PREPARATION FOR TESTING EXPERIMENT ON IREN NEUTRON BEAM

T.L. Enik, L.V. Mitsyna, V.G. Nikolenko, A.B. Popov, S.S.Parzhitski, G.S. Samosvat

Frank Laboratory of Neutron Physics
Joint Institute for Nuclear Research, Dubna Moscow region, 141980, Russia

A possibility of testing the experimental installation produced for an accurate definition of the neutron-electron scattering length using the time-of- flight method is discussed. Measuring the angle anisotropy of thermal neutrons scattered by noble gas at different energy intervals will allow to extract more precise value of n,e-scattering length.

The installation description and evaluation of expected intensity with vanadium sample were done. In addition, there is an independent interest in accurate definition of the thermal neutrons scattering anisotropy for vanadium.

The new device, which is almost ready for measurement of the slow neutrons scattering anisotropy on noble gases, is presented in our report. It is intended for extracting the neutron-electron scattering length from the forward-backward neutron scattering ratio with use of time-of-flight method and can be installed both at the vertical channel of the TRONS (Troitsk) spectrometer and at IBR-2M reactor.

The setup scheme is shown in Fig.1. A neutron beam collimated to 20 mm in diameter passes along the gas-filled chamber axis through vanadium windows on its ends. There are conical and cylindrical cadmium screens inside the chamber, which separate neutrons scattered in a central part of the chamber to angles near 45^0 and 135^0. Scattered neutrons are registered by four ^{3}He-counters of 30 mm diameter in the polyethylene boxes with boron and cadmium. The counters are installed perpendicularly to the surface of the turntable. The entrance slit of each counter is 3×18.5 cm^2, its efficiency at neutron energies up to 0.1 eV is close to 100%.

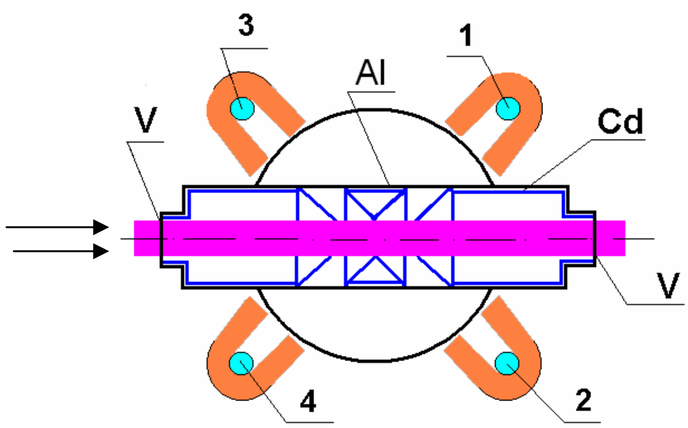

Fig.1. The scheme of setup. 1,2,3,4 are ^{3}He-detectors in the shielding fixed to the round turntable. Arrows show the neutron beam direction.

The chamber (gas sample) and the counters fastened in the turntable, which allows rotation of the measurement module for 180^0 changing the locations of detectors oppositely. Therefore for each measurement cycle the average ratio of scattering intensities forward/backward can be obtained as

$$R = \left(\frac{N_1}{N_1'} \cdot \frac{N_2}{N_2'} \cdot \frac{N_3'}{N_3} \cdot \frac{N_4'}{N_4} \right)^{1/4},$$

where N_1, N_2 are counts of counters 1 and 2, which initially register neutrons scattered forward, N_3, N_4 are counts of initially backward counters (3 and 4) and the primed counts means the counts of counters after turning. The final result will be R value averaged over all measurement cycles.

The time-of-flight method gives possibility to obtain results in rather narrow energy intervals what significantly raises reliability of the introduced corrections.

Inasmuch as the neutron flux of the IREN facility now is not elevated enough for the investigations of neutron scattering on gases, we design to perform a testing experiment with the vanadium sample instead of a gas as the first stage of our setup working. The chamber for gas will be removed and a thin plate of metallic vanadium as a standard scatterer will be placed to the neutron beam.

There is an independent interest in accurate definition of the thermal neutrons scattering anisotropy for vanadium. In some experiments it was used for calibration of the angular distributions. But in reality polycrystalline vanadium is not an ideally isotropic scatterer, and vanadium normalization leads to a systematic error of a few percent.

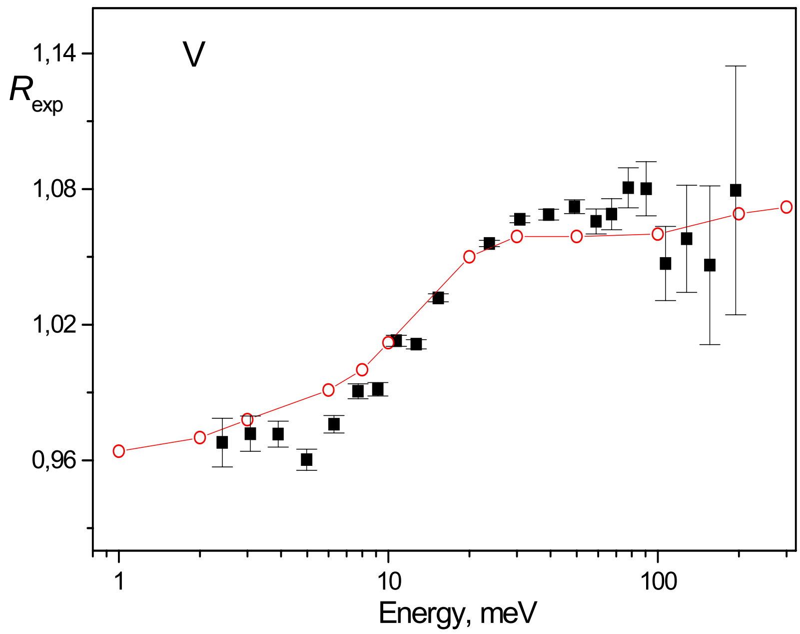

Fig.2. The ratio R_{exp} of neutron scattering intensities $30^0/150^0$ for vanadium. Black squares are the experimental points [1], light circles on the curve are the theory [2].

Anisotropy of vanadium is seen in our results [1] obtained on the beam of IBR-2 facility, which are shown in Fig.2. The ratios of the neutron scattering intensities at the angles 30^0 and 150^0 were obtained in the adjacent and gradually increasing energy intervals from ΔE ~ 0.5 meV at neutron energy E about 5 meV to ΔE ~ 40 meV at the energy of neutrons about 100 meV. The experiment (black squares) is in not bad agreement with the theory: the light circles connected with a smooth curve are the theoretical prediction from [2]. There are two peculiarities in measured intensity ratios: energy independence at the neutron energies less than 5 meV and more than 30 meV and a jump near 20 meV. These peculiarities would be subjects of future investigations.

The evaluations of the expected counts of our detectors at IREN facility were done taking into account the neutron flux and spectrum of IBR-30 [3]. In case of IREN integral intensity $1 \cdot 10^{11}$ neutrons per second we calculated a count N of one our detector at the flight path 10 m for different neutron energies E at the channel width 128 mks, vanadium thickness 1 mm and sample area 100 cm^2. The results are shown in Table.

Table

E, eV	0.005	0.01	0.02	0.03	0.04	0.05	0.08	0.1	0.2	0.5
$\Phi, s^{-1} \cdot eV^{-1}$	$8 \cdot 10^4$	$2 \cdot 10^5$	$4 \cdot 10^5$	$4 \cdot 10^5$	$4 \cdot 10^5$	$3.6 \cdot 10^5$	$2.2 \cdot 10^5$	$1.4 \cdot 10^5$	$3 \cdot 10^4$	$1 \cdot 10^4$
N, h^{-1}	6	45	250	450	700	900	1100	980	600	790

According to the data presented in Table we will have at IREN facility in intervals ΔE = 0.5 meV at E = 5 meV (12 channels, 128 mcs each) and ΔE = 40 meV at E=100 meV (3.5 channels) the detectors counts about 70 and 3400 per hour, respectively. Thus, in above mentioned intervals during 24 hours run we would obtain for the ratio R the accuracies 3.4% and 0.5%, correspondingly. In comparison with the results presented in Fig.2 the first of them is ~ 7 times worse but the second one is ~ 3 times better, what shows a significant difference between neutron spectra of IBR-2 and calculated neutron flux Φ of IREN from Table (apparently the neutron spectra of IBR-2 reactor is generated by more thick moderator than in case of IBR-30). In any case the comparison of the future results obtained in IREN facility and our data [1] measured at IBR-2 will be very interesting.

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