Simulation of the ROT-effect using GEANT4

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The effect of nuclear rotation, the so-called ROT effect, was first discovered in the angular correlations of α-particles from the ternary fission of ^{235}U induced by cold polarized neutrons [1]. Later, a similar effect was observed in the angular distributions of gamma rays and neutrons [2] in the binary fission of uranium isotopes. The ROT effect manifests itself in the asymmetry of the count rates of detectors of α-particles, gamma-rays or neutrons when the polarization of incident neutrons changes to the opposite one and is explained by a shift in the angular distributions of the corresponding fission products relative to the axis of emission of fission fragments. The observed value of the asymmetry coefficient $D=(N^{+}-N^{-})/(N^{+}+N^{-})$ is about 10^{-2} for α-particles in ternary fission and 10^{-4} for gamma-rays in binary fission of ^{235}U. Currently, the effect has been measured for fission induced by cold and thermal neutrons and for the 0.3 eV resonance in ^{235}U. Of great interest is the measurement of this effect in the resonance region, as well as for other fissile nuclei.

This paper will present the results of modeling the ROT effect using the Monte Carlo method and the GEANT4 toolkit. The influence of the geometry of the experimental setup, target parameters, degree of polarization, and other factors on the magnitude of the observed asymmetry was studied. Particular attention is paid to assessing the possibility of measuring the ROT effect in the emission of gamma-rays by determining the fission axis using the detection of prompt fission neutrons.

1. F. Goennenwein et al., Phys. Lett. B 652, 13 (2007).
2. G. V. Danilyan et al., Phys. At. Nucl. 74, 671 (2011).