

## Generation of an electrostatically guided Rydberg-Ps beam

D. B. Cassidy\*

*Department of Physics and Astronomy, University College London, United Kingdom*

\*email: d.cassidy@ucl.ac.uk

Positronium atoms that have been optically excited to specific Rydberg-Stark states [1] can be used for many experiments that cannot be performed with ground state atoms. This is primarily because the excited states essentially don't annihilate, and will therefore live for times determined by fluorescence (typically microseconds or longer [2]). In addition to having extended lifetimes, Rydberg Ps atoms can also be manipulated using inhomogeneous electric fields owing to their large electric dipole moments [3]. Thus, it is possible to produce a long-lived Ps beam that can in principle be decelerated and focused [4], although so far we have only demonstrated Ps velocity selection, using a curved quadrupole guide [5]. Nevertheless, this configuration is well-suited to the production of merged beams [6], allowing Ps interactions with other atomic and molecular species to be studied. This arrangement would, for example, be ideal for experiments designed to observe the production of positron-atom bound states [7] with very high efficiency, since the relative velocities of the Ps and the atom beam can be made to be low. I will discuss the Rydberg-Ps beam production experiments that have been conducted so far, and consider future prospects and applications.

- [1] *Selective Production of Rydberg-Stark States of Positronium*, T. E. Wall, A. M. Alonso, B. S. Cooper, A. Deller, S. D. Hogan, and D. B. Cassidy, *Phys. Rev. Lett.* **114**, 173001 (2015).
- [2] *Measurement of Rydberg positronium fluorescence lifetimes*, A. Deller, A. M. Alonso, B. S. Cooper, S. D. Hogan, and D. B. Cassidy, *Phys. Rev. A* **93**, 062513 (2016).
- [3] *Electrostatically Guided Rydberg Positronium*, A. Deller, A. M. Alonso, B. S. Cooper, S. D. Hogan, and D. B. Cassidy, *Phys. Rev. Lett.* **117**, 073202 (2016).
- [4] *Rydberg-Stark deceleration of atoms and molecules*, S. D. Hogan, *EPJ Tech. Instrum.* **3**, 1 (2016).
- [5] *Velocity selection of Rydberg positronium using a curved electrostatic guide*, A. M. Alonso, B. S. Cooper, A. Deller, L. Gurung, S. D. Hogan, and D. B. Cassidy, *Phys. Rev. A* **95**, 053409 (2017).
- [6] *3D-Printed Beam Splitter for Polar Neutral Molecules*, Sean D. S. Gordon and Andreas Osterwalder, *Phys. Rev. Applied* **7**, 044022 (2017).
- [7] *Formation of positron-atom bound states in collisions between Rydberg Ps and neutral atoms* A. R. Swann, D. B. Cassidy, A. Deller, and G. F. Gribakin, *Phys. Rev. A* **93**, 052712 (2016).