

Photodetachment threshold spectroscopy of the positronium negative ion -first determination of the electron affinity of positronium-

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The positronium negative ion is a three-body bound state consisting of a positronium atom and a loosely-bound electron. Its fundamental features provide good testing grounds for few-body system theories and three-particle QED calculations. Since the pioneering calculation [1] of its one-electron binding energy or the electron affinity of positronium, various theoretical approaches have been used to explore its features. However, the experimental verifications were limited to just a few measurements [2] on the decay rate mainly due to the extremely weak ion yield and its short annihilation lifetime (479 ps).

In the present work, we have demonstrated the photodetachment threshold spectroscopy of the positronium negative ion employing an efficient positronium ion source [3] and a tunable OPO/OPA laser system. The threshold corresponding to the electron affinity of positronium was determined experimentally for the first time by laser photodetachment threshold measurements [4] as shown in Fig.1. The determined electron affinity for positronium in the 1^3S_1 state is $326.88 \pm 0.09(\text{stat.}) \pm 0.10(\text{syst.})$ meV, which is consistent with a state-of-art calculation including relativistic and QED corrections [5].

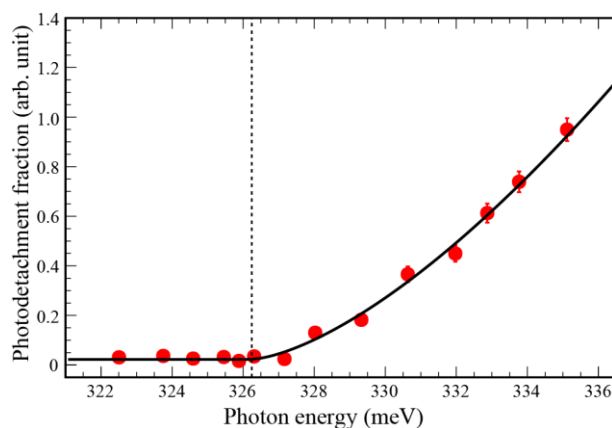


Fig.1. Threshold behavior of the photodetachment fraction of positronium negative ions.

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