**Experimental investigations of (n, α) reaction on fast neutrons using an ionization chamber**

Dr. Igor Chuprakov

Joint Institute for Nuclear Research, Frank Laboratory of Neutron Physics, Dubna, Russia

Nitro-chupa@mail.ru

**Abstract**

The relevance of the study of (n, α) reactions on fast neutrons is of great interest, the field of nuclear engineering, in particular, for assessing radiation damage to structural materials of nuclear installations, the choice of technical materials in carrying out calculations in the development of new objects for nuclear energy.

The data obtained in the experiments are collected in nuclear data banks. There are five such files or libraries, according to the number of major countries with nuclear technology. These are ENDF/B-VII (USA), JENDL-3.3 (Japan), JEFF-3.0 (European Union), CENDL-3 (China), BROND-3 (Russia).

The current state of affairs with theoretical estimates of the cross section (n, α) of the reaction given in various nuclear data libraries (ENDF / B-VII, JENDL-4.0, BROND 3 and others), for many nuclei that are part of structural materials, is also unsatisfactory and the scatter of the values of the estimated cross sections for many practically important isotopes exceeds 20–30%.

The aim of the work is to develop and master the method for measuring the reaction cross section (n, α) on a number of isotopes for fourth-generation nuclear-physical data libraries.

**Tasks**

1. Calculate the flux of fast monoenergetic neutrons from the D(d, n)3He reaction for a solid and gas target using the EnergySet program and obtain the energy spectrum of fast neutrons.

2. Calculate the reaction cross section (n, α) for 35CL, 91Zr nuclei using Talys-1.9 code and compare with experimental data.

3. Obtain two-dimensional and one-dimensional spectra (n, α) of the reaction for a number of isotopes.

**Preliminary schedule by topics/tasks**

The duration of this project is 6 weeks.

Week 1 – introduction lecture, reading the articles

Week 2 – lecture with task explanation

Week 3, 4 - task completion

Week 5, 6 – preparing of the report

**Required skills**

1. Neutron physics: fundamentals of nuclear reactions with neutrons.

2. Nuclear physics: particle paths in matter/nuclear interactions

3. Computer skills: Origin 8.0, Matlab

**Acquired skills and experience**

1. Skills for calculating the neutron flux and energy spectrum of neutrons.

2. Experience at data processing and fitting of data with physical model.

3. Understanding the device (detector of charged particles) and the technique for measuring the cross section (n, α) of the reaction on fast neutrons.

4. Understanding the global problem and the importance of world nuclear databases.

5. The skill of calculating theoretical estimates of the reaction cross section, as well as constructing two-dimensional and one-dimensional spectra.

**Recommended literature**

1. Guohui Zhang, E. Sansarbayar, Yu. M. Gledenov, G. Khuukhenkhuu, L. Krupa, N. S. Gustova, M. G. Voronyuk, I. Chuprakov, N. Battsooj, I. Wilhelm, M. Solar, R. Sykoram, Z. Kohout, Jie Liu, Yiwei Hu, and Zengqi Cui «Cross sections of the 91Zr(n, α)88Sr reaction in the 3.9–5.3 MeV neutron energy region. Physical Review C 106, 064602, 2022. DOI:10.1103/PhysRevC.106.064602

2. Haoyu Jiang, Zengqi Cui, Yiwei Hu, Jie Liu, Haofan Bai, Jin-Xiang Chen, Guo-Hui Zhang, Yu. M. Gledenov, E. Sansarbayar, G. Khuukhenkhuu, L. Krupa, I. Chuprakov, xichao ruan, Hanxiong Huang, Jie Ren and Qiwen Fan «Cross-section measurements for the 58,60,61Ni(n, α)55,57,58Fe reactions at 8.50, 9.50 and 10.50 MeV neutron energies», Chinese Physics C, 2021. DOI: 10.1088/1674-1137/ac3412

3. E. Sansarbayar, Yu. M. Gledenov, I. Chuprakov, G. Khuukhenkhuu, G. S. Ahmadov, L. Krupa, Guohui Zhang, Haoyu Jiang, Zengqi Cui, Yiwei Hu, Jie Liu, N. Battsooj, I. Wilhelm, M. Solar, R. Sykora, and Z. Kohout «Cross sections for the 35Cl(n, α)32P reaction in the 3.3–5.3 MeV neutron energy region», Physical Review C 104, 044620 (2021), DOI: <https://doi.org/10.1103/PhysRevC.104.044620> 4. Haoyu Jiang, Zengqi Cui, Yiwei Hu, Jie Liu, Jinxiang Chen, Guohui Zhang, Yu. M. Gledenov, I. Chuprakov, E. Sansarbayar, G. Khuukhenkhuu, L. Krupa «Cross-section measurements for 58,60,61Ni(n, α)55,57,58Fe reactions in the 4.50 –5.50 MeV neutron energy region», Chinese Physics C, Vol. 44. No. 11 (2020) <https://doi.org/10.1088/1674-1137/abadf2>