

Positronium beam production and scattering at low energies

This content has been downloaded from IOPscience. Please scroll down to see the full text.

2015 J. Phys.: Conf. Ser. 635 052069

(<http://iopscience.iop.org/1742-6596/635/5/052069>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 193.6.177.73

This content was downloaded on 20/11/2015 at 06:48

Please note that [terms and conditions apply](#).

Positronium beam production and scattering at low energies

S E Fayer¹, S J Brawley, M Shipman, L Sarkadi*, and G Laricchia

UCL Department of Physics and Astronomy, University College London, WC1E 6BT London, UK

* Institute for Nuclear Research of the Hungarian Academy of Sciences, H-4001 Debrecen, Pf. 51, Hungary

Synopsis We are now able to produce a positronium beam at energies in the range 1 – 400 eV, significantly lowering the previously achievable minimum of ~ 7 eV and opening up the possibility of investigating subtle quantum mechanical effects such as those which give rise to low energy electron scattering phenomena (*e.g.* resonances and 'barrier transparency').

Positronium (Ps) is the lightest atom, comprised of a bound state of an electron and its antiparticle, a positron. Ps investigations can yield both tests of fundamental physics (*e.g.* QED due to its purely leptonic nature) and increase the understanding of atomic scattering. However, due to experimental and theoretical difficulties, knowledge on Ps scattering is scarce [1]. There remains, therefore, much to be learnt about Ps scattering, particularly at low energies and at UCL a monoenergetic Ps beam is being used to measure positronium total cross sections for noble gases and some simple molecules [2].

A description of the equipment used in this work may be found in the literature, *e.g.* [7]. Collimated Ps production is performed by passing a positron beam through a gaseous target [8]. Recently, we have achieved for the first time a beam at energies as low as 1 eV, equivalent to a velocity of 0.2 a.u., by using Ar as the production target [8]. Details of this work will be presented at the conference.

In recent years, a similarity between the total cross sections of Ps and electrons at the same velocity has been reported [2]. This similarity has been seen to extend to structures appearing in the electron total cross section [7]. Following the new developments described above, positronium total cross sections are now being measured for the first time at low energies for various targets including Ar, Xe (both possessing a Ramsauer-Townsend minimum in the electron cross section at the particle velocity of 0.15 and 0.23 a.u. respectively) and N₂ (which displays a pronounced ²Π_g shape resonance near the velocity of 0.41 a.u.), as shown in figure 1. These results will be presented at the conference.

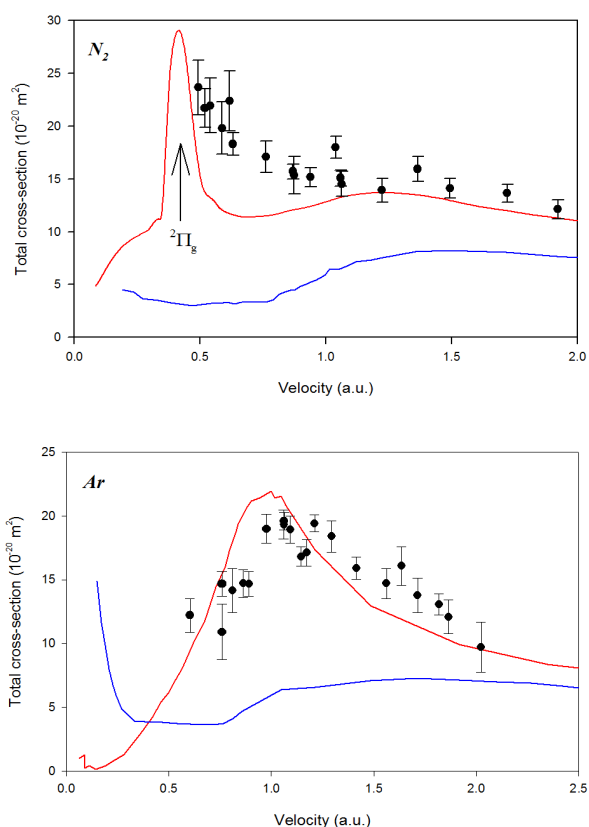


Figure 1. Total cross sections for N₂ and Ar for Ps [2], ●; electron [3], [4] (—) and positron [5], [6] (—).

¹E-mail: s.fayer@ucl.ac.uk

References

- [1] G. Laricchia and H. R. J. Walters 2012 *Riv. Nuovo Cimento* **35** 305
- [2] S. J. Brawley *et al* 2010 *Science* **330** 789
- [3] Y. Itikawa 2006 *J. Phys. Chem. Ref. Data* **35** 31
- [4] W. E. Kaupilla *et al* 1981 *Phys. Rev. A* **24** 725
- [5] K. R. Hoffman *et al* 1982 *Phys. Rev. A* **25** 1393
- [6] L. Chiari and A. Zecca 2014 *Eur. Phys. J. D* **68** 297
- [7] S. J. Brawley *et al* 2010 *Phys. Rev. Lett.* **106** 263401
- [8] M. Shipman *et al* 2014 *Eur. Phys. J. D* **68** 75

We are grateful to EPSRC for financial support under grant EP/J003980/1 and providing a studentship to SEF.

