§1. Design of a Portable Directional Neutron Source Finder

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An instrument that determines the direction of a remote existing neutron source has been designed. The instrument's configuration is shown in Fig. 1. This instrument combines a polyethylene block and four ^3He counter tubes. The advantages of the instrument are portability and good angular resolution. The count from the detector was varied with the neutron incident angle due to the moderator. Using this characteristic, the direction of the neutron source can be measured precisely by revising the axis of the instrument so that the difference between the four detectors measurements is minimized. Consequently, the direction of the central axis of the instrument in which the response difference of the four detectors reaches a minimum indicates the direction of the neutron source. The directional response of the ^3He counter tube was calculated using the Monte Carlo calculation code MCNP, and the possible use of the newly configured instrument as a directional neutron source finder was discussed.

In order to demonstrate the application of the instrument, an experiment on ^{252}Cf irradiation was carried out. The activity of the neutron source was 0.23 MBq. The neutron source was fixed at 1 m above the floor, and the center of the instrument was set at the same height. The distance between the source and the center of the instrument was 1.5 m. The change in the count difference between the two detectors is shown in Fig. 2. This change forms a point symmetry around the zero point. In order to derive the angle at which the count difference is zero, the curve was fitted by cubic polynomial. Accordingly, the derived value was 0.118 degrees. This angle corresponds to the measured direction of the source. As a result, the instrument was able to specify the direction of a neutron source with high precision when a $\pm 1^\circ$ angle error of the turntable is taken into account. In order to compare the experiment result with the calculated value, the calculation was done using MCNP for this experimental arrangement. The spectrum from the ^{252}Cf neutron source (ISO8529) was used. The comparison result is also shown in Fig. 2. As a consequence, the experimental results agreed well with the simulation results.

As a result, it was confirmed that the portable instrument is useful for specifying the direction of a remote existing neutron source on great angular resolution.

Fig. 1. Configuration of the instrument and calculation model. (a) Cross section of x-z plane. (b) Cross section of x-y plane. PE, polyethylene block, 10 cm x 10 cm x 30 cm; Det, Det-R, Det-L, ^3He counter tube; NS, neutron source; θ , angle of incidence.

Fig. 2. Measured count difference between Det-R and Det-L in regard to angle of incidence. Comparison the measured value with the calculated value.