

Studies of quantum entanglement in positronium decay with the J-PET detector

N. Krawczyk*

*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University,
Łojasiewicza 11 Kraków, Poland*

J-PET is the positron-emission tomograph (PET) constructed from plastic scintillators. It is optimized for the detection of photons from electron-positron annihilation [1,2,3,4]. Such photons, having an energy of 511 keV, interact with electrons in plastic scintillators predominantly via the Compton effect. According to Klein-Nishina formula polarization of a photon might be estimated by measurement of the momentum direction of primary and scattered photon. By investigating correlations between polarization vectors we are able to determine the initial state [5,6]. Predicted by theory but never experimentally proven, the two- and three-photon states should be entangled. In this talk I will present a method to determine single photons polarisation, correlations between polarisations as well as quantum information theoretic version of the Klein-Nishina formula in order to determine whether initial state was separable or entangled.

References

- [1] P. Moskal et al., Nucl. Instrum. Meth. A **764**, 317 (2014).
- [2] P. Moskal et al., Nucl. Instrum. Meth. A **775**, 54 (2015).
- [3] P. Moskal et al., Phys. Med. Biol. **61**, 2025 (2016).
- [4] L. Raczyński et al., Phys. Med. Biol. **62**, 5076 (2017).
- [5] P. Moskal, N. Krawczyk, B. C. Hiesmayr et al. Eur. Phys. J. C (2018) 78: 970.
- [6] B. C. Hiesmayr, P. Moskal, Witnessing Entanglement in Compton Scattering Processes via Mutually Unbiased Bases, arXiv:1807.04934

*Corresponding author, Email: nikodem.krawczyk@gmail.com