Preliminary Benchmark Study on the Large-Angle Neutron Scattering Cross Section of Liquid Nitrogen (LN₂)./液体窒素 (LN₂) の大角度中性子散乱断面積に関する予備ベンチマーク研究

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A preliminary benchmark study has been conducted to investigate the large-angle neutron scattering cross section of liquid nitrogen (LN_2). This work is motivated by the crucial role of nitrogen as a constituent nuclide in several materials used for the blanket and shielding systems of fusion reactors. Despite its importance, existing nuclear data for nitrogen remain insufficiently accurate, particularly in the high-energy neutron range. Hence, an experimental benchmark is essential to validate and improve these data.

The benchmark experiment was performed at the OKTAVIAN facility, Osaka University, Japan, employing the two-shadow-bar technique previously established by the author's group [1]. Four irradiation configurations were conducted, corresponding to two shadow-bar sizes (S1 and S2) with and without the target, denoted as S1t, S1nt, S2t, and S2nt. Unlike previous studies using solid targets, the present work utilized a liquid nitrogen target enclosed by Styrofoam to sustain the cryogenic condition during irradiation.

Monte Carlo simulations using MCNP5 [2] was carried out among major evaluated nuclear data libraries: JENDL-4.0 [3], JEFF-3.3 [4], and ENDF/B-VIII.0 [5]. The results indicated considerable discrepancies between experimental and calculated values. This large statistical error mainly attributed to target instability caused by LN_2 evaporation during irradiation. So that, several technical improvements are being developed, including optimization of container design, enhancement of thermal insulation, and selection of highly effective activation foils.

References

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