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Rydberg-Stark states of positronium

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Recent advances in positron trapping techniques, positron to positronium (Ps) converter materials, and commercially available pulsed laser sources has greatly simplified the generation of Rydberg states of Ps. Highly-excited states of this exotic atom are listed in several schemes being developed for synthesis of anti-hydrogen for (anti)gravity measurements. In contrast to its ground-state, which rapidly self-annihilates, prolonged measurements of Ps* are possible: an element interesting in its own right for being a purely leptonic, bound-state system.

A experiment designed for laser-spectroscopy of Ps and optical preparation of Rydberg states is presented. Tailoring of the electric field in the excitation region is demonstrated as a means to select specific Stark states of the $n = 11$ manifold. These states are significant for having large electric-dipole moments, which can be exploited to manipulate the atoms. Such techniques can in principle be employed to electrostatically focus a cold Ps beam, and eventually to measure gravitational deflection of the part-antimatter pair.

Primary author: DELLER, Adam (University College London)

Presenter: DELLER, Adam (University College London)

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