Isotopical effects in electron and atom molecular scattering

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Synopsis Isotopical effects, electron and atom molecular scattering

The principal difficulties in the investigation of the fundamental dynamic characteristics of few-body systems with three or more particles are associated with the multidimensionality of the problem and with the fact that real systems and processes do not agree with the approximations of well-known theories (perturbation theory, strong coupling, adiabatic theory, etc.). Thus, it is important to understand the physical meaning of numerous approximations applied to the few-body problem and their limitations. The following questions arise in this way.

1. What formalism should be used in investigation of the dynamics of a few-body system? It could be classical or quantum-mechanical equations of the motion, empirical or semi-empirical models, and so on.

2. What is the aim of the simulation? It can be a study of dynamic or static characteristics of a few-body system, calculations of the binding energy, cross sections, rate constants, thermodynamic features, etc.

3. Are the considered models adequate to real physical systems?

Answers to many of these questions can be found within the framework of the rigorous mathematical theory suggested by L.D.Faddeev, O.Ya.Yakubovsky and S.P.Merkuriev [1] which describes the dynamics of a few-body system using the correct mathematical basis.

For this reason we applied this formalism for the investigation of the different few-body processes based on the treatment of collision processes as many body processes, using Faddeev-Yakubovsky equations (FYE) in integral and differential forms[1-3].

In particular techniques based on FYE have been used successfully in studies of the dynamics of few-particle systems (bound-state properties and elastic, reactive and breakup scattering [2]. This is partly due to the increasing need for these cross sections in fields of pure and applied science.

The theoretical investigation of the collision of low energy electrons and atoms with diatomic molecules has emerged as a particulary rewarding field for the application of fundamental scattering theory as well as the common existence of strong threshold phenomena caused by the effect of long range electron molecular intersection potentials.

Investigation isotopical effects and resonant collisions of slow electrons and atoms with molecules set an urgent and challenging problem for contemporary theory [2-4].

The principal difficulty of this problem is due to two reason: strong interaction between the electron trapped in the intermediate resonance state and the heave particles motion, and the essentially multidimentionality character of this motion. Some of the most interesting phenomena arise from the connection of the electronic scattering dynamics with dynamics of nuclear motion in particular in processes rovibrational excitation, fragmentation and dissociation of the molecule.

References

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