

Scientific report
Activity under Short visit grant No 977
Miron Ya Amusia

Dates: 12 – 27 June 2006,

Place: University of Rome 1 “La Sapienza”

Host: Professor of theoretical physical chemistry **F. Gianturco**

1. Aim of the visit

The principle aim of the visit is to develop an approach that would permit to take into account VP formation in positron – molecule and positron – fullerene scattering. The first step should use the approximation that was employed in atoms, combining it with the methods already developed for molecules. It is essential to clarify, under which conditions the effective polarization potential for positron – molecule or positron – fullerene scattering could become repulsive instead of being attractive. During this visit it is planned to develop methods that would permit to take into account simultaneously the modifications of the targets polarizabilities due to VP formation, and due to higher order corrections in the electron – vacancy interaction within the target.

It is assumed that during my stay I will give several lectures on the many-body effect in photoionization of atoms and multi-atomic formations.

2. Description of the work carried out during the visit

During this visit I had extensive discussions with my host, Professor F. Gianturco and ten his collaborators, including Post. Doc's, PhD and undergraduate student – all, who were available during my visit. The discussions held permitted to learn to large extent the activity of the group in the directions of molecules' and clusters' structure, electron and positron scattering with these objects and their interaction with photons.

Of specific interest for me are the studies of peculiarities in the scattering amplitude due to polarization potential at very low collision energies and scattering of positrons.

I gave two talks, on the development of the theory of photoeffect “Einstein's theory of photoeffect” and on interaction of electromagnetic radiation with endohedral atoms “Photoionization and vacancy decay in endohedral atoms”.

During the discussions, a number of problems of general importance were touched, such as manifestations of the Levinson's theorem and Ramsauer minima in electron – molecule collisions, intermolecular Casimir forces, possibility of creating molecular condensates etc.

In our discussions I have also presented essential details of our method that was used to consider positron – atom scattering permitting to account for virtual positronium formation in intermediate state. I emphasized that our approach leads to repulsive polarization potential in collisions even for slow positrons with alkali atoms, while usually introduced polarization potential is at low collision energies always attractive. We discussed also Efimov-effect that leads to three-body bound states for particles with pair-wise very large scattering length.

We have discussed, although briefly, the possible consequences for electron-molecule scattering of the general features that are studied by us in the frame of considering a quasi-three-body problem: scattering of a light particle by a system of two heavy bound particles. Namely, it is expected that in such a case the polarization potential would decrease not as usual second power of the projectile-target distance but rather as its fourth power. This behavior is suggested on the ground of consideration of electron scattering by muonic hydrogen, i.e. an atom that consists of a mu-meson and a proton.

It seems to me that in view of the development by Prof. Gianturco and his group intensive studies of the electron –molecule scattering, it would be of common interest to study the behavior of the scattering amplitude in the unphysical domain of negative collision energies. The interest to this problem originates from studies of the analytic behavior of the forward electron-atom scattering amplitude where high-power singularities were discovered that appear at energies, equal to the binding energies of the outer electron in the target instead of the binding energy of the incoming electron by the target.

3. Description of the main results obtained

The main and most essential results achieved are the exchange of information about the objects of research in both groups and “know-how” in them and clarifications of those research directions where achievements from both sides could compliment each other, leading to new results in molecular collision physics.

4. Future collaboration with host institution

Prof. Gianturco and I came to the conclusion that our collaboration in a number of directions has a great perspective and as such has to be developed during future visits.

5. Other comments

Personally, I enjoyed this visit very much. Of course, I was aware from the literature about the very intensive and large-scale research performed by Prof. F. Gianturco with his collaborators and students. Personal acquaintance with the famous Rome group “in vivo” prominently enforced indirect positive impressions, making the perspective of future collaboration particularly attractive.