}Li,d)^{236}U], [^{232}Th(^{7}Li,α)^{235}Pa/ ^{232}Th(^{7}Li,t)^{236}U], [^{238}U(^{6}Li,α)^{240}Np /^{238}U(^{6}Li,d)^{242}Pu], and [^{238}U(^{7}Li,α)^{241}Np / ^{238}U(^{7}Li,t)^{242}Pu] transfer reactions respectively[2-4]. We have also determined ^{241}Pu(n,f) cross section in the equivalent neutron energy range 11.0 MeV to 18.0 MeV using ^{238}U(^{6}Li,d)^{242}Pu and ^{232}Th(^{6}Li,d)^{236}U transfer reactions employing surrogate ratio method[5].

In this talk, we start with a brief discussion on surrogate reaction methods and present some of the recent results on neutron induced fission cross section measurements carried out by our group and the possibility of extending the measurements for determining (n,γ), (n,2n) and (n,p) reaction cross-sections by surrogate reaction method will also be discussed.

References

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