International Conference on Exotic Atoms and Related Topics and conference on Low Energy Antiprotons (EXA/LEAP 2024)



Contribution ID: 46

Type: not specified

Multi-Photon decays of positronium with J-PET

Tuesday 27 August 2024 17:30 (2 hours)

Being governed by electromagnetic (EM) interaction, the bound state of electron and positron forms a metastable state-Positronium (Ps). Ps is hydrogen-like atom, free from any hadronic background as well as any weak interaction effects. Being a leptonic system, it is governed by Quantum Electrodynamics (QED) because of which accurate theoretical predictions can be made and put to stringent test [1]. Test for bound state QED could be carried out by probing the decay rates of Positronium. In particaular the Ps triplet state, the ortho-Positronium (o-Ps), which predominantly decays into three gamma quanta. The rate for o-Ps decaying into a higher number of photons is by six orders of magnitude smaller as expected from QED calculations [1, 2, 3]. However, higher decay channels could be probed using the multi-purpose Jagiellonian PET (J-PET) detector. J-PET is a plastic-scintillator based, multi-discipilinary PET tomograph [3, 4, 5] extending its reach from biomedical application to active fundamental studies like CPT invariance, photon entanglement and mirror matter searches.

J-PET aims to study the contribution of multi-photon decays in the context of the invisible mirror matter study. Mirror matter is a hypothetical particle to restore parity invariance. Study of multi-photon decays of ortho-Positronium empower us to have better control over the exploration of this invisible particle. The branching ratio of $o-Ps \rightarrow 5\gamma$ experimentally [6] determined in previous experiments is by several orders of magnitude less precise than the theoretical calculation [7]. In this work we will present the capabilities of J-PET and preliminary studies of the multi-photon decays of ortho-Positronium and aim to put stringent limits in this rare decay.

[1] S. D. Bass et al., Rev. Mod. Phys. 95, 021002 (2023).

[2] A. Ore et al., Phys. Rev. 75, 1696 (1949).

[3] P. Moskal et al., Sci. Adv. 7, 4394 (2021).

[4] P. Moskal et al., Nat. Commun. 12, 5658 (2021).

[5] P. Moskal et al., Nat. Commun. 15, 78 (2024).

[6] P. A. Vetter et al., Phys. Rev. A 66, 052505 (2002).

[7] G. S. Adkins et al., Phys. Rev. A 28, 1164 (1983).

Author: TANTY, Pooja

Co-authors: Dr DEL RIO, Elena Perez (Jagiellonian University); Prof. MOSKAL, Pawel (Jagiellonian University)

Presenter: TANTY, Pooja

Session Classification: Poster