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

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

XXIX International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC2015) IOP Publishing
Journal of Physics: Conference Series **635** (2015) 052069 doi:10.1088/1742-6596/635/5/052069

Positronium beam production and scattering at low energies

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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].

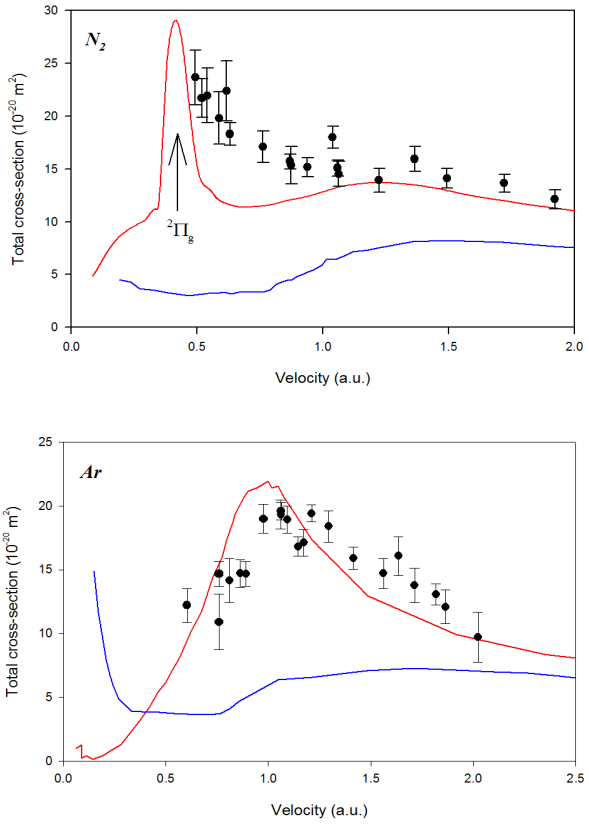

Figure 1. Total cross sections for N_2 and Ar for Ps [2], •; electron [3], [4] (——) and positron [5], [6] (——).

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 N_2 (which displays a pronounced $^2\Pi_g$ shape resonance near the velocity of 0.41 a.u.), as shown in figure 1. These results will be presented at the conference.

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

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