Measurement of Angle-correlated Differential (n,2n) Reaction Cross Section with Pencil-beam DT Neutron Source

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The (n,2n) reaction is a neutron multiplication reaction. And its cross-sections is needed to design a nuclear fusion reactor. Especially, the ^{9}Be(n,2n) cross-section is very important because beryllium is one of the candidate for neutron multiplier in a fusion reactor. In the previous experiments, the foil activation method was generally used to measure (n,2n) reaction cross-sections. However this method cannot be applied to the element that cannot make measurable isotopes by activation. And this method cannot give energy and angular distribution. Therefore there are many elements of which experimental value of (n,2n) reaction cross-section have not been measured.

In the present experiment, the coincidence detection technique was used. Two spherical NE213 detectors (4cm in diameter) were located at 18.8cm from a beryllium sample (2cm in diameter, 2cm long), and two neutrons simultaneously emitted by the (n,2n) reaction were detected by each detector. A pencil-beam DT neutron source of the Fusion Nuetronics Source (FNS) in Japan Atomic Energy Agency (JAEA) was used to remove background signals caused by directly incoming source neutrons and room returned neutrons. In addition, time difference spectrum between anode signals of the two detectors was measured to pick up the coincidence events from (n,2n) reaction.

Three angle parameters (θ_0, θ and ϕ) with respect to the detector position to measure azimuthal and longitudinal neutron emission distribution were defined as shown in Fig.1. Measurement points were decided by combination of these angle parameters for two detectors. Experiments for 9Be(n,2n) reaction have been done by about fifteen points.

Measured pulse height spectra have to be transformed into energy spectra. Energy spectra were obtained by unfolding pulse height spectra using SCINFUL and FORIST code. The necessary detector response matrix was estimated with the SCINFUL code. As a result, there was a strong forward oriented longitudinal distribution as shown in Fig.2. While, a slightly forward oriented azimuthal distribution was confirmed although it is not considered in the evaluated nuclear data. Total ^{9}Be(n,2n) cross-section was obtained by integrating energy and angular distributions by fitting with Legendre polynomials. The Total cross-section is agreed with JENDL-3.3.

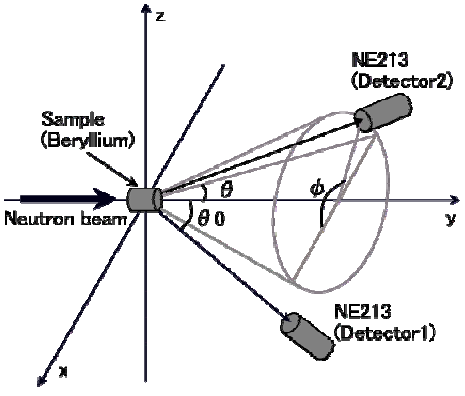

Fig.1 Experimental arrangement around detectors.

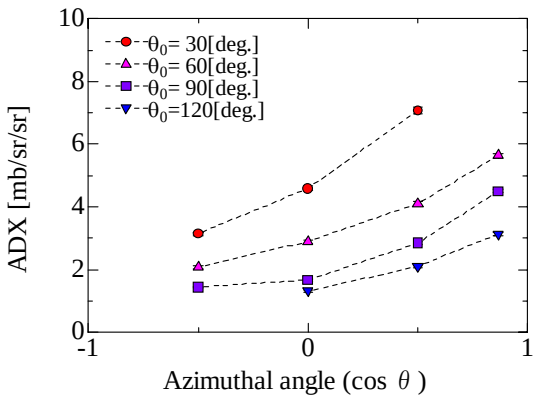

Fig.2 Angular distribution for axial direction.