Measurement plan for (n, γ) cross sections using a surrogate reaction at JAEA

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Neutron-capture reaction on unstable nuclei plays an important role in the stellar nucleosynthesis. In the nucleosynthesis by slow neutron capture process (s process) some unstable nuclei are sufficiently long lived such that (n, γ) reaction can compete with β decay. These nuclei act as branching points in the reaction path of the s process. In order to understand the stellar conditions for the s process nucleosynthesis, (n, γ) rates of unstable nuclei over a wide stellar temperature range from $kT \sim 8$ keV to $kT \sim 90$ keV are required [1]. In addition, (n, γ) cross sections of long-lived fission products (LLFPs) are the most important physical quantities for the study on the transmutation of nuclear wastes. Improvements of the (n, γ) cross section within the thermal and epithermal energy ranges (up to $\sim$ 1 MeV) are needed to develop the technology to efficiently transmute LLFPs using reactors (fast or thermal) or accelerator driven systems (ADS).

The measurement of the (n, γ) cross section of the unstable nuclei in the keV region are very difficult. The main reasons of the difficulty are due to a sample preparation and radioactivity of the sample. Recently, (^{3}He,pγ) and (d,pγ) reactions using stable targets have been proposed as surrogate reactions for (n, γ) reaction [2,3] on the basis of the assumption that the formation and decay of a composite nucleus are independent of each other (for each J and π). At the present time, however, the feasibility of the these reactions have never been demonstrated; e.g., J^π distribution of composite nuclei and reaction mechanisms such as multi-nucleon transfer reactions are not assessed.

Hence, we designed a new experiment at the JAEA-Tokai tandem accelerator facility [4] in order to measure the γ rays from the highly excited states produced by surrogate reactions in coincidence with outgoing particles. In this experiment, we will use a high-efficiency anti-Compton NaI(Tl) spectrometer with a large S/N ratio to detect the γ rays and Si-ΔE-E detectors with high resolution to detect the outgoing particles. In this contribution, we present a plan of our new experimental system and a proposal to benchmark the (^{3}He,pγ) reaction as a surrogate for (n, γ) reaction using a stable target and ^{3}He beam for nuclei with the (n, γ) cross section is well known.

References

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