Application of few-body approximation to the scattering hydrogen halide molecules by slow electron

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The electron scattering by hydrogen halogen molecules has been the subject a large number of experimental and theoretical papers [1,2].

If the energy of scattering electron is slow hydrogen halogen molecules HX (X is halogen atom) may be considered consisting of an proton and negative ion of halogen because electron affinity halogen atom is much more than the affinity of hydrogen atom [2].

In this assumption the processes of the collisions slow electron with hydrogen halogen molecules is treated as four-body process:

$$e + (H^+, X^-) \rightarrow \begin{cases} e + (\mathrm{H}^+,\, X^-) & (1) \\ e + (\mathrm{H}^+,\, X^-,(\mathrm{v,j})) & (2) \\ H + \mathrm{X}^- & (3) \\ H + X + e & \\ \mathrm{H}^+ + X^- + \mathrm{e} & (4) \end{cases}$$

The interaction of the electron with the hydrogen halogen molecule is replaced approximately by the pair-wise interaction with each component consisting hydrogen halogen molecule (H^+, X, e) as if they are simple field centers. In this case two-body potentials have form of sum the long-range part and short-range one. In this approach we consider all processes of the scattering of the electron by molecule such as elastic scattering (1), ro-vibrational excitation (2), dissociative attachment (3), ionization (4) simultaneously.

This approximation seems reasonable as long as the energy of incident electron is below the threshold of electronic excitation of hydrogen hyalogen molecule.

To calculate the cross section of the processes (1)-(4) we use the modified Faddeev-Yakubovsky equations (FYE) [3]. It is well known that the FYE are the most consisting and concise way of treating multiple scattering effect in few-body problems as well as the resonances connected with arbitrary number and location of the centers [4]. For the numerical solution of FYE we used the technique developed in [3,4].

Using this model the calculations of the electron scattering HF, DF, TF, HCl, DCl, TCl, HBr, DBr, TBr, HJ, DJ, TJ molecules of the processes (1)-(4) are presented and discussed.

The results of this calculations are compared with the available experimental data and other calculations [1,2,4].

References

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