ポジトロニウム負イオン光脱離断面積の計算

Calculation of the photo-detachment cross sections of Ps^-

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The positronium negative ion, Ps^- (e^-, e^-, e^+), is the lightest three body system, where the three particles with the same mass are bound through Coulomb interactions. The system has a single bound state of $^1S^e$ symmetry, the binding energy is ~0.33 eV, and the decay rate is ~2.1 ns^{-1}.

Some calculations are reported for the properties of the bound state, the annihilation rate, and the dynamics such as the e + Ps scattering and one-photon photodetachment. However, the experiments about the system have been done only for the lifetime due to the extremely weak intensity of Ps^- beam.

Recently a new method for efficient Ps^- formation has been developed [1,2], and the one-photon detachment cross section has been measured by the same group [3]. They are planning to determine the one-photon detachment cross section, to observe the resonances of Ps system, and to produce the energy tunable Ps beam by applying their photodetachment technique [2,4].

In association with the resonance observation, the resonance structure for the one-photon detachment cross section of Ps was already calculated in [5]. The two photon detachment cross section was calculated by Maniadaki *et al.* [6], but the calculation was not done up to the resonance region. We have calculated the two-photon detachment cross sections within the lowest-order perturbation theory for the final-state energies below the Ps(n=2) production threshold, where the coupled channel method with Ps orbitals are used to prepare the wavefunctions. For comparison, the calculation method is applied to an analogous system H^-, and one-electron calculations are carried out for Ps and H^-.

Main results are followings. Overall the energy dependencies of cross sections are similar to those of H^-. The present cross sections are about four orders of maginitude smaller than those of Maniadaki *et al.* The lowest $^1S^e$ and $^1D^e$ resonances below the Ps(n=2) threshold are clearly seen. The two-photon detachment rate becomes comparable to the one-photon detachment one at the laser intensity ~ 10^{10} W/cm^2. The one-electron calculation is valid both for Ps and H in the low energy region, where the scaling based on the zero-range potential model works fairly well for the one- and two-photon detachment cross sections of the two systems.

References

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