Few-body approximation in atomic and molecular physics

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Synopsis Electron scattering by atoms and molecules, multiple scattering approximation, Faddeev-Yakubovsky equations

The main difficulties in the research of few-body problems are bounded with the really many-channels and multidimensional nature of the these problem, impossible applied many well known theories such as adiabatic, impulse, coupled channels, etc.

For this reason we proposed new method for the investigation of the different few-body processes used the mathematically rigorous formalism based on the treatment of collision processes as many body processes, using Faddeev-Yakubovsky equations [1] (FYE) in integral and differential forms. 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]. That is why we applied this formalism for the theoretical investigation of the dynamics of the different processes in atomic and chemical physics. The following results are presented and discussed [2].

Calculation of low-energy characteristics in scattering processes like scattering length, effective range parameter, amplitude, cross section etc. in processes $p+d$, $n+d$, $p+He$, electron + molecule etc. for the verification of the fundamental principal of the atomic and chemical interaction.

The theoretical investigation of the quasi-bound, virtual and resonances states in few-body systems such as $p+d$, $n+d$, $e+H$, $e+He$, $p+H$, $p+He$.

Scattering the electrons, protons on the few-centers targets (atoms, molecules etc.) and the estimation the role of many center scattering in these cases.

The calculations of the excitation, rearrangement and ionization H and He atoms and its ions by the electrons and protons impact.

The investigation of the influence of the long range part of pair-wise potentials in FYE on the scattering in few-body systems.

The study on the correlation between low-energy characteristic in few-body scattering.

Scattering electrons by two atomic (H_2, HD, D_2, N_2, Cl_2, F_2, Br_2, J_2, HF, DF, HJ, DJ, HCl, DCl, HBr, DBr,$RbCl$, $RbBr$, $CsCl$, $CsBr$, KI) and few atomic molecules (CO_2, O_3, NF_3).

The investigation the theory of quasimolecule (electron + molecule), the ionization mechanism in quasimolecule and the main characteristics of quasimolecule autoionization states, determination of the bound between these states, the resonance states, potential energy surface (PES) and dynamics of the chemical reaction.

The scattering atoms with two ($O+CS$, $H+H_2$, $O+N_2$, $O+O_2$) and few atomic ($O+CF_3J$, $O+CS_2$, $O+OSC$, $HCl+HCl$) molecules, the many particles interactions, orientations of the reacting molecules etc. on the reactions dynamic, the confection between the interactions in FYE and PES, the investigation of the resonances, virtual states and threshold phenomena in chemical reactions.

The studding the unusual dynamical threshold phenomena in chemical reactions such as Efimov states based on FYE. This research may be obtain the information of the reaction mechanism, PES etc. and may have a strong influence on the scattering observable. Hence the careful studding of these states may be provide better understanding of the control and management of the chemical reaction processes.

The investigations of the possibility of the analytical solution of FYE in the different approximations, the construction of the solvable model in FYE approach are presented.

References

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