Rotation of polarized fissile nuclei ^{234}U и ^{236}U

G.V. Danilyan, V.A. Krakhotin, V.S. Pavlov, P.B. Shatalov
Alikhanov Institute for Theoretical and Experimental Physics
Moscow, Russia

Yu.N. Kopatch, V.V. Novitsky
Frank Laboratory of Neutron Physics, JINR
Dubna, Russia

J. Klenke
Heinz Maier-Leibnitz Zentrum, FRM II
Garching, Germany

Short history

TRI – effect

- In 1998 large collaboration [1] of Russian and German Institutes have performed an experiment on cold polarized neutrons beam of ILL HFR to measure the T-odd angular correlation in ternary fission of ^{233}**U,** which can be described as:

$$W \sim 1 + D_\alpha \cdot \mathbf{p}_\alpha \cdot [\mathbf{I}, \mathbf{p}_{LF}], \qquad (1)$$

and it was found that

$$D_\alpha\ ^{233}U = -(3.9 \pm 0.1) \cdot 10^{-3}$$

In the next experiment the same measurement have been performed for target of ^{235}**U** and it was found that correlation coefficient has opposite sign:

$$D_\alpha\ ^{235}U = +(1.7 \pm 0.2) \cdot 10^{-3}$$

The sign of D in the experiment defined relative to the neutron beam polarization vector **P**, but direction of **I** in (1) is parallel to **P** when I(+) = J+1/2 and antiparallel when I(-) = J-1/2. Moreover, coefficient D depends also on I.

Short history

ROT - effect

In 2005 the collaboration of PNPI and TU [2] continued the detailed investigation of TRI-effect in ternary fission of ^{235}U, and have detected the strange effect - the angular distribution od α-particles was shifted on a small angle when neutron beam polarization was reversed. A. Gagarski came to on idea that this shifting arise due to the rotation of fissile nucleus at the scission, and it was called the “ROT-effect”.

Very soon the same effects were found by ITEP team in the angular distributions of prompt γ-rays and neutrons at thermal neutrons induced fission of ^{235}U [3]. Because the anisotropy of prompt γ-rays is not so large, the ROT-effect in emission of prompt γ-rays may by described by the five-vectors correlation:

$$W \sim 1+D_{\gamma} \cdot \mathbf{p}_{\gamma} \cdot [\mathbf{I},\mathbf{p}_{LF}] \cdot (\mathbf{I} \cdot \mathbf{p}_{LF}). \qquad (2)$$

It means that signs of correlation coefficients in ternary fission (TRI-effect) and in binary fission (ROT-effect) for prompt γ-rays emission must be the same. For this reason we have performed the simultaneous measurements of ROT-effects for targets of ^{235}U and ^{233}U [3]. Our results are in contradiction with results of PNPI team [4]. All results are shown in next table.

Experimental data

	Particle	Correlation	^{233}U	^{235}U
1	α TRI	$W \sim 1+D_\alpha \cdot p_\alpha \cdot [\sigma \times p_{LF}]$	$-(3{,}9 \pm 0{,}1)\cdot 10^{-3}$ ITEP, PNPI, TU	$+(1.7 \pm 0.2)\cdot 10^{-3}$ ITEP, PNPI, TU
2	α ROT		+ (0,021 ± 0.004)° **PNPI, TU**	**+ (0,215 ± 0,005)°** **PNPI, TU**
3	γ ROT	$W \sim 1+R_\gamma \cdot k_\gamma \cdot [\sigma \times p_{LF}]\cdot(k_\gamma \cdot p_{LF})$	**$-(6{,}3 \pm 1{,}6)\cdot 10^{-5}$** **ITEP**	**$+(16{,}6 \pm 1{,}6)\cdot 10^{-5}$** **ITEP**
4	n ROT		**$-(4{,}8 \pm 1{,}6)\cdot 10^{-5}$** **ITEP**	**$+(21{,}2 \pm 2{,}5)\cdot 10^{-5}$** **ITEP**

Conclusion

- As it can be seen, the same signs for ROT-effects in ternary fission for nuclei ^{233}U and ^{235}U are in contradiction with all other results.

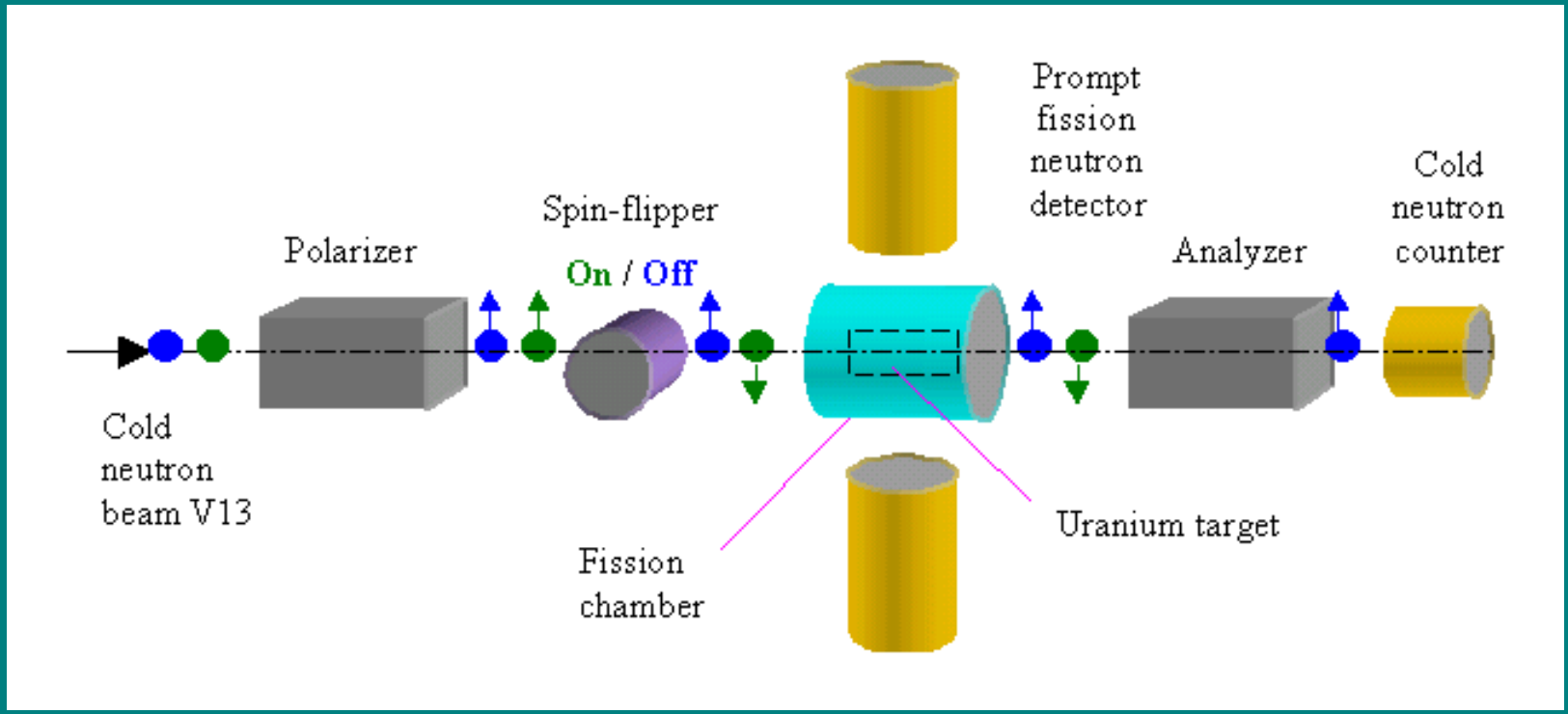
What does it mean ?

Our thanks for any comments !

Literature

1. P. Jesinger, G. V. Danilyan, A. M. Gagarski, et al., Phys. At. Nucl. 62, 1608 (1999).
2. A. Gagarski, I. Guseva, F. Goennenwein, et al., in Proceedings of the XIV International Seminar on Interactions of Neutrons with Nuclei, Dubna, Russia, 2006, p. 93.
3. G.V. Danilyan, J. Klenk, Yu.N. Kopatch, V.A. Krakhotin, V.V. Novitsky, V.S. Pavlov, P.B. Shatalov, PHAN, 77, 715 (2014).
4. A. Gagarski, F. Goennenwein, I. Guseva et al. in Proceedings of the XVII International Seminar on Interactions of Neutrons with Nuclei, Dubna, Russia, 2010, p. 17.

СХЕМА УСТАНОВКИ



Cross section of fission chamber