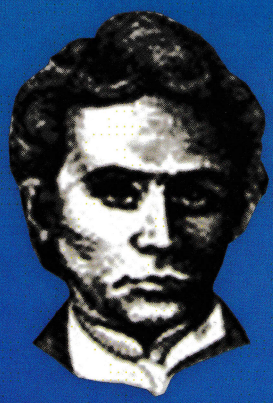

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INFLUENCE OF SYMMETRY ON THE RESONANCE TWO-ELECTRON CHARGE EXCHANGE IN SLOW ATOMIC COLLISIONS

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A theoretical investigation is made of one- and two-electron charge exchange in collisions between an atom and an ion of the same chemical element, the latter with two missing electrons. The term crossing in this system changes physical nature of resonant two-electron exchange. There are new ways of two electron exchange during the collision:

$$A + A^{++} \nearrow A^+ + A^+ \to A^{++} + A, \qquad (1a)$$

$$\searrow A^+ + (A^+)^* \to (A^+)^* + A^+ \to A^{++} + A. \qquad (1b)$$

The first channel (1a) corresponds to crossing of initial state term with the term of ground state of double charged molecular ion $A_2^{++} = A^+ + A^+$, and the second one (1b) – with excited state $(A_2^{++})^* = A^+ + (A^+)^*$. Therefore, the probability of two-electron exchange is

$$P_2^{(*)} = \omega^2 \sin^2\left(\frac{1}{2}\int_{-\infty}^{+\infty}\Delta E_1 dt'\right) + (1-\omega^2)\sin^2\left[\int_{-\infty}^{-t_1}\Delta E_1 dt' + \frac{1}{2}\int_{-t_1}^{t_1}\Delta E_2 dt'\right], \qquad (2)$$

where ω is the probability of non-adiabatic transition, ΔE_1 and ΔE_2 are term splittings which correspond to direct channel $A + A^{++} \to A^{++} + A$ and excitation transmission $A^+ + (A^+)^* \to (A^+)^* + A^+$ occurring at particles motion during the time between the two pseudocrossings $\pm t_1$. For electrons located near various atoms, besides of instant Coulomb interaction r_{12}^{-1} it is necessary to take into account retarded interaction depending on the light velocity and vanishing at $c \to \infty$. Thus, in our papers [1, 2] within of 2-nd and 3-rd order effects of quantum electrodynamics the operator of electric dipole interaction of two atomic electrons located at an arbitrary distance between each other is obtained accounting only orbital degrees of freedom. Using this operator both the exchange term splittings ΔE_1 and ΔE_2 and cross sections of two-electron charge exchange $H^- + H^+ \to H^+ + H^-$ are estimated. Performed estimations show that contribution of direct channel into total cross section of two-electron exchange is determined by value $\sigma_1(\upsilon = 0.1) < 5 \cdot 10^{-19}\,\text{cm}^2$, two orders of magnitude less than the experimental cross section $\sigma_{1\text{exp}}(\upsilon = 0.1) \approx (4 \pm 2) \cdot 10^{-17}\ \text{cm}^2$. Consequently, the total cross section of two-electron exchange is governed by the second channel (1b).

[1] V Yu Lazur, S I Myhalyna, O K Reity 2010 Phys. Rev. A 81 062707
[2] V Yu Lazur, O K Reity, O F Pavlyk 2010 J. Phys. A 43 175208