CHARGE TRANSFER IN PROCESSES OF AIS EXCITATION BY POSITIVE IONS

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A post-collision interaction(PCI) is considered in resonant processes of an excitation of autoionizing(AI) state by positive ions, followed by its decay. The special case when PCI yields a production of bound state of the projectile—AI electron pair is investigated. These resonant processes are presented in the form

$$I + A \to I + A^* \to I + e + A^+ \to (Ie) + A^+ \qquad (1)$$

and can be considered as a particular case of charge transfer in resonant processes. The aim of this work is the development of the amplitude and the cross section of the resonant processes (1). Earlier PCI leading to the discrete final state was investigated in the near-threshold processes where the bound state is produced by the pair: the slow scattered electron and the target-ion[1,2,3]. Contrary to these processes the bound state in the reaction (1) is created by the fast projectile and the AI electron. Note that the PCI effects in the continuum final state of the resonant processes (1) has been intensively investigated by many authors (see the review[4]).

We will mark henceforth the positive projectile as a particle A, the AI electron as a particle B, and the target-atom as a particle C. The Coulomb interaction between the particles A and B proves to be the main contribution to the (AB) bound state production. The influence of the third particle C yields a small correction to the cross section. It is due to the small value of the width Γ of the atomic AIS and due to the large value of the projectile velocity $V_A \sim V_B \sim 1 a.u.$ In this case the influence of third particle C can be taken into account within the eikonal approach[5]. The amplitude M of the bound state production can be obtained in the analytical form by the method developed in[5]. The analysis of the analytical expression for M shows that the influence of third particle C is actually determined by the ratio $\xi/(l+1)$, where the dimensionless parameter $\xi = z_A z_B / V_{AC}$ is appeared due to the interaction with the target-ion C and l is orbital quantum number of the final state. The cross section $\sigma_{n,l}$ for the final state with the main and orbital quantum numbers n and l is proportional to $\mid M \mid^2$. The analysis of $\sigma_{n,l}$ shows that the excited states with large l are produced for the most part. Neglecting the interaction with third particle the total cross section of the n*th* bound state production $\sigma_n = \sum_l \sigma_{n,l}$ can be obtained in the analytical form:

$$\sigma_n = \frac{\sigma_0 \Gamma_{BC} z_A z_B}{2\Gamma V_A V_B n^3} \left\{ 1 - \left[1 - \frac{2\Gamma V_A / n}{(\epsilon + E_n - \frac{m_A}{m_B}(E_B - E_n))^2 + 4(\frac{m_A}{m_B} + 1)\epsilon E_n)} \right]^n \right\} \qquad (2)$$

where σ_0 is the cross section of the AIS excitation; Γ_{BC} is the partial width of its decay; ϵ is the projectile energy, and E_n is the binding energy of the (AB) pair. It is seen that σ_n reveals the resonance behaviour in the region $\epsilon \sim \frac{m_A}{m_B} E_B$. As an example we have calculated the cross sections $\sigma_{n,l}$ and σ_n for the cases of the excitation of the $(3s^{-1}4p)^1P$ AIS of Ar by proton impact.

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