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Low energy positron scattering from krypton and xenon

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Synopsis Absolute grand total, positronium formation, and grand total minus positronium formation cross sections for positron scattering from krypton and xenon have been measured with an energy resolution of ~60 meV over the energy range 0.5-60 eV. Experimental results for elastic differential cross sections measured using the same apparatus, for selected energies both below and above the Ps threshold, are also presented. Theoretical estimations of these cross sections are also performed using the convergent close coupling method (CCC) and the relativistic optical potential (ROP) approach.

Studies of positron scattering from noble gases provide a vital meeting point for contemporary quantum scattering theory and experiment. The grand total cross section, σ_{GT}, is the simplest to measure, and has been the most studied. Amongst all the inelastic channels that contribute to σ_{GT}, the cross section for the positronium (Ps) formation channel (σ_{Ps}) is typically the largest in most atoms and molecules in the energy range below 100 eV. In many atomic and molecular systems, σ_{Ps} can constitute up to half of σ_{GT}, particularly in the region within 10-20 eV above the Ps threshold.

The most notable observation from a perusal of the literature results for Kr and Xe, for both σ_{GT} and σ_{Ps}, is that the level of agreement amongst them is poor (see for example [1, 2]). In this work, studies of low energy positron scattering from atoms have been carried out using a pulsed high resolution (~ 60 meV) positron beam [3], to measure σ_{GT}, σ_{GT} - σ_{Ps} and σ_{Ps} cross sections. Elastic differential cross sections (DCS) have also been investigated for these two targets, for selected energies below and above the Ps threshold (E_{Ps}).

Figure 1 shows results for σ_{Ps} and elastic DCS for Xe. The DCS are measured at two E_{Ps} threshold energies of 5.33 and 6.64 eV, corresponding to the ground state $^2P_{3/2}$ - $^2P_{1/2}$ fine-structure splitting of the Xe^+ ion. In Figure 1 we find no signature in the σ_{Ps} of the second Ps formation threshold at 6.64 eV. These and the rest of the results will be discussed in detail at the conference.

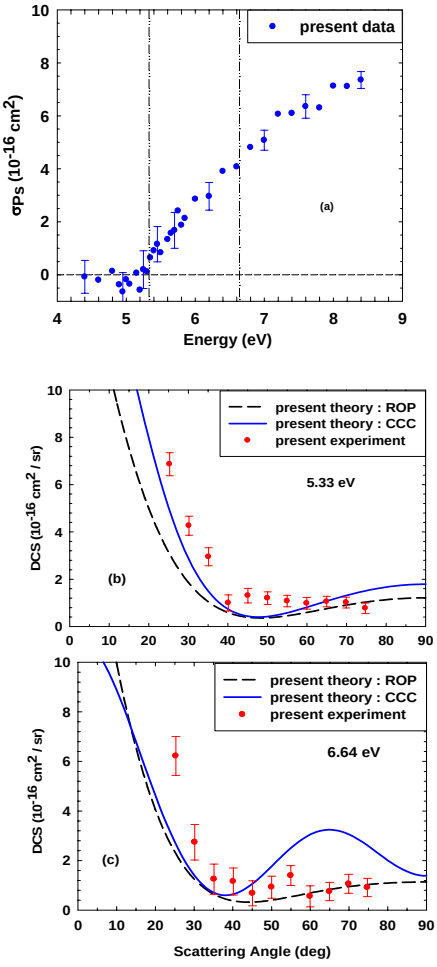

Figure 1. Positron-Xe Ps formation cross section (a), and elastic DCS at the E_{Ps} energies 5.33 eV (a) and 6.64 eV (b). The vertical dash-dot-dot-dash lines in (a) show the positions of E_{Ps}, i.e., 5.33 and 6.64 eV.

References

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