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DYNAMICAL ADIABATIC THEORY OF ATOMIC COLLISIONS

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Abstract. The concept of dynamical adiabatic states has originally been proposed to describe low-energy one-electron atom(ion)-ion collision systems (see chapter 7 in Solov'ev 2017 and references therein). In the impact parameter approach the essential steps of the method are: the scaling of electronic coordinates by the internuclear distance R and transformation to rotating molecular frame. The advantages of a dynamical adiabatic basis are threefold. First, it is compatible with the physical boundary conditions, whereas in standard adiabatic two-Coulomb center basis we have nonvanishing inelastic transitions when internuclear distance $R\rightarrow\infty$. Second, rotational transitions are transformed into radial transitions via a type of hidden crossings in contrast with the standard adiabatic basis, where these transitions could only be included by numerical close-coupling calculations. And third, the ionization process can be described using a basis of the complete discrete orthogonal wave packets, which is much more satisfactory for the process compared with the standard adiabatic approach where the continuum states which have no direct physical meaning are employed. The properties of the dynamical adiabatic potential energy curves have been studied for a complete range of internuclear separations R as well as their hidden crossings in the complex R-plane (Grozdanov et al. 2013, 2014).

Results of calculation for the $(HeH)^{2+}$ quasimolecular system have been used to study the low-energy charge-exchange processes: $He^{2+}+H(1s) \rightarrow He^{+}+H^{+}$ and $H^{+}+He^{+}\rightarrow H+He^{2+}$ (Grozdanov et al. 2015, 2018). The obtained results for transition probabilities and cross sections are in good agreement with hyperspherical and standard close-coupling calculations as well as with experiments. We shall discuss also an earlier application of dynamical adiabatic theory to a model problem of electron detachment process: $A+A^{-}\rightarrow A+A+e$, where the electron-atom interactions are described by the zero-range potentials (Grozdanov et al. 1999).

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