

Inseparable positron annihilation and positronium formation in positron-hydrogen collisions

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A unified treatment of positron annihilation and positronium (Ps) formation in collisions of positrons with hydrogen atom is presented. The effects of the positron annihilation are directly included in the Hamiltonian as an absorption potential, and hence the finite lifetimes of Ps in ns states are automatically taken into account. The Schrödinger equation is solved using the close-coupling method in terms of hyperspherical coordinates. This theory elucidates that, near the Ps($1s$) threshold E_{th} , the annihilation and Ps formation in the conventional sense are inseparable, and that Ps formation constitutes just a part of annihilation as an indirect process. Thus the annihilation cross section, which would diverge close to E_{th} if Ps($1s$) had an infinite lifetime, is found to connect smoothly across E_{th} to the cross section for Ps formation, which is meaningful only at energies well above E_{th} . A preliminary report of this work has been published elsewhere [1].

[1] A. Igarashi, M. Kimura, and I. Shimamura, Phys. Rev. Lett. **89**, 123201 (2002).

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