Contribution ID: **252** Type: **not specified**

Investigation of the possibility of applying an available cross-section library in the production of ultracold neutron source using Monte Carlo simulation

Pham K.T.1,2,, *Nezvanov A.Yu.3, Muzychka A.Yu.3*
1Department of Fundamental and Applied Problems of Microworld Physics, Landau Phystech School of Physics and Research, Moscow Institute of Physics and Technology (National Research University), 141701, Institutskiy Pereulok, 9, Dolgoprudny, Moscow Oblast, Russia
2Vietnam Atomic Energy Institute, 59 Ly Thuong Kiet, Ha Noi, Viet Nam
*3Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, 141980, Dubna*kham.kt@phystech.edu.ru

The calculation of neutron transport plays an important role in the development of neutron sources. The choice of nuclear data library, in particular the neutron cross-sections, is the primary determinant of the calculation's certainty. Nowadays, there are several types of nuclear data, and libraries already exist, such as the Japanese Evaluated Nuclear Data Library (JENDL), the Evaluated Nuclear Data Files (ENDF), the Joint Evaluated Fission and Fusion Nuclear Data Library, the TALYS-based Evaluated Nuclear Data Library (TENDL), the evaluated neutron data library (BROND), the ACE Application Nuclear Data Libraries, and others.
In our research, we have examined the neutron data library for solid ortho-deuterium (sD2) at 5 K. It is one of the most efficient materials that could be used in the design of very cold neutron (VCN) and ultracold neutron (UCN) sources as a converter of such neutrons. The library was developed in ACE format by the Spallation Physics Group at the European Spallation Source. It is predicated on J.R. Granada's neutron scattering kernel for sD2 [1]. The main characteristics of Granada's model are contained in the mathematical formalism, including the lattice's density of states, the Young-Koppel quantum treatment of the rotations, and the internal molecular vibrations. Additionally, a thorough description of the elastic processes involving coherent and incoherent contributions is provided, along with the spin-correlation effects.
Calculations were conducted for investigating the used cross-section library for sD2 at 5 K by using a Monte Carlo code, including: 1. Total cross-section for neutrons interacted with a flat layer of sD2 of a thickness of 1 cm. The initial energy range was from 10^-2 to 10^3 meV. The simulation results show a similarity to the measured cross-section. 2. The differential inelastic cross-section of energy transfers due to the interaction of neutrons with the initial energy of 20.4 meV. In this case, the simulation configuration was a sD2 sphere with a radius of 5 cm and a point isotropic neutron source at its centre. The neutron scattering data was compared with the results published by A. Frei [2], showing agreement for the range of energy loss of sub-thermal neutrons in the sD2 converter material.
Based on the results of the calculations mentioned above, we have calculated the cross section for generating VCN with velocities from 50 - 200 m/s.
Moreover, for simulations relating to the production and transport of UCN, the library shows a lack of necessary data. The limitation applies to the range of neutron energies from 10^-2 to 10^3 meV. In the next stage of our research, we will focus on using the neutron scattering kernel for sD2 that was proposed by J.R. Granada for the development of a data library for Geant4 extended to the UCN energy region.

References

[1] Granada, J. R. "Neutron scattering kernel for solid deuterium."Europhysics Letters 86.6 (2009): 66007.
[2] Frei, A., et al. "Understanding of ultra-cold–neutron production in solid deuterium."Europhysics Letters 92.6 (2011): 62001.

Section

Nuclear physics (Section 1)

Primary author: Mr PHAM, K. T. (Vietnam Atomic Energy Institute)

Co-authors: Mr NEZVANOV, A. Yu. (Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research); Mr MUZYCHKA, A. Yu. (Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research)

Presenter: Mr PHAM, K. T. (Vietnam Atomic Energy Institute)

Track Classification: The V International Scientific Forum “Nuclear Science and Technologies”: Nuclear physics (Section 1)