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THIRD ALL-UNION CONFERENCE ON PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS

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THE position occupied by electronic and atomic collisions in the general circle of problems and applications of atomic physics is in many respects analogous to the position occupied by nuclear reactions in the physics of the atomic nucleus. In both branches collisions are used to obtain particles in different states and to analyze these states. In both branches, the same parameters are calculated and measured (effective cross sections, angular distributions, resonance positions, etc.) although, of course, the numerical values of the corresponding quantities are quite different. The theoretical analysis in one branch has much in common with that in the other, and frequently methods developed in one branch are transferred to the other. By way of an example we can cite the method of distorted waves in the theory of direct nuclear reactions, which was initially developed for problems in electron-atom collisions, and the method of resonances in electron-atom collisions, which was borrowed from the theory of strong interactions of elementary particles.

In spite of the importance of electronic and atomic collisions for atomic physics, their role was patently underestimated as recently as ten years ago. The situation has changed radically in connection with the appearance of such practical problems as the development of MHD generators and developments in plasma physics, outer-space physics, physics of the atmosphere, quantum radiophysics, etc. New, non-traditional problems in kinetics, connected with the indicated problems, has served as a mighty impetus for the development of the physics of electronic and atomic collisions. Greatly contributing to this development was the appearance of new theoretical and experimental methods of investigating the processes. The theoretical calculations became much more effective as a result of the use of electronic computers. In the experiments, the use of mass-spectrometry methods and of the method of crosses beams has been expanded, and papers reporting the coincidence method have been published. All this has made it possible to study in much greater detail the processes and to effect a better argumented and critical comparison of theory with experiment.

The revival of interest in the physics of electronic and atomic collisions has contributed to the appreciable growth of research in this field in many countries, particularly in the USSR. At the present time appropriate investigations are being carried out in our country in a number of scientific research institutions and higher institutes of learning, including: the A. F. Ioffe Physicotechnical Institute of the USSR Academy of Sciences (LFTI), the P. N. Lebedev Physics Institute of the USSR

Academy of Sciences (FIAN), the Physico-technical Institute of the Ukrainian Academy of Sciences (FTI AN USSR), the Institute of Chemical Physics of the USSR Academy of Sciences, the L. Ya. Karpov Physicochemical Institute, the Institute of Physics of the Latvian Academy of Sciences, and the following universities: Moscow, Leningrad, Khar'kov, Kiev, L'vov, Uzhgorod, Tomsk, and others.

A manifestation of this stage in the development of physics of electronic and atomic collisions is the organization of conferences especially devoted to this field. By now, four international and three all-union conferences were held. The first international conference was held in New York in 1958, the first all-union conference in 1949 in Riga. Participating in this conference were 130 delegates and 30 papers were delivered. At the second conference (Uzhgorod, 1962) there were 280 delegates and 91 papers, while at the third there were 300 delegates and 119 papers.

The Khar'kov conference opened with a paper by **V. V. Afrosimov, Yu. S. Gordeev, M. N. Panov,** and **N. V. Fedorenko** (LFTI) "Ionization and Scattering at Characteristic Losses of Energy in Atomic Collisions." The paper presented results of experiments, which demonstrated that ionization processes during collisions of many-electron systems, at energies of the order of several dozen keV, are accompanied by characteristic energy losses. In the opinion of **M. Ya. Amus'ya**, this phenomenon can be attributed to collective vibrations of the electrons in the electron shells. Both the paper itself and the proposed treatment aroused considerable lively discussions, to which a specially organized symposium was devoted.

The experimental investigations reported at the conference encompass a large circle of processes, differing in the form of the interactions, the range of energies, and the type of interacting particles.

The main results of most of these investigations were dependences of the effective cross sections of the corresponding processes on the particle velocities.

A large number of papers was devoted to collisions of heavy particles, in most cases at medium energies, from approximately one to several dozen keV. The reported investigations dealt with various processes: ionization, excitation, stripping (loss of electrons by fast particles), resonant and nonresonant charge exchange, formation of negative ions, and dissociation of molecules. Let us name some of these papers. **B. I. Kikiani, G. N. Ogurtsov,** and **I. P. Flaks** (LFTI) investigated the ionization and charge exchange during collisions of ions and atoms of alkali metals with inert gases, and also with hydrogen and nitrogen in the energy interval 1—30 keV. An appreciable influence of the structure of the electron shells of the colliding particles on the magnitude of the ionization cross section was noted. In particular, relatively large cross sections were observed when the electron shells have similar structures. The charge-exchange cross sections increase monotonically with increasing ion velocity and with increasing atomic number of the ions, reaching at the highest velocities values on the order of 10^{-16} cm^2. **V. F. Kozlov** (FTI AN USSR) reported results of measurements of the cross section of double charge exchange of singly-charged positive ions or such combinations of interacting particles and for such energies, in which the possibility of formation of any particle in the excited state is excluded. The interacting partners were ions of hydrogen (atomic), lithium, sodium, potassium, and neutral particles—atoms of helium, neon, argon, and hydrogen molecules. The results of the measurements, which were carried out in the adiabatic region, disclosed noticeable deviation of the effective cross section from the theoretical predictions.

V. A. Gusev, D. V. Pilipenko, and **Ya. M. Fogel'** (FTI AN USSR) measured the cross sections for electron loss by negative hydrogen ions colliding with the molecules O_2, NO, and CO. In the case of H^-—CO collisions, a structure is observed on the plot of the cross sections against the velocity. The nature of this structure is related by the authors to the transfer of the electron to the CO molecule, the produced negative ion then being capable of dissociating into charged or neutral fragments and an electron. They also measured the cross section for the formation of negative ions. Electron loss by negative ions was also the subject of the paper by **Yu. F. Bydin** (LFTI), who investigated this process in collisions between ions of alkali metals and inert-gas atoms. The ion energy in these experiments ranged from 600 to 3000 eV. The results were analyzed from the point of view of the theory of interaction of negative ions with atoms, developed by O. B. Firsov and B. M. Smirnov.

R. N. Il'in, V. A. Oparin, E. S. Solov'ev, and **N. V. Fedorenko** (LFTI) have demonstrated in their paper that the formation of highly excited excited hydrogen atoms during charge exchange of protons with energy up to 30 keV with alkali-metal atoms is much more effective than in charge exchange with atoms of inert gases. This is part of a series of investigations connected with the idea of accumulating in magnetic traps fast hydrogen ions produced as a result of Lorentz ionization of atoms which are at high excitation levels (with principal quantum number from 10 upwards). Among the papers connected with the problems of controlled thermonuclear reactions is one by **G. F. Bogdanov, A. N. Karkhov,** and **Yu. A. Kucheryaev** "Dissociation of Fast Molecular Ions of Hydrogen and Charge Exchange of Fast Protons in a Lithium Arc." The authors measured the cross sections for the formation of protons and hydrogen atoms upon dissociation of molecular hydrogen ions by lithium ions, as well as the cross sections for charge exchange of protons in the energy region from 40 to 160 keV.

Collisions at high particle energies (hundreds of keV and MeV) was the subject of a small number of papers, presented especially by the laboratory of the Nuclear Physics Institute of the Moscow State University, headed by V. S. Nikolaev, and by the members of the Physico-technical Institute of the Ukrainian Academy of Sciences, headed by L. I. Pivovar. These papers reported results of investigations of angular and energy distributions of scattered particles, formation of multiply charged ions (with ionization multiplicities up to 12), measurements of cross sections for the loss and capture of electrons by positive and negative ions.

Progress in work on low-temperature plasma calls for the knowledge of the cross sections of different processes in the low-energy region, down to several fractions of an eV. Unfortunately, this region of energies poses appreciable difficulties for the experimenter. Reports of investigations of this type are very scarce. Only two papers were delivered at the conference, both pertaining to the measurements of the cross section for resonant charge exchange. In one of them, by **B. M. Palyukh** and **L. S. Savchin** (L'vov University), the cross section for the charge exchange of potassium and cesium at energies from 100 to 3 eV was determined by the "classical" method of the retarding field. In the second paper, **V. A. Belyaev, B. G. Brezhnev,** and **E. M. Erastov** proposed an original method for measuring cross sections, based on the fact that the beams of interacting particles move together with nearly equal velocities. In the paper which is still preliminary in character, the authors report measurements of the cross section of charge exchange of protons with hydrogen atoms. The energy of the particles in the beam was approximately 1 keV, and the energy of relative motion of the protons and the atoms was on the order of several dozen eV. Unfortunately, even when the latter energy is close to 30 eV, the error of the measured cross sections is still too large.

Besides measuring the cross sections for the interactions of heavy particles, some investigators used these interactions as research means. Mention should be made first of the development of a procedure for investigating hot plasma with beams of fast particles. Using resonant charge exchange of hydrogen atoms on protons, **V. V. Afrosimov, B. A. Ivanov, A. I. Kislyakov,** and **M. P. Petrov** (LFTI) measured the concentration of protons with the "Alpha" installation. **L. I. Krupnik** and **N. G. Shulik** (FTI AN USSR) have analyzed theoretically the possibility of a procedure for determining the parameters of a hydrogen and helium plasma at different density and different degree of ionization.

Included among such investigations is also that by **A. B. Kamnev** and **V. B. Leonas**, in which small-angle scattering upon collision of atoms was used to determine the potential functions of interactions of all combinations of inert-gas atoms.

Among the reported experimental investigations, the largest group constituted investigations of collisions (predominantly inelastic) between electrons and atoms or molecules. In most of these investigations, special attention was paid to high monokinetization of the electron beams, so as to be able to resolve the structure of the excitation functions. In papers presented by Uzhgorod University (**I. P. Zapesochnyĭ, L. L. Shimon, O. B. Shpenik** et al.), results were presented of measurements of the excitation functions of alkaline-metal atoms, metals of the second group, inert gases, and nitrogen molecules. Extensively discussed in this case was the question of the nature of the complex structure of the excitation functions. Whereas the nature of many maxima is not subject to any doubt, since it can be readily attributed to the presence of cascade transitions, in other cases the origin of an appreciable number of peaks still needs to be explained. In the opinion of **I. P. Bogdanova** (LGU), the additional peaks on the excitation-function curve of helium (near the excitation threshold) are due to the presence of impurities.

Ionization of atoms by electron impact was the subject of research by **G. M. Beĭlina, S. I. Pavlov,** and **V. I. Rakhovskiĭ** (All-union Electrotechnical Institute im. V. I. Lenin). In their investigation they used the method of crossing beams, which enabled them to measure the cross sections for the ionization of heavy atoms (silver, copper, lead).

Investigations of different processes during collisions of electrons and ions with molecules, accompanied by ionization, dislocation, occurrence of excited electronic and vibrational states, etc., was the subject of a series of papers headed by a review paper by **N. N. Tunitskiĭ** "Collisions of Electrons and Ions with Molecules." This author considered the laws and the mechanism of collisions of multiply charged ions with atoms and molecules, and presented data on the influence of the electronic and vibrational excitation on ion-molecular reactions.

A. A. Perov, S. E. Kupriyanov, and **N. N. Tunitskiĭ** (Karpov Physico-chemical Institute), studying the dissociation of molecular ions of hydrogen by neon, have shown that the measured cross section of the dissociation depends on the method of ion formation. In ionization of hydrogen-containing molecules, the cross sections are much larger than in ionization of hydrogen molecules. The authors attribute this difference to the difference in the distribution of the obtained ions over the vibrational states.

G. E. Spezhakova, M. V. Tikhomirov, and **N. N. Tunitskiĭ** reported results of an experimental investigation of ion-molecular reactions of molecular hydrogen ions with hydrogen molecules and helium atoms at different ionizing-electron energies. These results are in good agreement with the theoretical considerations developed on the basis of the statistical model of the processes proposed by O. B. Firsov.

The same group of questions was the subject of two papers by **S. E. Kupriyanov**, "Long-lived Excited States of Ions and Molecules and Their Role in Collision Processes'' and ''Formation of Ions of Hydrides of Noble Gases and H_3^+ Ions in Collisions of Excited Atoms and Molecules with Unexcited Ones,'' the paper by V. Yu. **Orlov** ''Multiply Charged Ions in Mass Spectra of Certain Silicon-organic Compounds,'' and some others.

A number of papers was delivered, in which information on elementary processes occurring in a plasma were obtained not by studying single collisions and measuring the corresponding cross sections, but on the basis of an analysis of the properties and behavior of the plasma itself. Although the characteristics determined thereby are, as a rule, averaged over the energies, investigations of this kind are perhaps the only means at present of obtaining information on collisions in low-temperature plasma, since, as already mentioned above, direct measurements at such low energies entail appreciable experimental difficulties.

Investigations of low-temperature plasma were carried out by different methods: optic, electrical, radio frequency, and sometimes by a combination of all. The results of these investigations make it possible to estimate the relative role of individual elementary processes under different conditions of creating and maintaining plasma.

M. A. El'yashevich and his co-workers (Physics Institute of the Belorussian Academy of Sciences) considered the conditions under which forbidden transitions occur in a plasma under the influence of intermolecular electric fields. Their intensities were used to determine the concentrations of the charged particles in a dc arc and in a plasma jet of a pulsed discharge. **T. V. Bazhenova** and **Yu. S. Lobastov**, using a radiowave absorption method, investigated the plasma of a gas heated by shock waves to temperatures 2000–7000°K. On the basis of the measured values of the electron concentrations and the effective number of electron collisions with the atoms, they determined the values, averaged over the velocity distribution, of the collision cross sections in nitrogen, oxygen, CO, CO_2, and argon. By measuring the optical and electrical characteristics of a discharge in N_2 + Ar, CO + Ar, N_2 + CO, and N_2 + He mixtures, **L. A. Chernenko**, **V. V. Kokhonenko**, and **N. A. Prilezhaeva** (Tomsk University) determined the cross sections for impacts of the second kind between excited atoms and molecules. Also on the basis of electric and optical measurements, **É. G. Gnevysheva**, **L. A. Luizova**, **V. S. Krivchenkova**, and **A. D. Khakhaeva** investigated the mechanism of excitation of ionization of helium and neon in a positive discharge column.

Elementary processes in a helium discharge were the subject of the paper by **I. Ya. Fugol'** and **P. L. Pakhomov**, ''Investigation of the Process of Pair Collisions of Metastable Atoms in the Afterglow of a Helium Plasma at 77 and 20°K,'' and by **V. P. Chebotaev**, ''Destruction of 2^3S and 2^1S Metastable Atoms of Helium by Electrons in the Positive Column of a Glow Discharge.'' These papers present, on the basis of experimental data, estimates of the cross sections for the disintegration of metastable atoms—for a 2^3S atom colliding with a normal 1^1S atom in the first and the cross sections averaged over the electron velocities for 2^3S and 2^1S atoms colliding with electrons in the second.

The results of the investigation of a low temperature plasma and the elementary processes occurring in it were reported also in the papers by **L. I. Grechikhin** and **L. Ya. Min'ko**, ''Investigation of Processes Causing Glow in Electrode Discharge Tubes,'' by **V. M. Kaslin**, **G. G. Petrash**, and **A. S. Khaĭkin** ''Investigation of Energy Transfer Between Levels in a Gas-laser Plasma,'' by **E. P. Ostapchenko**, **O. N. Oreshak**, and **V. A. Stapov**, ''Investigation of a Discharge in Mercury-krypton and Cadmium-xenon Mixtures,'' and by **A. P. Motornenko**, ''Investigation of Electric and Spectral Properties of a High-frequency Gas Discharge.'' Some of the foregoing and similar papers were connected with problems of quantum radiophysics and technical magnetohydrodynamics. Other papers were devoted to processes of interest for physics of the upper layer of the atmosphere. Significant among these was the review by **G. S. Ivanov-Kholodnyĭ** and **A. D. Danilov**, ''The Chemistry of the Ionosphere,'' in which it is shown how the results of laboratory investigations of elementary processes, on the one hand, and data obtained by studying the ionosphere, on the other, should supplement each other. This is all the more necessary, since in many cases the laboratory values of the constants of elementary processes are not reliable enough.

A. G. Koval', **V. T. Kippe**, and **Ya. M. Fogel'** (FTI AN USSR), investigating the glow spectra of the molecules N_2, O_2, CO, CO_2, NO, and air and comparing these spectra with the emission spectra of the same gases excited by slow electrons and 37-keV protons, and with the spectra of auroras, reached the conclusion (which is only tentative) that slow electrons also play an important role in the mechanism of excitation of auroras, and not only fast electrons. On the basis of this analysis, the authors propose that the oxygen is essentially in dissociated state in those layers of the atmosphere where auroras are produced.

Problems raised by astrophysics were reflected in the paper by **V. I. Cherednichenko** (Kiev Polytechnic Institute) who, using empirical relations for the charge-exchange, ionization, and molecule dissociation cross sections, advanced the hypothesis that the most probable processes in the decay of CO_2 molecules in atmospheres of comets are charge exchange, dissociative charge exchange, and dissociation upon collision.

Three conference papers were devoted to photoionization. In the first (by **G. S. Voronov**, **V. M. Gorbunkov**, **G. A. Delone**, **N. B. Delone**, **L. V. Keldysh**, **O. V. Kudrevatova**, and **M. S. Rabinovich**) are reported theoretical calculations and experiments on multiphoton ionization in a strong electromagnetic field of optical frequency, produced by a laser in a gas at such a low pressure that the mean free path is much larger than the region in which the electric field is concentrated, so that the field acts on individual atoms. In the second paper, **M. E. Akopyan, F. I. Vilesov,** and **A. N. Terenin** presented the results of an investigation of the photoionization of a number of organic molecules, including some compounds of low volatility, in a spectral region extending to 14 eV. The third paper, by **N. Ya. Dodonova,** reported an investigation of the fluorescence of NO upon photodissociation of N_2O under the influence of vacuum ultraviolet radiation at a photon energy up to 11.7 eV.

The greatest number of reported theoretical papers, as well as experimental ones was devoted to collisions between electrons and atoms. The corresponding investigations were carried out essentially at the Leningrad University, the Physics Institute of the USSR Academy of Sciences, and the Physics Institute of the Latvian Academy of Sciences. Most of these investigations feature extensive use of electronic computers, which made it possible to take into account many new factors which previously could not be calculated, and also to extend the number of calculated quantities.

Let us name some of the papers pertaining to this field and their results. **M. Gaĭlitis,** using a variational principle proposed by Hahn, calculated the triplet and singlet phases of the scattering of electrons by hydrogen atoms with a total angular momentum $L = 0, 1, 2$. The calculation revealed the presence of pre-threshold resonances. **I. Vinkalns** calculated the partial cross sections for the ionization of a hydrogen atom by electron impact, for angular momenta L from 0 to 6. The paper considers the influence of various factors: exchange, polarization, etc. **E. Karule** and **R. Peterkop** calculated the cross sections for the scattering of electrons by alkaline-metal atoms at energies lower than the excitation threshold, and the excitation cross sections at energies somewhat higher than threshold (up to 5 eV).

V. Valdre, L. Rabik, and **A. Lyash** determined in the Born approximation the total effective cross sections for the excitation of neon and argon for transitions of all first six excited configurations.

All the foregoing investigations were carried out at the Institute of Physics of the Latvian Academy of Sciences.

The Leningrad University presented the following papers in this field.

In "Resonant Phenomena in Elastic Scattering of Electrons by Helium Atoms" **T. V. Zhikhareva** investigated the behavior of the cross section of S and P scattering near the excitation threshold. When account is taken of exchange, at energies below the threshold of the 2^3S excited level, resonance is observed in the cross section, due to the bound state of the electron in the field of the excited atom.

V. F. Brattsev and **V. I. Ochkur,** in "Exchange Excitation of a Helium Atom by Electron Impact," calculated with the aid of a modified Born-Oppenheimer formula the excitation functions of a helium atom from the ground state and the 2^3S state.

Theoretical investigations of electron collisions, carried out at the Physics Institute of the USSR Academy of Sciences, were reported in the following papers:

L. A. Vaĭnshtein and **L. P. Presnyakov,** in "Excitation of Atoms via an Intermediate Level," calculated, with the aid of methods proposed by the authors (together with I. I. Sobel'man), the cross sections for a number of transitions in atoms of alkaline elements to levels located above resonance. It turns out here that for the transitions $n_0S \rightarrow (n_0 + 1)P$ (n_0 is the principal quantum number of the ground-state level) the cross section of the transition via the intermediate level is much larger than the cross section of the direct transition.

L. A. Vaĭnshtein and **A. V. Vinogradov,** in "Ionization of an Atom with Simultaneous Excitation of an Ion by Electron Impact," considered processes that change the states of not more than two electrons. The calculation, carried out in the second Born approximation, has shown that the cross sections of the process of the type $Ar(3p^6) + e$ are comparable in order of magnitude with the cross section of ordinary ionization.

I. L. Beĭgman, in "Cross Section for the Ionization of Ions by Electron Impact in the Born-Coulomb Approximation," calculated the cross section of ionization of several levels of excited ions of carbon and helium.

M. A. Mazing and **I. I. Sobel'man** demonstrated the possibility of estimating the effective cross section of inelastic interactions of electrons with excited atoms, by measuring the widths and shifts of the spectral lines in a plasma. On the basis of the corresponding measurements, they determined the effective cross sections of a number of transitions between excited levels of He, Ne, and Ar^{++}.

A number of theoretical papers was devoted to collisions of heavy particles. We note among them papers on the investigation of resonant and nonresonant charge exchange. **G. V. Dubrovskiĭ** and **V. D. Ob"dekov** (LGU) considered endothermal reactions of the type $A^+(^1S) + B(^1S) \rightarrow A(^2S) + B(^2P) - \Delta E$ in the energy range 1–2 keV. A feature of the process is strong polarization interaction of the particles in the final state. On the basis of the obtained results the authors calculated the charge exchange cross sections of alkaline metal ions with inert-gas atoms **E. E. Nikitin** (Institute of Chemical Physics) developed a theory of nonresonant charge exchange of multiply charged ions, in which account is taken of strong Coulomb interaction. The solution is carried out in the two-level approximation using exact asymptotic values for the electronic wave functions. The obtained results make it possible to delineate the limits of applicability of different theories of nonresonant charge exchange. **Yu. E. Murakhver** (LGU) calculated the angular distribution of resonant charge exchange of ions and atoms of helium. Allowance, in the quasiclassical approximation, for the difference in the trajectories for symmetrical and antisymmetrical states of the quasimolecule leads to a smoothing of the oscillations.

Yu. N. Demkov developed the theory of detachment of an electron in slow collisions between a negative ion and an atom, when the bound state merges with the continuous spectrum when the nuclei come together.

Calculations of various ionization and excitation processes in atomic and atom-molecule collisions are contained in papers by **A. V. Vinogradov** and **I. A. Poluéktov** (FIAN) "Excitation of Atoms by Neutral Particles" (calculation of the cross sections for the excitation of a hydrogen atom colliding with a nitrogen molecule and a hydrogen atom), **A. D. Derbeneva** (Tadzik Acad. Sci.) "Ionization Cross Sections and Diffusion Cross Sections for Fe, Ca, Si, Mg with O and N at 0.4—1.5 keV," **Yu. Sazhinev** and **Yu. V. Bulgakov** "Calculation of the Cross Section for the Dissociation of an H_2^+ Ion Colliding with a Hydrogen Atom," and others.

In addition to concrete calculations, reports were also presented devoted to general problems of theory and development of new calculation methods. **Yu. N. Demkov** and **G. F. Drukarev** considered the conditions under which the S matrix has second-order poles in the complex angular momentum plane. The resonant scattering in the approximation of two close (or coinciding) poles was investigated. **V. S. Rudakov** (LGU) proposed a variational principle for quasistationary and virtual states, with the aid of which calculations are made for several very simple examples. **V. D. Ob"edkov** (LGU) introduced a complex potential describing the scattering of an electron at energies on the order of the ionization potential. An estimate of the scattering of the electron by a hydrogen atom turns out to be in close agreement with the data obtained in the second Born approximation. A similar method of introducing a complex potential is used in the paper by **L. G. Yakovlev** and **D. Kh. Khalikova** (Phys. Inst. Uzbek Acad. Sci.) to describe collisions of atoms with ions. As a concrete example, they carry out calculations for collisions of ions with atoms of helium, neon, and argon at energies up to several dozen keV. The results obtained are in satisfactory agreement with the experimental data. **M. I. Faĭngol'd** (Nuc. Phys. Inst. Uzbek Acad. Sci.) indicates the need for taking into account the effect of the twisting of the particles around the scattering center during collisions that occur at energies on the order of 0.001—0.01 eV. The presence of this effect should play a noticeable role in processes occurring in a low-temperature plasma.

The foregoing survey of the problems discussed at the conference shows that investigation of electronic and atomic collisions occupies an appreciable place in the USSR in the general plan of physical scientific-research investigations, and encompasses all the most important problems in this field. The performed investigations and published papers have won deserved recognition in the entire world. Evidence of this fact, in particular, is that the next, fifth International Conference on Electronic and Atomic collisions will be held in Leningrad in 1967, and will be combined with the Fourth All-union Conference.

Translated by J. G. Adashko