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Study of time reversal symmetry in the decay of Ortho-Positronium atoms using J-PET

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Collaboration

J-PET

Abstract content

The Jagiellonian Positron Emission Tomograph (J-PET) is one of its kind based on organic scintillators being developed at Jagiellonian University in Krakow, Poland [1,2]. J-PET is an axially symmetric and high acceptance scanner that can be used as a multi-purpose detector system. It is well suited to pursue tests of discrete symmetries in decays of positronium in addition to medical imaging [3,4,5]. J-PET enables the measurement of the momentum vector $\vec{k_i}$ and the polarization vector $\vec{\epsilon_j}$ of annihilation photons [4]. Measurement of polarization of high energy photons (511 keV) is a unique feature of the J-PET detector which allows the study of time reversal symmetry violation by determining the expectation values of the time reversal symmetry odd operator [4], $(\vec{\epsilon_j}.\vec{k_i}), (\text{for} j \neq i)$. So far, Time reversal symmetry violation has not been observed in purely leptonic systems [6]. The best experimental upper limits for CP and CPT (C-Charge Conjugation, P-Parity, and T-Time) symmetry violation in positronium decay is set to 0.3×10^{-3} [7,8]. According to the standard model predictions, photon-photon interaction or weak interaction can mimic the symmetry violation at the level of 10^{-9} (photon-photon interaction) and 10^{-13} (weak interactions) respectively [9-11]. There are about 6 orders of magnitude difference between the present experimental upper limit and the standard model predictions [6]. J-PET group aims to improve the sensitivity for the tests of the time reversal symmetry with respect to the previous experiments in the leptonic sector. At the turn of 2017 and 2018, a three month experimental run with the positronium produced in the porous polymer was conducted. The first results of the analysis will be presented in the poster.

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