

# The method for verifying the enhancement of multipole transitions by vortex photons via activity measurement

Y. Wang<sup>1\*</sup>, O. V. Bogdanov<sup>1</sup>, F. A. Rasulova<sup>2</sup>, Y. Yang<sup>3</sup>

<sup>1</sup> National Research Tomsk Polytechnic University, Tomsk, Russia

<sup>2</sup> Flerov Laboratory of Nuclear Reactions of Joint Institute for Nuclear Research, Dubna, Russia

<sup>3</sup> Shanghai Advanced Research Institute, Chinese Academy of Sciences, Shanghai, China

\*e-mail: [yanchzhao1@tpu.ru](mailto:yanchzhao1@tpu.ru)

It is believed that twisted photons [1], [2], [3] can enhance multipole transitions in atomic nuclei; however, this effect has not yet been experimentally confirmed. Direct verification of multipole transition enhancement presents difficulties. We have found that, it can be verified through indirect processes – specifically, by exciting the atomic nucleus to a higher energy level, followed by particle emission and de-excitation to an isomer state. The yields of radioactive products resulting from low-energy photonuclear reactions – such as  $^{44\text{m,g}}\text{Sc}$ ,  $^{58\text{m,g}}\text{Co}$ , and  $^{87\text{m,g}}\text{Y}$ —along with their isomeric states can be determined through activity measurements. Furthermore, the isomeric yield ratios (IYR) of these isomeric pairs provide information regarding the spin distribution of the compound nuclear states [4], [5].

We propose that by comparing the IYR and isomeric production cross section obtained under irradiation by planar photons versus vortex photons, one can experimentally test whether vortex photons indeed transfer additional angular momentum. We outline four distinct experimental methods to detect the multipole enhancement induced by twisted photons, applicable to  $(\gamma, \gamma')$  and  $(\gamma, n)$  reactions across various energy regimes. We also enumerate specific isomeric pairs and their corresponding photonuclear reactions that satisfy the requisite experimental conditions. Based on the energy spectrum parameters of the quasi-monoenergetic beam obtained from the Back Compton scattering of the SLEGS and the IYR results of  $^{85\text{m,g}}\text{Sr}$  and  $^{89\text{m,g}}\text{Zr}$  obtained from the photoneutron reaction of the plane beam, the IYR variation caused by the vortex beam was calculated.

## References

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