LXXII INTERNATIONAL CONFERENCE
NUCLEUS - 2022

July, 11-16, 2022

Difference between distributions of intermediate and slow neutron flux from photoneutron source exit channel

Potashev S.I.[1,2*], Burmistrov Yu.M.[1], Kasparov A.A.[1], Drachev A.I.[1], Ponomarev V.N.[1]

1 - Institute for Nuclear Research, Russian Academy of Sciences
2 - P.N. Lebedev Physical Institute, Russian Academy of Sciences

Introduction

The output channel with the neutron collimator about 50 cm long and 3 cm in diameter was created in its moderator to perform out experiments at the photoneutron source of the INR RAS. The slow neutron spatial distribution in the flux, in particular, in the thermal energy region in our experimental hall was studied by various methods. However, many experiments must be carried out at intermediate energies, for example, in the region of neutron resonances on nuclei. An example is the spatial investigation of gold inclusions in geological samples using the well-known resonance on the ^{197}Au nucleus of about 5 eV energy [1].

1 – M. Ooi, M. Teshigawara, T. Kai et al. Neutron resonance imaging of a Au-In-Cd alloy for the JSNS [Physics Procedia, 2013, V. 43, P. 337].

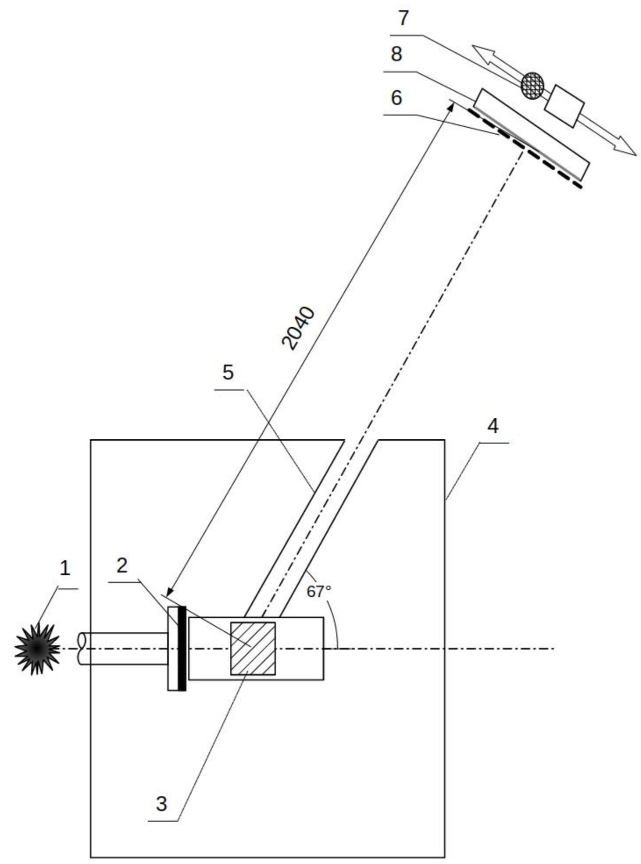
Application ^{10}B neutron detector

Previously, we found that a neutron detector based on a layer of the ^{10}B solid isotope and a wire proportional chamber is well suited for studying the spatial distribution of neutrons both in the thermal and intermediate neutron energy ranges [2]. An important advantage of this detector is selective sensitive to a neutron motion direction [3]. A cadmium filter is used which absorbs neutrons with energies below 0.55 eV in order to isolate neutrons of intermediate energies. We can neglect the influence of fast neutrons by choosing a sufficiently large distance from the center of the neutron production target ~ 200 cm.

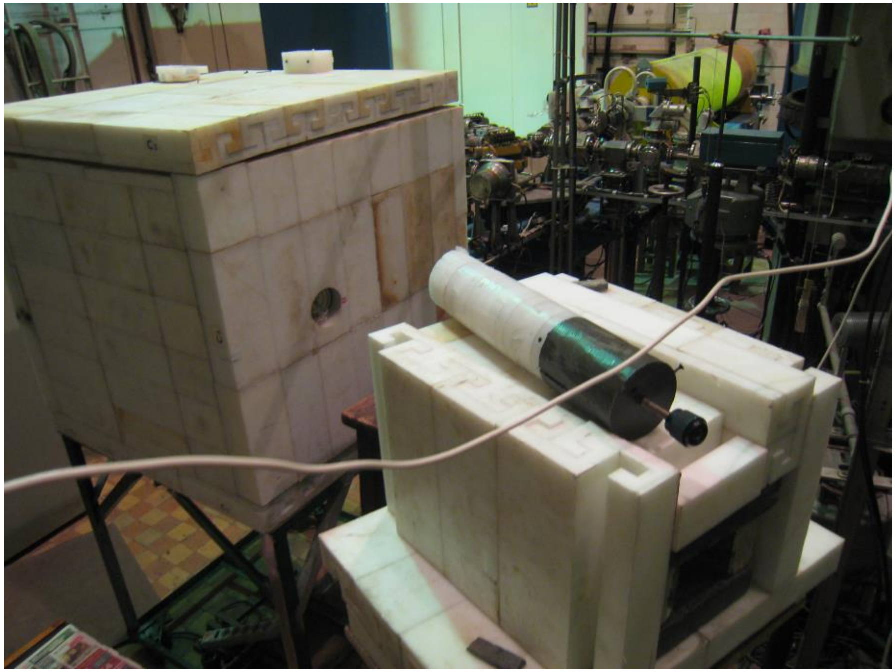
2 – И.В. Мешков, С.И. Поташев, А.А. Афонин, Ю.М. Бурмистров и др. [Известия РАН. Серия физическая, 2020, Т. 84, № 4, С. 497].
3 – С.И. Поташев, А.А. Каспаров, И.В. Мешков и др. [Известия РАН. Серия физическая, 2022, Т. 86, № 8, С. 1087].

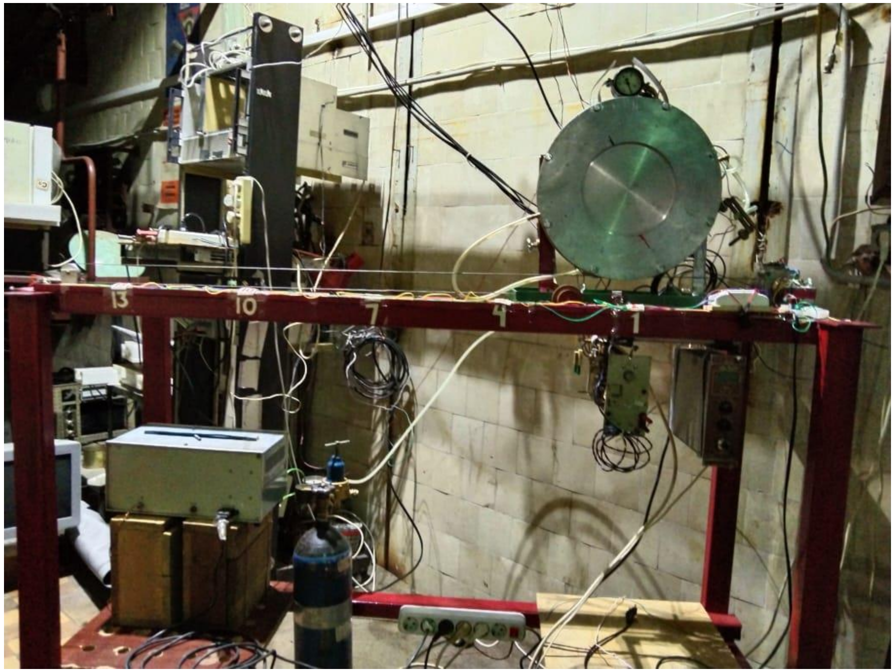
Experimental setup

Measurements were performed at the photoneutron source of the Institute of Nuclear Research, Russian Academy of Sciences. It is based on the LUE-8 electron accelerator beam 1 of which generates bremsstrahlung in W-target 2. Neutron flux is produced in ^{9}Be-target 3 which is set at the center of 1 m^3 polyethylene cube moderator 4. The neutron flux through the collimator 5 of 3-cm diameter and ~50 cm length falls on a position-sensitive neutron detector (PSDN) 6 consisted of ^{10}B solid layer and wire chamber. The moved standard ^{3}He counter 7 is placed behind it for monitoring the total neutron flux. Cd-mask 8 can be set in front of PSND.



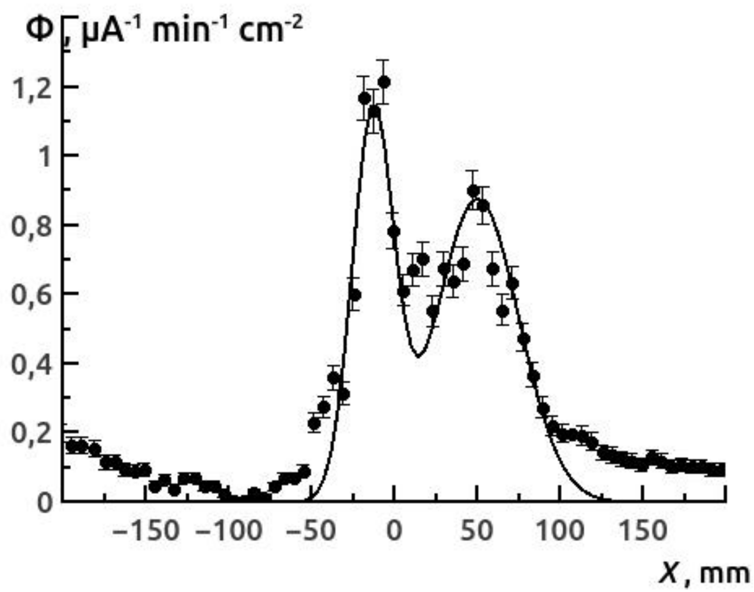
Neutron moderator and PSND

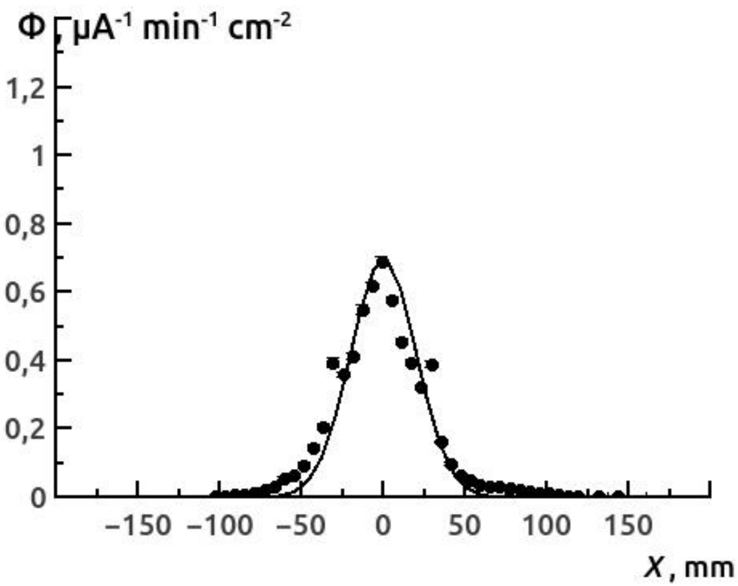




Neutron flux spatial distribution measured by PSND

On the left spatial distribution without cadmium filter. On the right distribution with Cd-filter in front of PSND. Energy of cutting for cadmium filter is 0.55 eV. Distance between Be target center and PSND is 204 cm.



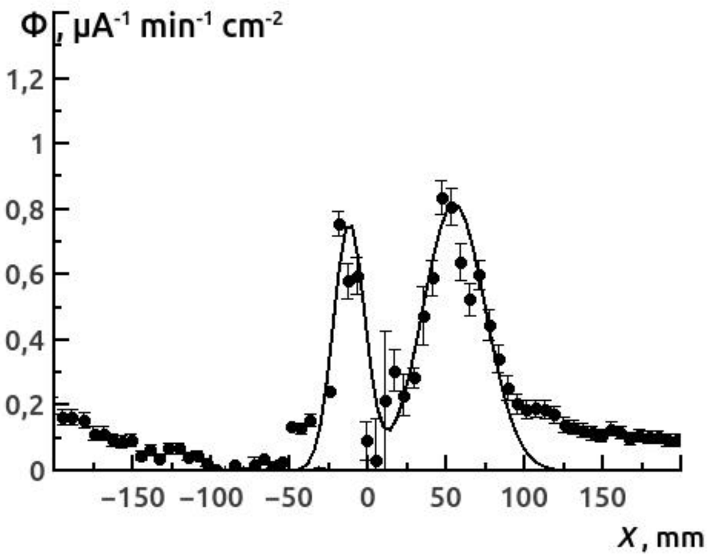


Total neutron flux distribution distribution

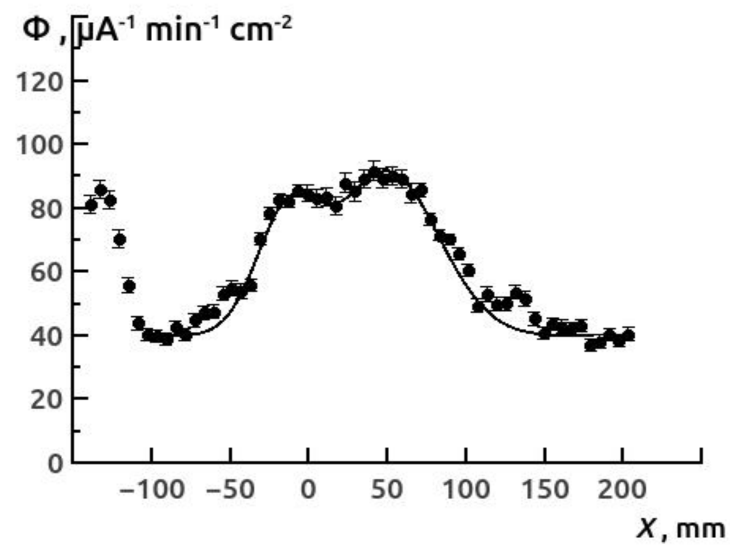
Fast neutron flux

Thermal spatial distribution by PSND and ^{3}He counter

On the left slow neutron spatial distribution measured by ^{10}B PSND.
On the right the same distribution measured by the moving ^{3}He-counter.
Explanation: scattering by collimator walls.



Slow neutrons, PSND



Same one, moving ^{3}He-counter

Discussion of the results

Gaussian fit to the distribution of intermediate neutrons at E_n > 0.55 eV gives the full width at half maximum of 4 cm which corresponds to the collimator size at a distance of 204 cm. Difference distribution corresponding to the slow neutron flux has the shape of two maxima. One maximum is located to the left of the collimator axis and another to the right of it.

E_n	X, cm	θ, degree	$FWHM_1$, cm	A	Background level
E_n > 0.55 eV ^{10}B-PSND.	0	0	4	35	0
E_n < 0.55 eV ^{10}B-PSND.	-1.2	-0.34	2	19	0
	+5.5	+1.54	4	41	
E_n < 0.55 eV ^{3}He-counter.	-1.4	-0.39	4	1800	40

Summary and conclusions

A significant difference was observed in the distribution shape of two groups of neutrons at energy above and below the cadmium boundary using the position-sensitive ^{10}B detector.

The observed small angular discripancy in the direction of intermediate and slow neutron fluxes relative to the collimator axis can be used for simultaneous experiment on two setups at both thermal and intermediate energy.

Thank you!