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CPT symmetry test in positronium annihilations with the J-PET detector

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Discrete symmetry under the combined transformation of charge, parity, and time-reversal (CPT) can be tested in the decays of positronium atom, the lightest bound system built of charged leptons. Jagiellonian Positron Emission Tomograph (J-PET) device constructed from plastic scintillators, detects the photons originating from electron-positron annihilation. This feature enables J-PET to study CPT symmetry in the three-photon annihilations of the triplet state of positronium. Signs of violation of the CPT symmetry can be sought as a non-vanishing expectation value of an angular correlation operator that is odd under CPT transformation. Technique to estimate the spin of ortho-positronium and momenta of annihilation photons for a single recorded ortho-positronium event allows J-PET to measure the expectation value of CPT symmetry odd angular correlation operator. J-PET measures a broad range of kinematical configurations of ortho-positronium annihilation to three photons and is the first experiment to determine the full range of the CPT-odd angular correlation. The presentation will include the methods of performing the CPT symmetry test using an angular correlation operator which involves the spin and momenta of photons originating from $o\text{-Ps} \rightarrow 3\gamma$ decay using extensive size positronium production and annihilation chambers with the J-PET detector.

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