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Positronium collisions with atoms, protons, and antiprotons[1]

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Recently observed similarities between positronium (Ps) scattering and electron scattering from several atoms and molecules [1] in the intermediate energy range were explained [2,3] by the dominance of the electron exchange interaction with the target atom or molecule. An explicit proof of this equivalence was given using the framework of the impulse approximation [2], valid above the Ps ionization threshold. For lower collision energies a pseudodopotential method [3] was developed. It was successfully applied to the calculation of Ps scattering from heavy rare gas atoms, and gave results in good agreement with those of the beam experiments [1]. The same method was applied to Ps collisions with molecular hydrogen [4]. In general we observe the similarity between electron and Ps scattering at energies above the Ps ionization threshold. However, below the threshold the two sets of cross sections are different because of the different nature of the long-range interaction between the projectile and the target, the polarization interaction in the case of electron collisions and the van der Waals interaction in the case of Ps collisions. In particular the Ramsauer-Townsend minimum is not seen in theoretical cross sections for the heavy rare gas atoms. The second part of this talk will summarize recent results on the threshold behavior of Ps collisions with protons and antiprotons [5]. Partial cross sections for elastic and quasielastic scattering exhibit oscillations as functions of $\ln E$ where E is the Ps energy. The quantum-mechanical threshold behavior of hydrogen and antihydrogen formation show features which make them different from results of classical trajectory Monte Carlo simulations. [1] S. J. Brawley, S. Armitage, J. Beale, D. E. Leslie, A. I. Williams, and G. Laricchia, Science **330**, 789 (2010). [2] I. I. Fabrikant and G. F. Gribakin, Phys. Rev. Lett. **112**, 243201 (2014). [3] I. I. Fabrikant and G. F. Gribakin, Phys. Rev. A **90**, 052717 (2014). [4] R. S. Wilde and I. I. Fabrikant, Phys. Rev. A **92**, 032708 (2015). [5] I. I. Fabrikant, A. W. Bray, A. S. Kadyrov, and I. Bray, Phys. Rev. A **94**, 012701 (2016).

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