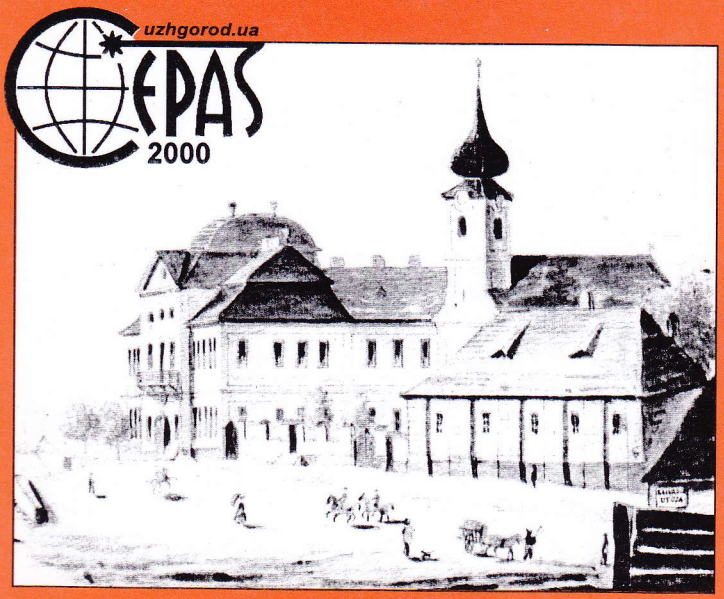
Europhysics Conference

25-28 July 2000, Uzhgorod, Ukraine

ELEMENTARY PROCESSES IN ATOMIC SYSTEMS

Abstracts and conference programme



Conference Schedule

TUESDAY 25 JULY	WEDNESDAY 26 JULY	FRIDAY 28 JULY
08:00-09:00 Registration		
09:00 Opening Ceremony and Welcome		
09:30-11:00 PLENARY LECTURES AND INVITED TALKS session I	**09:00-11:00** PLENARY LECTURES AND INVITED TALKS session IV	**08:30-11:00** PLENARY LECTURES AND INVITED TALKS session VII
11:00-11:30 COFFEE BREAK		
11:30-13:00 PLENARY LECTURES AND INVITED TALKS session II	**11:30-13:00** PLENARY LECTURES AND INVITED TALKS session V	**11:30-13:00** PLENARY LECTURES AND INVITED TALKS session VIII
13:00-14:30 LUNCH		
14:00-15:00 POSTERS session I	**14:00-15:00** POSTERS session II	**14:00-15:00** POSTERS session III
14:30-15:30 PLENARY LECTURES AND INVITED TALKS session III	**14:30-16:00** PLENARY LECTURES AND INVITED TALKS session VI	**14:30-16:15** ORAL PRESENTATION session III
16:00-16:30 COFFEE BREAK		
16:30-18:30 ORAL PRESENTATION session I	**16:30-18:30** ORAL PRESENTATION session II	**16:30-18:00** ORAL PRESENTATION session IV
		18:00 Farewell

✓ **THURSDAY 27 JULY:** 09:00 Excursion

EUROPEAN PHYSICAL SOCIETY
MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
UKRAINIAN NATIONAL ACADEMY OF SCIENCES
BUREAU OF PHYSICS AND ASTRONOMY
INSTITUTE OF ELECTRON PHYSICS

ELEMENTARY PROCESSES IN ATOMIC SYSTEMS

Europhysics Conference

ABSTRACTS
AND CONFERENCE
PROGRAMME

Uzhgorod
Art Line
2000

ББК 22.38л(о)+32.85
Е 50
УДК 530.1(06)+539.1+621.38

Елементарні процеси в атомних системах

Тези та програма Міжнародної наукової конференції

Україна, Ужгород, 25-28 липня 2000 р.

Elementary Processes in Atomic Systems

Abstracts and Conference Programme

Ukraine, Uzhgorod, 25-28 July 2000

Укладач
А.М. Завілопуло, д. ф.-м. н.

Відповідальні за випуск:
Ю.М. Ажнюк, к. ф.-м. н.,
О.В. Снігурський, к. ф.-м. н.,
І.О. Цапфел

Збірник включає тези доповідей та програму міжнародної конференції "Елементарні процеси в атомних системах" (CEPAS'2000). До збірника увійшли роботи, надіслані на адресу оргкомітету з 12 європейських країн та США. Доповіді присвячені дослідженню явищ, які відбуваються в різноманітних атомних системах у твердому, газоподібному та рідкому станах.

The book contains Abstracts and Programme of the international Conference on Elementary Processes in Atomic Systems (CEPAS'2000). The book covers the contributed papers submitted to the Organizing Committee from 12 European countries and the USA. The papers are devoted to the studies of phenomena occurring in different atomic systems in solid, gaseous and liquid state.

На обкладинці: вид старого Ужгорода,
акварель Шандора Лама, 1862 р.

The cover includes the picture of old Uzhgorod
by Sándor Lám from 1862

GENERAL

The European Conference on the Elementary Processes in Atomic Systems (CEPAS'2000) is being supported by the European Physical Society and organized in accordance with the rules for Europhysics Conferences. The international Scientific Committee and the Local Organizing Committee have the pleasure to invite you to participate in the conference, which is being held in Uzhgorod, Ukraine on July 25-28, 2000. The meeting is organized by the Institute of Electron Physics, Ukrainian National Academy of Sciences, and will include plenary lectures, invited talks, oral presentations and poster sessions The official language of the Conference is English. The list of topics, covered by the Conference, includes:

- *Elementary processes and phenomena stimulated by interactions of electron, ion, atomic and molecular beams of low and intermediate energy with each other and with condensed matter*
- *Elementary processes and mechanisms of lasing excitation in gas lasers*
- *Photonuclear reactions, radiation strength of materials and devices, nuclear-physical technologies in industry and medicine*
- *Bound states in nuclear systems and elementary particle systems, bound states in adsorption and catalysis processes*

CONFERENCE CHAIRMAN
O.B.Shpenik (*Ukraine*)

INTERNATIONAL SCIENTIFIC COMMITTEE
D.Berenyi (*Hungary*), I.I.Fabrikant (*USA*)A.A.Kikineshi (*Ukraine*), V.F.Klepikov (*Ukraine*), V.I.Lengyel (*Ukraine*), N.J.Mason (*UK*), A.G.Naumovets (*Ukraine*), L.P.Presnyakov (*Russia*), E.Sheregii (*Poland*), V.Yu.Slivka (*Ukraine*), I.Stasiuk (*Ukraine*), Cz.Szmytkowski (*Poland*), L.Szótér (*Hungary*), A.N.Zavilopulo (*Ukraine*), M.Zubek (*Poland*)

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CONFERENCE SECRETARIES
LG.Romanova,Yu.M.Azhniuk

FOREWORD

Let me sincerely greet all the participants of the International Conference on Elementary Processes in Atomic Systems in our beautiful city of Uzhgorod. I hope that interesting talks, creative atmosphere, stimulating discussions, hospitality of the organizers will provide the success of the conference, enabling to establish fruitful contacts between the scientists of different countries.

Among the variety of international forums devoted to studies of various phenomena at the interactions of atomic particles, in our opinion, there is a lack of a conference unifying the processes taking place in solid, gaseous and liquid state. Thus, the organization of such conference may become a start of the "unifying" forum of physicists working in different areas of science.

It is a pleasure to note that the idea of such a forum was eagerly supported by Prof. H.Hotop, the Executive Chairman of the International Conferences on Electron and Atomic Collisions and met response and approval in the European Physical Society which has found the possibility of financial support for this scientific event.

The conference was preceded by a thorough work of the International Scientific and Local Organizing Committees, Ministry of Education and Science of Ukraine, Bureau of Physics and Astronomy of Ukrainian National Academy of Sciences, Transcarpathian Physical Society, Science and Technology Centre in Ukraine. Due to their efforts we managed to meet here the representatives of scientific schools and institutions from various countries of the world, in spite of the established tight schedule of international forums being traditionally held in summer.

Unfortunately, today here we miss the distinguished scientist Prof. Volodymyr Lengyel, for whom the organization of this conference has become his last contribution into the noble work in the field of science. We will always miss his bright image, inexhaustive energy and great talent.

This conference, as planned by its organizers, is intended to be a starting event for a series of meetings of scholars working in the advanced fields of modern science. Wishing it to be successful, we hope it will become traditional and will be held in different countries throughout the world. Let our results be the realization of all our efforts directed at deeper knowledge of well-known, not very well known and unknown phenomena of nature.

With the best wishes of fruitful work,

Otto Shpenik

CONFERENCE PROGRAMME

TUESDAY, July 25

08:00-09:00 ***Registration***

09:00 **OPENING CEREMONY AND WELCOME**
Chairman of CEPAS'2000 Otto Shpenik

PLENARY LECTURES AND INVITED TALKS — *SESSION I*

Chairman: **Prof. Otto Shpenik** (Institute of Electron Physics, Uzhgorod, Ukraine)
Secretary: **Dr. Yuriy Azhniuk** (Institute of Electron Physics, Uzhgorod, Ukraine)

09:30 A.Gopalan, J.Bömmels, E.Leber, J.M.Weber, S.Barsotti, D.Klar, M.W.Ruf, H.Hotop (*Fachbereich Physik, Universität Kaiserslautern, Germany*) **"High Resolution Studies of Low-Energy Electron Collisions with Gaseous Targets"** p.22

10:00 I.I.Fabrikant, (*Department of Physics and Astronomy, University of Nebraska-Lincoln, Lincoln, USA*). **"Theoretical Studies of Dissociative Attachment: from Gas Phase to Condensed Phase"** p.23

10:30 A.A.Sorokin, L.A.Shmaenok, S.V.Bobashev (*Ioffe Physico-Technical Institute RAS St. Petersburg, Russia*), B.Möbus, M.Richter, G.Ulm (*Physikalisch-Technische Bundesanstalt, Berlin, Germany*) **"New Measurement of Absolute Electron-Impact Ionization Cross-Section of Ne, Ar, Kr, and Xe from 140 to 4000 eV"** p.24

11:00-11:30 **COFFEE BREAK**

PLENARY LECTURES AND INVITED TALKS — *SESSION II*

Chairman: **Prof. Ilya Fabrikant** (University of Nebraska-Lincoln, Lincoln, USA)
Secretary: **Dr. Lyudmila Bandurina** (Institute of Electron Physics, Uzhgorod, Ukraine)

11:30 N.Avdonina (*University of Pittsburgh, Pittsburgh, USA*) **"Small-Angle Electron Scattering: General Properties and Specific Features"** p.25

12:00 A.Kalinin (*Institute for Problems in Mechanics of Russian Academy of Sciences, Moscow, Russia*) **"Study of Elastic and Inelastic Interactions in Atoms and Molecules by Small-Angle Fast Molecular Beam Technique"** p.26

12:30 A.F.Borghesani, G.Bressi, G.Carugno, E.Conti, C.Del Noce, D.Iannuzzi (*INFM, Sezione di Padova, Universita' di Padova, Italy*) **"Infrared Emission Induced by Electrons Moving in Noble Gases and Liquids"** p.27

13:00-14:30 **LUNCH**

PLENARY LECTURES AND INVITED TALKS — *SESSION III*

Chairman: **Prof. Alexander Kikineshi** (Uzhgorod State University, Ukraine)
Secretary: **Dr. Anna Gomonai** (Institute of Electron Physics, Uzhgorod, Ukraine)

14:30 C.Szmytkowski, P.Możejko. (*Atomic Physics Division, Faculty of Applied Physics and Mathematics, Technical University of Gdańsk, Poland*) **"Recent Progress in Absolute Total Cross Section Measurements for Electron Scattering from Molecular Targets at Low and Intermediate Energy Range"** p.28

15:00 V.G.Litovchenko (*Institute of Semiconductor Physics, NAS of Ukraine, Kiev, Ukraine)* **"Peculiarities of Secondary Ion Emission from Matrices with Polar Chemical Bond"** p.29

15:30 A.Glushkov (*Atom.-Mol.-Laser Spectr. Centre and Inst. Appl.Math. OHMI, Odessa, Ukraine)* **"QED Theory of Deformation of the Radiation Atomic Lines in Strong Laser Field. Multiphoton Resonances"** p.30

16:00-16:30 COFFEE BREAK

ORAL PRESENTATIONS *SESSION I*

Chairman: **Prof. Mariusz Zubek** (Technical University, Gdańsk, Poland)
Secretary: **Dr. Mykola Erdevdi** (Institute of Electron Physics, Uzhgorod, Ukraine)

16:30 S.V.Ambrosov (*Atom.-Mol.-Laser Spectr. Centre and Inst. Appl.Math. OHMI, Odessa, Ukraine)* **"Selective Ionization of Atoms and Molecules by Electric and Light Field. Autoionizing Rydberg Resonances in Heavy Atoms. Optimal Isotope-Separation Selective Ionization Schemes"** p.50

16:45 A.I.Bercha, P.Bogdan, K.Glukhov,(*Uzhgorod State University, Ukraine*) M.Sznajder, D.M.Bercha, (*Pedagogical University, Rzeszów, Poland*) **"Energy States and the Type of the GaAs/AlAs Short-Period Superlattices"** p.51

17:00 J.Cebulski, J.Polit, E.M.Sheregii (*Institute of Physics Pedagogical University, Rzeszów, Poland)* **"Magnetophonon Spectroscopy of $Zn_xCd_yHg_{1-x-y}Te$"** p.53

17:15 A.A.Efremov, G.Ph.Romanova (*Institute of Semiconductor Physics, NAS of Ukraine, Kiev, Ukraine*) **"Interaction of Low-Energy Oxygen Ion Beam with Silicon Surface: Transition Kinetics of Phase and Structural Transformations."** p.55

17:30 Yu.A.Bandurin (*Uzhgorod State University, Ukraine)* **"Continuum Radiation During Ion Bombardment of Metals"** p.56

17:45 A.Glushkov[1], S.V.Malinovskaya ([1]*Atom.-Mol.-Laser Spectr. Centre and Inst. Appl.Math. OHMI, "NPO "Comput. Centre", Odessa, Ukraine*) **"Relativistic Models in Dynamics of Interaction for Atoms, Atomic Ions, Molecules Electron Shells with Nuclei Nucleons: New Effects"** p.57

18:00 L.A.Vitavetskaya (*Atom.-Mol.-Laser Spectr. Centre and Inst. Appl. Math. OHMI, Odessa, Ukraine)* **"Accurate QED Perturbation Theory Calculation of the Heavy and Super Heavy Elements Atoms and Ions Z=110-114 and Multicharged Ion Structure with Account of Nuclear Size Effect and QED Corrections"** p.58

18:15 I.Yu.Krivsky (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Further Development of Many-Particle, Many-Channel and Field Methods in Atomic Physics Problems"** p.59

POSTERS (14:00-15:00) *SESSION I*

Chairman: **Prof. Arpad Imre** (Institute of Electron Physics, Uzhgorod, Ukraine)
Secretary: **Dr. Alexander Snegursky** (Institute of Electron Physics, Uzhgorod, Ukraine)

1. E.T.Kucherenko, O.E.Lushkin, V.B.Nazarenko, (*Kyiv T. Shevchenko University, Radiophysical Dep., Kyev, Ukraine*) **"The Magnetron Spraying Equipment for Obtaining Ferroelectric Films"** p.80
2. I.E.Kacher, A.K.Shuaibov, A.I.Dashchenko, M.Ju.Rigan (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Experimental Equipment for Optical Studies of Laser Plasma of Multicomponent Compounds"** p....
3. P.M.Milyan, Zh.O.Kormosh, O.O.Semrad (*Uzhgorod State University, Department of Chemistry, Uzhgorod, Ukraine*) **"Rhenium Doped Alloys of Pb-Sb-O System : Synthesis, Analysis and Some Physico-Chemical Properties"** p.82
4. Yu.M.Azhniuk, A.V.Gomonnai, D.B.Goyer, I.G.Megela, V.V.Lopushansky (*Institute of Electron Physics, Uzhhorod, Ukraine*) **"Resonant Interactions and Disorder Effects in $CdS_{1-x}Se_x$ Mixed Crystals Raman Spectra"** p.83
5. V.V.Betsa, L.V.Galagovets, L.E.Barchij, E.Yu.Peresh, Yu.V.Popik, M.Yu.Szabo (*Uzhgorod State University, Chemistry Department, Uzhgorod, Ukraine*) **"The Influence of Electron Processes at Adsorption on the Thermoelectric Properties of Tl_4TiS_4 Single Crystals"** p.84
6. M.V.Kurik[1], L.T.Siksai, O.Yu.Bandurin (*Uzhgorod State University, Uzhgorod, Ukraine, [1]Institute of Ecology Ukrainian National Academy of Sciences, Uzhgorod, Ukraine*) **"Studies of the Bile Crystallization Structure for Patients with Liver Pathologies"** p.85
7. I.I.Bondar, V.V.Suran, M.I.Dudich (*Physical Department, Uzhgorod State University, Uzhgorod, Ukraine*) **"Nonresonant Mixing of Low Metastable Levels of Ba Atoms by Laser Radiation"** p.86
8. G.G.Bogachev (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"On the Configuration Mixing Effects in the Excitation of ZnII and CdII Lines at Electron-Atom Collisions"** p.87
9. A.A.Borovik, V.N.Krasilinec, O.I.Zatsarinny (*Institute of Electron Physics, Uzhgorod Ukraine*) **"Total Electron-Impact Excitation Cross Sections for Low-Energy Autoionizing States in Lithium"** p.88
10. I.V.Chernyshova[1], J.E.Kontros[1], O.B.Shpenik[1], L.Szótér[2] (*[1]Institute of Electron Physics, Uzhgorod, Ukraine, [2]Department of Physics, Miskolc University, Miskolc, Hungary*) **"Cross Sections for Slow Electron Scattering by Cadmium Atoms"** p.89

22. M. Rytel *(Atomic and Molecular Physics Laboratory, Pedagogical University in Rzeszow 35-310 Rzeszow, Poland)* **"The Radial Harmonic Oscillator Problem: Some Results"** p.101

WEDNESDAY, July 26

PLENARY LECTURES AND INVITED TALKS — *SESSION IV*

Chairman: **Prof. Volodymyr Litovchenko** (Institute of Semiconductor Physics, NAS of Ukraine, Kiev, Ukraine)
Secretary: **Dr. Lyudmila Romanova** (Institute of Electron Physics, Uzhgorod, Ukraine)

9:00 A.Kisiel *(Instytut Fizyki, Uniwersytet Jagiellonski, Poland)* **"Band Structure Analysis of II-VI Group Ternary Compounds with Transition Metals"** p.29

9:30 I.I.Fabrikant, *(Department of Physics and Astronomy, University of Nebraska-Lincoln, Lincoln, USA)* **"Theory of Electron-Molecule Collisions in the Sub-meV Range"** p.31

10:00 N.J.Mason, *(Department of Physics and Astronomy, University College London, United Kingdom)* **"Experimental Studies of Transient Molecules"** p.32

10:30 A.A.Kikineshi, *(Uzhgorod State University, Uzhgorod, Ukraine)* **"Structural Transformations in the Amorphous Nano-Layered Chalcogenide Films"** p.33

11:00-11:30 COFFEE BREAK

PLENARY LECTURES AND INVITED TALKS — *SESSION V*

Chairman: **Dr. Nigel Mason** (University College London, London, UK)
Secretary: **Dr. Zoltan Torich** (Institute of Electron Physics, Uzhgorod, Ukraine)

11:30 T.Märk, *(Institut für Ionenphysik, Leopold Franzens Universität, Innsbruck, Austria)*, G.Senn, G.Hanel, T.Fiegele, H.Drexel, M.Rümmele, D.Muigg, G.Denifl, P.Scheier, A.Stamatovic[a], N.Mason[b], J.D.Skalny[c]. *([a]Faculty of Physics Beograd, Yugoslavia, [b]Dept. Physics and Astronomy, UCL, London, United Kingdom, [c]Dept. Plasma Physics, Comenius University, Bratislava, Slovak Republic)* **"Inelastic Interaction of Electrons with Atoms, Molecules and Clusters: Attachment Cross Sections and Appearance Energies"** p.34

12:00 E.Takacs *(Massachusetts Institute of Technology, Cambridge, USA and University of Debrecen, Debrecen, Hungary)* **"Laboratory Astrophysics with Highly-Charged Ions Using an X-Ray Micro-calorimeter"** p.35

12:30 D.B.Goyer, I.G.Megela, A.V.Gomonnai, Yu.M.Azhniuk *(Institute of Electron Physics, Uzhgorod, Ukraine)* **"Investigation of Formation and Annealing of Radiation Defects in III -V Semiconductors under Electron Irradiation"** p.36

12:45 V.Maslyuk, O.Parlag, O.Lendyel, T.Marinets, V.Bondarenko (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"The Effect of Elementary Particles Emission at the Heavy Nuclei Fission Fragments Mass Distribution"**

p.37

13:00-14:30 LUNCH

PLENARY LECTURES AND INVITED TALKS — *SESSION VI*

Chairman: **Prof. Eugen Sheregii** (Institute of Physics Pedagogical University, Rzeszów, Poland)

Secretary: **Dr.Tetyana Popik** (Institute of Electron Physics, Uzhgorod, Ukraine)

14:30 A.K.Kazansky, (*Institute of Physics, St.Petersburg University, St.Petersburg, Russia*), L.Malegat, P.Selles, (*LSAI, Batiment 350, Universite Paris-Sud, Orsay Cedex, France)* **"Account of the Two Electron Correlations in the Two-Electron Near-Threshold Photoionization"**

p.40

15:00 N.Stolterfoht, J.Tanis[1], J.-Y.Chesnel[2], J. H.Bremer, (*Hahn-Meitner-Institut GmbH, Berlin, Germany, [1]Western Michigan University, USA, [2]Centre Interdisciplinaire de Recherche Ions Lasers and Université de Caen, Cedex, France*), B.Skogvall (*Technische Universität Berlin, Germany*), F.Frémont, D.Lecler, D.Hennecart, X.Husson, A.Cassimi, J.P.Grandin (*Centre Interdisciplinaire de Recherche Ions Lasers and Université de Caen, Cedex, France*), Cs.Koncz, L.Gulyás, B.Sulik (*Institute of Nuclear Research (ATOMKI), Debrecen, Hungary*) **"Analogies in the Ionization Mechanisms Induced by Photons and Fast Ions"**

p.41

15:30 V. Matolin, N. Tsud *(Department of Electronics and Vacuum Physics, Faculty of Mathematics and Physics, Charles University, V Holesovickach 2, 180 00 Prague 8, Czech Republic)* **Influence of Metal-Substrate Interaction on Mechanism of Co Adsorption on Alumina Supported Palladium Particles: XPS and TDS Studies**

p.38

15:45 O.B.Shpenik *(Institute of Electron Physics, Ukrainian National Academy of Sciences Universitetska 21, 88000 Uzhgorod, Ukraine)* **Elementary Processes And Phenomena Stimulated By The Slow Electron Collisions**

p.39

16.00-16.30 COFFEE BREAK

ORAL PRESENTATIONS — *SESSION II*

Chairman: **Prof. Alexander Kalinin** (Institute for Problems in Mechanics of Russian Academy of Sciences, Moscow, Russia)

Secretary: **Dr. Yuri Shpenik** (Institute of Electron Physics, Uzhgorod, Ukraine)

16:30 V.Lengyel, Yu.Fekete, I.Haysak (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Spin Effects in Quarkonia"**

p.60

16:45 M.M.Kapustey, I.V.Khimich, V.Yu.Pojda, **R.M.Plekan** (*Uzhgorod State University, Department of Nuclear Physics, Uzhgorod, Ukraine*) **"The Adiabatic Three-Particle Shell-Model of Nucleus"**

p.61

17:00 I.I.Shafranyosh, V.Marushka, I.I.Shafranyosh (*Department of Physics, Uzhgorod State University*) **"Measurement of Cross Section of Superelastic Electron Scattering from Magnesium"**

p.62

17:15 V.A.Kelman, A.S.Rybak, Yu.O.Shpenik, Yu.V.Zhmenyak (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Discharge in Indium Iodide Vapor for Laser on In 451.1 nm Selfterminating Transition"**

p.63

17:30 N.V.Maksyuta, V.I.Vysotskii (*Shevchenko University, Radiophysical Faculty, Kiev, Ukraine*) **"The Mechanism of Particle Regularization of Positive Ions Motion in Monocrystals"**

p.64

17:45 S.V.Malinovskaya (*Atom.-Mol.-Laser Spectr. Centre and Inst. Appl. Math. OHMI, Odessa, Ukraine*) **"S-Matrix Formalism in Calculation of Oscillator Strengths, Radiation and Autoionization Widths for Complex Atoms and Multicharged Ions"**

p.65

18:00 P.Możejko, B.Żywicka-Możejko, C.Szmytkowski (*Atomic Physics Division, Faculty of Applied Physics and Mathematics, Technical University of Gdańsk, Poland*) **"Elastic Cross Section Calculations for Electron Scattering on Polyatomic Molecular Targets: XY_4 (X = C, Si, Ge; Y = H, F, Cl), XF_6 (X = S, W, U), C_2F_6, and C_6Y_6 (Y = H, F)"**

p.66

18:15 R.Olszewski, M.Zubek (*Department of Physics of Electronic Phenomena, Technical University, Gdańsk, Poland*) **"Electron Impact Excitation of Nitric Oxide"**

p.67

POSTERS (14:00-16:00) ***SESSION II***

Chairman: **Prof.Volodymyr Kelman** (Institute of Electron Physics, Uzhgorod, Ukraine)
Secretary: **Dr.Irina Chernyshova** (Institute of Electron Physics, Uzhgorod, Ukraine)

1. B.M.Hunda, V.M.Marunchak, A.M.Solomon, I.I.Turok, M.M.Borisyuk (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Thermostimulated Luminescence in the Tb-Doped Lithium Tetraborate Polycrystals"**

p.102

2. V.M.Holovey, O.O.Parlag, V.T.Maslyuk, P.P.Puga, V.M.Marunchak, M.I.Holovey, I.Yu.Kobaly (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"The Use of the Photo- and Neutron Activation Analysis in Determining Eu Content in Lithium Tetraborate"**

p.103

THURSDAY, July 27

9:00 Excursion

FRIDAY, July 28

PLENARY LECTURES AND INVITED TALKS — *SESSION VII*

Chairman: **Dr. Nina Avdonina** (University of Pittsburgh, Pittsburgh, USA)
Secretary: **Dr. Alexander Borovik** (Institute of Electron Physics, Uzhgorod, Ukraine)

8:30 I.Sellin (*National Cancer Institute, Frederick, USA*). **"Coronal Lithium Atoms"**

9:00 N.J.Mason (*Department of Physics and Astronomy, University College London, London, United Kingdom*). **"Molecular Spectroscopy Probed by Synchrotron Radiaiton and Electron Scattering"** p.421

9:30 M.Pociask, E.M.Sheregii (*Pedagogical University, Institute of Physics, Rzeszów, Poland*). **"Creation of the Heterojunction and Periodical Structures in Solid Solution by Laser Annealing".** p.43

10:00 L.P.Presnyakov (*P.N.Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia*). **"Ionization of Atoms by Highy-Charged Ions and by Intense Electromagnetic Fields".** p.44

10:30 B.V.Robouch, A.Kisiel[2] ([1]*Ex-Associazion Euroatom ENEA Sulla Fusione,*[2] *Instytut Fizyki, Uniwersytet Jagiellonski, Poland*) **"Ternary Elemental Zinc Blende Tetrahedra Size, Shape, Preferences as Deduced From EXAFS Observations (Generalities, Model, Validation, Analysis, Comment on Some Results)"** p.45

11:00-11:30 COFFEE BREAK

PLENARY LECTURES AND INVITED TALKS — *SESSION VIII*

Chairman: **Prof. Tilman Märk** (Institut für Ionenphysik, Leopold Franzens Universität, Innsbruck, Austria)
Secretary: **Dr. Oleg Parlag** (Institute of Electron Physics, Uzhgorod, Ukraine)

11:30 M.Popescu (*National Institute of Materials Physics, Bucharest-Magurele, Romania*). **"Modifications Induced by Ultraviolet Light in Non-Crystalline Chalcogenides"** p.46

12:00 M.Zubek (*Department of Physics of Electronic Phenomena, Technical University, Gdansk, Poland*). **"Elastic and Inelastic Electron Scattering by Atoms and Molecules in the Backward Direction"** p.47

12:30 D.Uskov (*P.N.Lebedev Physical Institute, Moscow, Russia*). **"Collisional Processes Involving Negative Hydrogen Ions"** p.48

13:00-14:30 LUNCH

ORAL PRESENTATIONS

SESSION III

Chairman: **Prof. Vyacheslav Klepikov** (Scientific and Technological Center of Electrophysics, NAS of Ukraine)
Secretary: **Dr. Boris Hunda** (Institute of Electron Physics, Uzhgorod, Ukraine)

14:30 A.K.Kazansky (*Institute of Physics, St.Petersburg University, Russia*), A.G.Borisov, J.-P.Gauyacq (*LCAM, Unite Mixte de Recherche CNRS - Universite, Cedex, France*) **"Application of the Wave-Packet Propagation Approach to Some Problems of Interaction Between Atomic Particles and Metal Surface"** p.68

14:45 V.A.Kelman, Yu.O.Shpenik (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Metal Vapor Lasers on Self-Terminating Transitions"** p.69

15:00 P.P.Puga, B.M.Hunda (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Thermostimulated Luminescence and X-Ray Luminescence of Undoped $Li_2B_4O_7$ Single Crystals"** p.70

15:15 A.I.Imre (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Study of Direct and Resonance Processes in Collisions of Electrons with Atoms and Ions"** p.71

15:30 M.Zubek[1], B.Mielewska[1], G.C.King[2] ([1]*Department of Physics of Electronic Phenomena, Technical University, Gdańsk, Poland,* [2]*Department of Physics and Astronomy, Schuster Laboratory, Manchester University, UK*) **"Absolute Differential Cross Sections for Electron Scattering in Nitrogen in the Angular Range from 120° to 180°"** p.72

15:45 J.Polit[1], E.M.Sheregii[1], E.Sciesińska[2], J.Sciesiński[2], ([1]*Institute of Physics Pedagogical University, Rzeszów,Poland,* [2]*Institute of Nuclear Physics, Cracow, Poland*) **"The Reflection-Absorption Spectroscopy of the Semiconductor Thin Films"** p.73

16:00 M.I.Haysak, M.M.Dovhanich, V.V.Onysko[1] (*Institute of Electron Physics, Uzhgorod, Ukraine,* [1]*Uzhgorod State University, Uzhgorod, Ukraine*) **"Hyperspherical Approach in Few-Body Systems"** p.74

16:15 –16:30 COFFEE BREAK

ORAL PRESENTATIONS — ***SESSION IV***

Chairman: **Prof. Anatoly Zavilopulo** (Institute of Electron Physics, Uzhgorod, Ukraine)
Secretary: **Oksana Kudelich** (Institute of Electron Physics, Uzhgorod, Ukraine)

16:30 O.Parlag, M.Stets, P.Puga, V.Maslyuk (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Natural Gamma-Activity Dynamics Monitoring"** p.75

16:45 G.Tomaka[1], E.M.Sheregii[1], J.Cebulski[1], W.Sciuk, W.Strupiński[2], L.Dobrzański ([1]*Institute of Physics of Pedag. Univer., Rzeszów, Poland*, [2]*Institute of Electronic Materials Technology, Warsaw, Poland*) **"Controlling of the Thermal Stress in the Multiple Quantum Wells Using Magnetophonon Spectroscopy"** p.76

17:00 A.V Snegursky (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Threshold Peculiarities of Electron-Impact Dissotiative Ionization in Polyatomic Molecules"** p.60

17:15 I.V.Sokolyuk, T.M.Zajac (*Uzhgorod State University, Department of Nuclear Physics, Uzhgorod, Ukraine*) **"On the Question of the Agrement of Experimental Data with Theoretical Estimations of the Cross-Sections of Reactions of Non-Elastic Gamma-Quanta Scattering on Metastable States"** p.77

17:30 V.M.Simulik, I.Yu.Krivsky (*Institute of electron physics, Uzhgorod, Ukraine*) **"Further Development of the Classical Electrodynamical Model of Atom"** p.78

17:45 I.I.Opachko (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Silver Jubilee of Laser-Plasma Investigations in Uzhgorod State University"** p.53

POSTERS (14:00-16:00) — ***SESSION III***

Chairman: **Prof. Volodymyr Masluk** (Institute of Electron Physics, Uzhgorod, Ukraine)
Secretary: **Tetyana Smereka** (Institute of Electron Physics, Uzhgorod, Ukraine)

1. E.Yu.Remeta, V.I.Kelemen (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Optical Potential Model for Elastic Scattering of the Metastable He($2\ ^{1,3}S$) Atoms by the Na($3\ ^{2}S$) Atoms in the 0.1 – 1000 meV Energy Region"** p.122

2. E.Yu.Remeta, V.I.Kelemen, Yu.Yu.Bilak, L.L.Shimon (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Optical Potential Approach for Low-Energy Electron Elastic Scattering by the Be, Mg, Ca, Ba and Yb Atoms in the Forward and Backward Hemispheres of Angles"** p.123

3. I.I.Shafranyosh, M.O.Margitich, L.L.Shimon (*Department of Physics, Uzhgorod State University, Uzhgorod, Ukraine*) **"Electron-Impact Ionization Cross-Sections of Sr Atoms from Ground- and Metastable States"** p.124

4. I.I.Shafranyosh, T.A.Snegurskaya (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Energy Dependences of Electron Excitation Cross Sections out of Metastable States of Lower Mg, Ca and Sr Levels"** p.125

5. V.N.Polischuk (*Comput. Dept. OHMI, Odessa, Ukraine*) **"Quasimolecular Terms for Systems: "An Inert Gas Atom – Halogen Atom", "An Inert Gas Atom – Rare Earth Atom""** p.127

6. P.P.Popovich (*Institute of Solid State Physics and Chemistry, Uzhgorod State University, Uzhgorod, Ukraine*) **"Fluctuation Effects in High-Temperature Superconductor Oxides"** p.128

7. Yu.Pylypchenko, Z.Bigan, I.Kobal (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"Formation of Nuclei Isomeric States in the Photofission Reactions"** p.129

8. I.V.Shevera, A.K.Shuaibov, L.L.Shimon, A.I.Dashchenko, A.I.Minja (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Investigation of the Work Conditions and Characteristics of Multiwave Emitters on Rare Gas Chlorides and Ftorides"** p.131

9. I.V.Sokolyuk, T.M.Zajac (*Uzhgorod State University, Department of Nuclear Physics, Uzhgorod, Ukraine*) **"Isomer Hf-178m (16+) as an Effective Solid for the Realization of a "Hot Gamma-Laser""** p.126

10. M.Stets, M.Hoshovsky, O.Parlag (*Institute of Electron Physics, Uzhgorod, Ukraine*), V.Buzash, V.Okogrib (*Uzhgorod State University, Uzhgorod, Ukraine*) **"The Activation Analysis of Electronic Scrap Samples Elemental Composition"** p.132

11. M.Stets, M.Hoshovsky (*Institute of Electron Physics, Uzhgorod, Ukraine*), M.Potushnyak (*Uzhgorod Group of Archaeological Department of the I.Krip'yakevich Institute of Ukrainian Studies, National Academy of Sciences of the Ukraine*) **"Gamma-Spectrometry in Identification of Archaeological Samples"** p.133

21. O.I.Zatsarinny, L.A.Bandurina (*Institute of Electron Physics, Uzhgorod, Ukraine*) **"R-Matrix Calculation of the Electron-Impact Excitation of Zn+ and Cd+."** p.142

22. B.Sulik[a], Cs.Koncz[a], A.Orbán[a], K.Tőkési[a,b], D.Berényi[a] (*[a]Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI), Debrecen, Hungary, [b]Institute for Theoretical Physics, Vienna University of Technology, Vienna, Austria*) **"Multiple Scattering of the Electrons Emitted in 150-250 keV/u C^+ + Inert Gas Collisions"** p.143

23. A.K.Shuaibov, L.L.Shimon, A.J.Dashchenko, M.P.Chuchman (*Uzhgorod State University, Uzhgorod, Ukraine*) **"Optical Characteristics of Laser Erosion Plasma of Gallium, Indium and Copper"** p.144

24. F.F. Telychko (*Uzhgorod State University, Uzhgorod, Ukraine*) **"New View on the Initial Cause of the Appearance of Pathological Processes"** p.145

25. M.Haysak, M.Nagy[1], V.Onysko[2] (*Institute of Electron Physics NAS of Ukraine, Uzhgorod, Ukraine, [1]Institute of Physics of Slovak AS, Bratislava, Slovakia, [2]Uzhgorod State University, Uzhgorod, Ukraine*) **"Description of Angular Correlation of Electrons in Positron Negative Ion by Hyperspherical Coordinates Method"** p.146

26. L.V.Poperenko, M.V.Vinnichenko, V.S.Voitsenya[1](*Physics Department, National Kyiv Taras Shevchenko University, Kyiv, Ukraine, [1]National Science Center "Kharkov Institute of Physics and Technology", Kharkov, Ukraine*) **"Spectroellipsometric Studies of D^+ Ion Irradiated W (110) and (111) Single Crystals"** p.147

27. A.K.Prykarpatsky, A.Szum (*Dept. of Nonlinear Mathematical Analysis, IAPMM the NAS, Lviv, Ukraine , Dept. of Applied Mathematics at the AGH, Krakow, Poland, Dept.of Physics, Adam Mickiewicz University, Poznan, Poland*) **"Chern-Simons Field Theory and the Hadrons Confinement Problem Within a Faddeev Yang-Mills Field Decomposition"** p.148

28. V.G.Kravets, K.L.Vinnichenko (*National Taras Shevchenko Kyiv University, Physics Department, Kyiv, Ukraine*) **"Electron-Beam Irradiation-Based Recording on Organic Dye Films"** p.149

29. V.Moroz, K.Mašek *(Faculty of Math. and Phys., Charles University, Depth. of Electronics and Vacuum Physics, Prague, Czech Republic)* **"RHEED investigation of noncontinuous bimetallic layers"** p.81

18:00 Farewell

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EPAS 2000

ABSTRACTS

LECTURES AND INVITED TALKS

HIGH RESOLUTION STUDIES OF LOW ENERGY ELECTRON COLLISIONS WITH GASEOUS TARGETS

A.Gopalan, J.Bömmels, E.Leber, J.M.Weber, S.Barsotti, D.Klar, M.-W.Ruf, H.Hotop

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Collisions between electrons and atoms, molecules or clusters at low energies are of great fundametal and applied interest. Especially, the attachment af electrons to molecules XY with formation of either long-lived anions XY^- or dissociated products $X^- + Y$ (dissociative attachment) is an important process in connection with the dielectric breakdown strength of gases. Processes involving vibrational excitation and negative ion formation are strongly mediated through resonances in the collision complex. Apart from the well known shape resonances, vibrational Feshbach resonances have recently been observed to play an important role. In these studies, it became clear that very high energy resolution (energy width around 1 meV) is necessary to reveal the details of the resonance structure and - in electron attachment experiments - the steep rise in the cross-section towards zero energy (s-wave attachment).

Over the last ten years, our group has developed laser photoelectron sources with (sub) meV energy widths [1-3]. They rely on resonant two step laser photoinization of metastable Ar* or ground state K atoms with tunable narrow-band lasers in conjunction with a careful characterization and minimization of the residual electric field in the reaction region. So far, most of the experiments have addressed electron attachement processes with selected molecules and molecular clusters. In these studies, the photoelectrons react with a collimated target nozzlebeam in the region of their production.

At very low photoelectron currents energies down to E = 0,02 meV and energy width down to 0,015 meV where achieved [3], but more typically, effective energy widths between 0,2 and 2 meV where used at currents between 1 and 50 pA. For the first time, the E-1/2 limit ($E \rightarrow 0$) for s-wave attachment processes was clearly observed [1-4] and step-like structure was observed in the attachment yield at onsets for vibrational excitation [1-4]. Prominent, narrow vibrational Feshbach resonances were recently observed in electron attachment reactions with CH_3I [4] and CH_2Br_2 molecules as well as with clusters of N_2O [5, 6] and CO_2 [7]. Experiments are under way to exploit the potential of these laser photoelectron sources for scattering experiments involving atoms in a well collimated supersonic beam. In this setup, the electrons are created at threshold with very low kinetic energy, extracted by a weak electric field and formed into a collimated beam by suitable electron optics.

Our work has been supported by the Deutsche Forschungsgemeinschaft, the Graduiertenkolleg Laser- und Teilchenspektroskopie and the Zentrum für Laser-meßtechnik und Diagnostik.

References:

[1] D. Klar et al., Aust. J. Phys **45** (1992) 263
[2] D. Klar et al., Meas. Sci. Technol. **5** (1994) 248
[3] A. Schramm et al., Phys. Rev. Lett. **81** (1998) 778
[4] A. Schramm et al., J. Phys. B **32** (1999) 1253
[5] J.M. Weber et al., Phys. Rev. Lett. **82** (1999) 516
[6] E. Leber et al., Chem. Phys. Lett. (2000) in press
[7] E. Leber et al., Eur. Phys. J. D (2000) in press

THEORETICAL STUDIES OF DISSOCIATIVE ATTACHMENT: FROM GAS PHASE TO CONDENSED PHASE

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Dissociative attachment (DA) processes in electron collisions with molecules are important for the description of a broad variety of phenomena including gas discharge, controlled thermonuclear fusion, astrophysical processes and environmental control. In spite of this, DA reactions are relatively poorly studied theoretically. There are many examples where we have not achieved even qualitative understanding of the DA processes. The situation becomes even more complicated when DA is affected by environment, like in the case of DA to clusters and adsorbates and molecules embedded in condensed medium.

The present paper will discuss recent theoretical studies of DA in gas and condensed phase performed at the University of Nebraska. Our approach is based on two formulations of the resonance scattering theory. The first one is the Feshbach projection-operator method which we employ for studies of collisions with simple diatomic molecules. The second formulation employs the single-pole approximation of the R-matrix theory which is convenient for semiempirical calculations. The R-matrix theory has been used to calculate DA cross sections and rates for methyl halides. We have shown that the rates for methyl chloride and methyl halide obey Arrhenius law with the activation energy which is higher for the methyl halide whereas methyl iodide does not obey the Arrhenius law. For all methyl halides the cross section as a function of electron energy exhibits structure at the vibrational excitation thresholds which is associated with the vibrational Feshbach resonances.

The semiempirical R-matrix approach allows us to extend the theory to the description of condensed-matter effects in DA. The position of the negative-ion resonance is affected in this case by the polarization of the environment by the negative ion. This effect leads to a massive enhancement of the DA cross section for methyl chloride adsorbed on surfaces.

NEW MEASUREMENTS OF ABSOLUTE ELECTRON IMPACT IONIZATION CROSS SECTIONS OF Ne, Ar, Kr AND Xe FROM 140 TO 4000 eV

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A method and apparatus for precise measurements of absolute total cross-sections for electron-impact ionization of Ne, Ar, Kr, and Xe have been developed. Method is based on the comparison of the total ion yields resulting from ionization of rare gases by electrons and photons. Ratios of total cross sections for electron-impact ionization and photoionization in Ne, Ar, Kr, and Xe in the energy range from 140 eV to 4000 eV for electrons and from 16 eV to 1012 eV for photons were measured. Comparatively low relative standard uncertainties of 1.3 % to 1.9 % were achieved using an apparatus combining two instrumental developments. The first is associated with a highly accurate device for the determination of soft X-ray and vacuum-UV photon flux, a cryogenic electrical substitution radiometer [1]. The second is associated with an experimental approach proposed in [2] and an upgraded ionization chamber for the precise comparison of total ion yields for electron and photon impact. On the basis of our measured cross-section ratios and well-known total photoionization cross section data, we deduced absolute total electron-impact ionization cross sections for Ne, Ar, Kr, and Xe with relative standard uncertainties as low as 2.8 %.[3,4]. A comparison of new cross-section data with published experimental and theoretical data is given.

References:

[1] F. Scholze, H.Rabus, and G.Ulm, J. Appl. Phys. **84**, 2926, (1998).
[2] S.V.Bobashev and L.A. Shmaenok., Rev. Sci. Instr., **52**, 16, (1981).
[3] A.A.Sorokin, L.A. Shmaenok, S.V.Bobashev, B. Meubus and G.Ulm., Phys. Rev.A , 58 (4), 2900, (1998).
[4] A.A.Sorokin, L.A. Shmaenok, S. V. Bobashev, B.Moebus, M. Richter and G. Ulm., Phys. Rev.A, **61**, 022723, (2000).

SMALL-ANGLE ELECTRON SCATTERING: GENERAL PROPERTIES AND SPECIFIC FEATURES

Nina Avdonina

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The difficulties of measuring reliably the electron differential cross sections at small scattering angles, including their attendant normalization, are well documented in the literature. In the talk we present a new and simple representations of the kinematics of the inelastic electron scattering. We use these representations to elucidate the behavior of the apparent generalized oscillator strengths (AGOSs) at small, including zero, scattering angles. Our approach can be used as a test for reliability of the experimental and theoretical results in general. Possible specific features of AGOSs are discussed. We show that analytical properties of matrix elements and kinematic properties of the process of the small angle scattering dictate asimilarity in their behavior. To support our predictions for AGOSs we use results of the close coupling approximation (CCC). The AGOSs obtained in CCC are used to reveal improper normalization of the measured and to identify spurious behavior in the theoretical calculated electron differential cross sections. We also contrast the small scattering angle AGOSs to the results obtained in the First Born approximation in high-energy limit as well as at near threshold energy. Significance of the higher-order Born terms is manifested by the fact that neither the slope of AGOSs with respect to the momentum transfer K nor d(AGOS)/dK2 at the zero K obey the FBA. At big K apparent generalized oscillator strengths and First Born approximation results also have different asymptotic behavior. We show that they converge to different limits at low energy.

STUDY OF ELASTIC AND INELASTIC INTERACTIONS IN ATOMS AND MOLECULES BY SMALL ANGLE FAST MOLECULAR BEAM TECHNIQUE

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It is more than fifty years since the method of fast (energy E~1 keV) molecular beam scattering at small angles (10^{-4} – 10^{-2} rad) is used to study the repulsive interaction potentials of atomic particles (atoms, molecules and ions). As usual such experiments were considered to have only elastic collisions. We have designed and constructed experimental set up at the Institute for Problems in Mechanics of Russian Academy of Sciences which allowed not only to measure the fact of particle scattering (differential cross section measurements - black squares in Fig.1) but simultaneously to define the energy of a scattered particles (energy loss spectra measurements - fig.2).

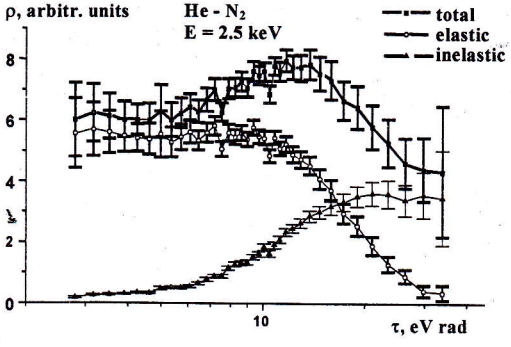

Fig. 1. Differential cross sections

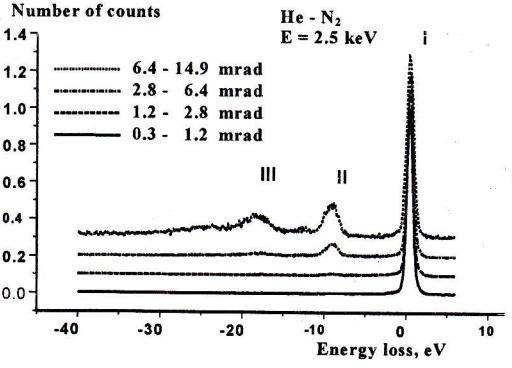

Fig. 2. Energy loss spectra

Fig.1 uses reduced coordinates: $\tau=\theta E$ and $\rho=\sigma\theta^2$ (θ- scattering angle, σ – differential cross section). Fig.2 gives the energy loss spectra per several scattering angles. Peak I corresponds to elastically scattered particles, and peaks II and III - to inelastic ones. Thereby one experiment combines both angle and energy measurements and allowing to obtain the double differential cross sections. This became possible by using the position-sensitive microchannel plate detector and the energy loss spectra time of flight measuring technique. Measurements of double differential cross sections for various systems including molecules proved good possibilities for definition either elastic (open circles, Fig. 1) and inelastic (triangles, Fig. 1) differential cross sections, or studies of the low lying electronic states excitation in molecules for collisions of the fast projectile and target particles.

INFRARED EMISSION INDUCED BY ELECTRONS MOVING IN NOBLE GASES AND LIQUIDS

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[b]*Universita' di Padova, Italy*
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[e]*Universita' di Pavia,Italy*

The motion of excess electrons in matter is mainly determined, among other things, by the electron-atom scattering properties. In rare gases and liquids two different behaviors can be observed. The first one is related to electrons with a mean energy much higher than the thermal contribution. In this case electrons loose energy by inelastic collisions with the surrounding atoms. A quite different phenomenology shows up when electrons interact with atoms at near thermal energies. Elastic collisions prevail under these conditions. We present an. experimental study on both phenomenologies. We are investigating the infrared (IR) emission induced by both high-and low-energy electrons drifting in noble gases and in noble liquids at near atmospheric pressure. A 100 keV electron beam enters an ionization chamber containing the sample. The IR light emission is measured for the high energy electrons as well as for the drifting electrons as a function of the applied electric field. IR emission spectra are recorded by means of a spectrometer. We observed experimentally IR emission at zero field. In this case, IR radiation is emitted during the electron thermalization process involving only energetic electrons. A detailed study of this phenomenon may shed light on the interaction experienced by the high-energy electrons in the sample. As the electric field is increased and the thermalized electrons drift, also the intensity of the IR emission increases. The enhancement of the IR light output seems to be related to the drift motion of the low energy electrons. This phenomenon, still to be clearly understood, may prove a valuable tool for the investigation of the interaction between low-energy electrons and atoms in dense gases or liquids.

RECENT PROGRESS IN ABSOLUTE TOTAL CROSS SECTION MEASUREMENTS FOR ELECTRON SCATTERING FROM MOLECULAR TARGETS AT LOW AND INTERMEDIATE ENERGY RANGE

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Electron scatttering on atoms and molecules is an important tool in investigation of interaction of electrons with matter. Total cross section (TCS) for electron collision with atoms or molecules contains information of all possible processes which occurs in collision phenomena and thus is valuable and usefull quantity which may be used in atomic and molecular physics, low temperature plasma, astrophysics and etc.

In the present work we review absolute total cross sections for electron scattering from molecular targets obtained recently of plasma interest and molecular compound of great importance in manufacturing of electronic microcircuits: XY_4 (X = C, Si, Ge; Y = H, F, Cl), XF_6 (X = S, W), X_2Y_6 (X = C, Si; Y = H, F), C_6Y_6 (Y = H, F).

In figure 1 we compare TCS for e^--C_2F_6 collisions determined in different experiments: normalized TCS for energies ranging from 0.9 to 20 eV was obtained by Sueoka et al [1] with time-of-flight technique, Sanabia et al [2] determined absolute TCS from near-thermal energies to 20 eV with the trochoidal spectrometer, for measurements of absolute TCS from 0.5 eV to 250 eV, electrostatic 127^0 electron spectrometer was used by Szmytkowski et al [3]. Description of methods and further results will be presented at the Conference.

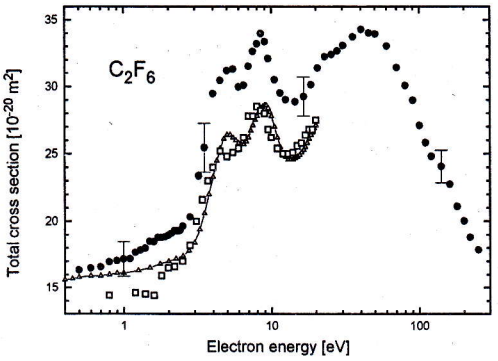

Fig. 1. Total cross section for electron collisions with C_2F_6 molecules: □, [1]; -Δ-, [2]; •, [3]

This work has been supported in part by Polish State Committee for Scientific Research (KBN215/P03/99/17)

References:

[1] O. Sueoka, H. Takaki, A. Hamada and M. Kimura, 20th ICPEAC (Vienna 1997) (Abstracts of Contributed Papers, vol 1) eds F. Aumayer, G. Betz and H.P. Winter (Vienna) WE057

[2] J.E. Sanabia, G.D. Cooper, J.A. Tossell and J.H. Moore, J. Chem. Phys. **108**, 389 (1998)

[3] Cz. Szmytkowski, P. Możejko, G. Kasperski and E. Ptasińska-Denga, J. Phys. B. **33**, 15 (2000)

PECULIARITIES OF SECONDARY ION EMISSION FROM MATRICES WITH POLAR CHEMICAL BOND

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It was found that secondary ion emission (SIE) from non-conductive matrices with polar chemical bonds (pure ionic, or mixed ionic-valence) demonstrate some interesting and important peculiarities. The most important are the high values of secondary ion yields for single atomic particles. These yields correlate fairly well with the bond ionicity degree, or with the effective charge on an atom. The next important feature is a correlation between maximum position of energy spectra of respective single atomic secondary ions and structural parameters of a target, namely displacement energy and chemical bonds rigidity.

Several additional peculiarities are observed for emission of cluster secondary ions.

Their yield drops sufficiently with the increase of number of atoms in a cluster. Such behavior as will be shown in the present work may be described by exponential dependence, which takes into account the *effective charge number* of a cluster and the degree of inner ionization of the cluster.

Experimental data, dealing with secondary ion emission from SiO_2-Si system and illustrating the mechanisms described here are presented.

BAND STRUCTURE ANALYSIS OF II-VI GROUP TERNARY COMPOUNDS WITH TRANSITION METALS

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The problem of the electronic structure of the II-VI semiconducting ternary compounds with transition metals is still topical. To resolve this problem many experimental and theoretical approaches were used. In this lecture our interest has been limited to the experimental analysis of the selected optical methods i.e. reflectivity of light and photoemission spectroscopy, which serve in the study of valence bands and X-ray Absorption Near Edge Structure (XANES) and Bremstrahlung Isochromat Spectroscopy (BIS) collecting information on the density of states of conductivity bands. These experimental approaches are compared with LMTO theoretical band structure calculations.

QED THEORY OF DEFORMATION OF THE RADIATION ATOMIC LINES IN STRONG LASER FIELD. MULTIPHOTON RESONANCES

A.V. Glushkov

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A quantum-electrodynamical (QED) approach is utilized for studyng the interaction of the atom with the laser field. Method bases on a description of atom in the field by the k- photon emission and absorption lines [1,2]. The lines are described by their QED momenta of different orders which are calculated with the use of the Gell-Mann & Low adiabatic formalism. To calculate the values m, we use the Gell-Mann and Low adiabatic formula for the Lorentz & Gauss (there are considered the cases of the single-, multimode, coherent, stochastic) laser pulse shape. An account for the stochastic fluctuations in a field effect is of a great importance. Results of the calculation for the multiphoton resonance and multiphoton ionization profile in the H, Na,Cs atoms are presented. It is studied the phenomenon when an energy spectrum liberated in the high intensity multiphoton ionization exhibits succession of peaks separated by photon energy (above threshold ionization). Efficiency of method is demonstrated by calculating two-photon ionization cross-sections and photoelectron angular distribution for extended photon energy range (including above-threshold ionization) in magnesium. Comparison with the eigenchannel R-matrix calculations of Luc-Koenig et al [3] is given. There is considered a phenomenon of the Rydberg stabilization of the H atom in a strong laser field and estimated the rate of transition between the stabilized Rydberg state (n=40, m=2; E~10(8)V/cm) and ground state, when it's possible the radiation of photons with very high energy(the short-wave laser amplification). There are presented the generalization of method for description of the multiphoton processes in molecules. Preliminary results for some molecules are considered. It has been developed the consistent QED theory for the Relay and Raman vibration scattering of the light on the metastable molecular levels. As example the H_2, HD, D_2 molecules are considered. The polarizability estimates and depolarization degree under Relay and Raman light scattering on the frequencies of Nd and Rb lasers are presented.

References:

[1] A.V.Glushkov and L.N. Ivanov, Phys.Lett.170 33 (1992); Preprint ISAN, AS-2, Troitsk, 1994; J.Techn.Phys. 38 211,219(1998).

[2] A.V.Glushkov amd L.N. Ivanov, J. Phys.B.:Atom.Mol.Opt.Phys.26, N16 L386 (1993);); Preprint ISAN, AS-3, Troitsk, 1994;

[3] E.Luc-Koenig , A.Lyras, J-M.Lecomte , M.Aymar , J.Phys.B. 30 5213 (1997).

[4] V.S.Letokhov, Nonlinear Selective photoprocesses in atoms and molecules.- Moscow, 1983.

THEORY OF ELECTRON-MOLECULE COLLISIONS IN THE SUB-meV RANGE

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Low-energy electron-molecule collisions are strongly affected by long-range interactions and weakly bound or virtual states. The present paper discusses the role of these states in the processes of rotational deexcitation and dissociative electron attachment in the energy region below about 1 meV. In particular we analyze the role of dipole-supported states in collisions with HF and CH_3Cl molecules. Both molecules possess supercritical dipole moment that means that they can support bound states in the fixed-nuclei approximation. However, when rotation is included, these states turn into virtual states corresponding to S-matrix poles for each particular set of rotational quantum numbers. We analyze the position of these poles in the complex energy plane and their role in rotational deexcitation. The dipole-supported states can also play important role in dissociative attachment. A typical example is electron collisions with methyl iodide molecules where the cross section is enhanced by two orders of magnitude. Another important feature of low-energy attachment is a strong enhancement of the capture cross section due to polarization interaction. This can be described by the quantum-mechanical model for capture into polarization well developed by Vogt and Wannier [1]. We generalize this model for targets possessing permanent dipole moment and analyze its validity for several molecules.

This work was supported by the US National Science Foundation.

References:

[1] E. Vogt and G. H. Wannier, Phys. Rev. **95,** 1190 (1954).

EXPERIMENTAL STUDIES OF TRANSIENT MOLECULES

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The need for an accurate understanding of the interaction of electrons with molecular targets remains a crucial prerequisite for many areas of applied research and technology while providing academic researchers with considerable challenges both in laboratory studies and theoretical modelling.

One of the major research imperative in electron collisions in the next quarter century will be to increase our knowledge of the interaction of electrons with more complex targets, for example those short lived (unstable) molecular targets often classified as 'transients' since they provide drive much of the local site reactive chemistry.

Low energy collisions with molecules are difficult to model theoretically and hard to measure experimentally. Theoretically the problem arises because (a) the multicentred nature of the interactions which cannot be handled by a simple potential, (b) the need, for problems of interest, to treat many electronic states of the target molecule, (c) many dissociation and excitation processes occur outside the standard Born-Oppenheimer approximation. These problems are particularly exacerbated for polar .open shell and free radical species as even modelling the target wavefunctions for these species is difficult. Hence it is unlikely that theoretical models will be able to provide the data required by the applied community, thus the emphasis is placed upon the experimental community to provide fundamental data upon electron interactions with transient/reactive molecular species. However to date few experimental groups have been able to combine the synthesis techniques needed to produce such transient species with current collisional apparatus.

In this talk I will review recent scattering experiments from reactive, transient molecules illustrating the techniques developed by describing recent low energy electron collision dynamics with the transient (polar/radical) species O_3; OClO; Cl_2O; ClO and NO_2 (all important molecules in the Earth's stratosphere) and discuss how these techniques may be used to study other transient species important in astrochemistry, technological plasmas and the life sciences.

STRUCTURAL TRANSFORMATIONS IN AMORPHOUS NANOLAYERED CHALCOGENIDE FILMS

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Size restrictions and quantum-size effects in artificial nanostructures have been extensively investigated within last decades with a view to the fundamental problems of electron spectra, electron or mass transport, optical properties and their applications in materials science, electronics. Amorphous or amorphous-crystalline, one- two- and three-dimensional semiconductor nanostructures (first of all based on a-Si:H) became important besides the typical crystalline GaAs/AlGaAs superlattices.

Amorphous nanolayered films containing 3-6 nm thick sub-layers were produced with success on the basis of a-Se, AsSe, As_2Se_3, As_2S_3, Se_xTe_{1-x} or similar glasses and used for fundamental investigations of the photoinduced structural transformations, hologram recording [1,2]. Two main groups of problems in theoretical and experimental investigations of these films are as follows: i) electron energy spectra and related optical, electrical properties and ii) material structure dependence on the thickness, technology conditions and external influences.

The first group of the problems were examined with respect to the "blue shift" of the fundamental absorption edge, changes in the reflection, absorption and refraction of the material, especially during light- or heat treatment of the nanostructure.The second-type problems are connected with the change of the internal energy of the system, phase transitions, diffusion and stress relaxation.

Both groups of problems have been demonstrated in the developed amorphous nanolayered films. The photo- and thermoinduced changes of optical parameters (due to the laser irradiation with different intensities) were especially investigated and the mechanism of structural transformations was connected with amorphous-amorphous or amorphous-crystalline transitions, as well with interdiffusion and related intermixing, stress relaxation in the given nanolayered structure.

These results were used for the development of possible mechanisms of optical recording with surface deformations, for the optimization of the recording process and resulting parameters of the recording materials.

References

1. Kikineshi A., Optical Engineering, **34**, 1040 (1995).
2. Palyok V., Mishak A., Szabo I., Beke D.L., Kikineshi A., Appl.Phys. **A68**, 489 (1999).

INELASTIC INTERACTION OF ELECTRONS WITH ATOMS, MOLECULES AND CLUSTERS: ATTACHMENT CROSS SECTIONS AND APPEARANCE ENERGIES

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Electron impact ionization and electron attachment is an important tool in the study of atoms, molecules and clusters, in particular concerning the production and identification of the corresponding cations and anions in mass spectrometry and related studies about the properties of these ions (determination of cross sections, fragmentation patterns, structure, reactivity, energetics, etc.). Details of these properties are of importance for modelling and diagnostic purposes in a variety of fundamental and applied fields including plasma physics and chemistry, atmospheric and interstellar physics, environmental sciences, etc.

With the recent progress concerning high resolution electron guns (achieving well monochromatized electron beams with appreciable currents allowing to study also reactions with small cross sections close to the ionization onset) it is now also possible to perform high resolution measurements with electrons on rather elusive species such as atomic or molecular clusters. Particular successful examples for investigations along this line are recent electron attachment studies in our laboratory using a high resolution trochoidal electron monochromator which allowed us to measure vibrationally resolved electron/cluster attachment spectra for oxygen [1,2] and nitric oxide clusters [3,4] thus obtaining quantitative information about the underlying attachment reactions (attachment mechanisms, energetics, cross sections). Moreover, we have also investigated recently electron attachment to H_2 [5] and O_3 [6] molecules and N_2O clusters [7] using a high resolution hemispherical monochromator in an attempt to solve open questions concerning the details of the corresponding cross sections curves for dissociative electron attachment.

In addition, we have applied this new generation of high resolution crossed electron/molecular beam type machines to the investigation of the electron ionization near threshold (determination of appearance energies) of various molecules (O_3 [8] etc.) and clusters (including rare gas clusters [9], H_2 clusters [9] and N_2O clusters [10]).

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[1] S.Matejcik, A.Kiendler, P.Stampfli, A.Stamatovic and T.D.Märk, Phys.Rev.Lett., 77 (1996) 3771. **[2]** S.Matejcik, P.Stampfli, A.Stamatovic, P.Scheier and T.D.Märk, J.Chem.Phys., 111 (1999) 3548. **[3]** Y.Chu, G.Senn, P.Scheier, A.Stamatovic, T.D.Märk, F.Brüning, S.Matejcik and E.Illenberger, Phys.Rev., A57 (1998) R697. **[4]** Y.Chu, G.Senn, S.Matejcik, P.Scheier, P.Stampfli, A.Stamatovic, E.Illenberger and T.D.Märk, Chem.Phys.Lett., 289 (1998) 521. **[5]** H.Drexel, G.Senn, P.Scheier, A.Stamatovic, N.J.Mason and T.D.Märk, Contributions SASP 2000 (D.Bassi and P.Tosi, Eds.), Folgaria (2000) PA-8. **[6]** G.Senn, J.D.Skalny, A.Stamatovic, N.J.Mason, P.Scheier and T.D.Märk, Phys.Rev.Lett., 82 (1999) 5028. **[7]** G.Hanel, T.Fiegele, A.Stamatovic and T.D.Märk, Int.J.Mass Spectrometry, in print (2000). **[8]** D.Muigg, G.Denifl, T.Fiegele, N.J.Mason, A.Stamatovic and T.D.Märk, J.Chem.Phys., in print (2000). **[9]** T.Fiegele, G.Hanel, M.Rümmele, I.Torres, M.Stano, A.Stamatovic, P.Scheier and T.D.Märk, Contributions SASP 2000 (D.Bassi and P.Tosi, Eds), Folgaria (2000) PB-4. **[10]** G.Hanel, T.Fiegele, A.Stamatovic and T.D.Märk, Z.Phys. Chemie, in print (2000).

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LABORATORY ASTROPHYSICS WITH HIGHLY CHARGED IONS USING AN X-RAY MICROCALORIMETER

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Highly charged ions in nature are created under extreme conditions, mostly in hot plasmas of different astrophysical environments. Plasmas of special interest are found for example in the magnetically heated coronae of late-type stars, the bubbles of gas heated by supernovae, the halos of elliptical galaxies, the nuclei of active galaxies, and the vast regions in galaxy clusters.

Recently new X-ray telescopes and spectrometers were sent into space aboard satellites (e.g. ASCA, Chandra and XMM-Newton) to study X-rays emitted by cosmic sources. These measurements are used to determine the temperature distribution, density, ionization state, and elemental composition of hot astrophysical plasmas. Although, the determination of the physical parameters that define the plasma relies on complex models of the continuum and line emission, there are only rare cases where the theoretical atomic physics data are adequate with the accuracy achievable with the new X-ray space instruments. To achieve the best scientific interpretation of the data from Chandra, XMM-Newton and ASCA, theoretical calculations must be verified or modified by the results obtained from spectroscopic measurements in the laboratory.

An excellent way to study the behavior of highly charged plasma ions is to confine them in an Electron Beam Ion Trap (EBIT). The EBIT produces customized, well-characterized plasmas suited to a wide variety of precision measurements. The manipulation of the plasma conditions in the EBIT can generate a comprehensive database for comparison with theoretical atomic physics calculations. We used a cryogenic X-ray microcalorimeter to conduct a spectroscopic survey of astrophysically relevant plasma ions in the EBIT at the National Institute of Standards and Technology (NIST). The X-ray microcalorimeter combines the broadband capability and high throughput of the semiconductor ionization detectors with a resolving power approaching that of a Bragg crystal. Single X-ray photons absorbed in the microcalorimeter are converted into heat causing a temperature rise proportional to the X-ray energy. It is an ideal instrument for EBIT plasma studies.

In this talk the EBIT-microcalorimeter instrumental combination will be discussed and an overview of the recently obtained data will be presented.

INVESTIGATION OF FORMATION AND ANNEALING OF RADIATION DEFECTS IN III-V SEMICONDUCTORS UNDER ELECTRON IRRADIATION

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III-V semiconductors are widely applied in modern engineering. Improvement of solid-state electronic devices operation is directly related to the studies of various structural defects in these materials, the presence of which determining their physical and operational properties. One of the most suitable ways for simulation of physical processes in defect crystals is electron irradiation, enabling both elementary point defects as well as more complex cluster-type aggregates to be introduced, depending on the irradiation conditions.

In optical absorption spectra of electron-irradiated III-V crystals additional absorption in the near-edge range is revealed due to large-scale spatial fluctuations of potential caused by strongly compensated radiation defect levels and disordered areas. The analysis of the frequency dependence of free-carrier absorption in $InAs_xP_{1-x}$ has shown an additional free carrier scattering mechanism in the irradiated samples, resulting in the increase of the absorption cross-section $\sigma = \alpha/n$ and the decrease of the power index in the frequency dependence $\alpha \sim \nu^{-r}$ and being caused by local deformational fields.

The studies of the radiation defect thermal stability have shown that in all the materials under investigation the radiation defects are partly mobile already in the process of irradiation at 78 K, hence the resulting stable radiation defects being the complexes containing the impurity atoms.

The thermal stability of the radiation defects is shown to depend not only on the electron energy, but on the irradiation dose as well. At the dose increase the annealing stages are observed to shift to higher temperatures; in the course of annealing new complex defects are formed, annealing at higher temperatures.

THE EFFECT OF ELEMENTARY PARTICLES EMISSION AT THE HEAVY NUCLEI FISSION FRAGMENTS MASS DISTRIBUTION

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The mass and charge distribution (MCD) of fission products is a fundamental characteristic that defines the peculiarities of heavy nuclei fission and allows one to study the influence of shell effects and initial nucleus excitation energy on that process. In the case when fission product sets create a canonical ensemble, MCD is defined by the probability of their realization and can be described within a framework of statistical thermodynamics.

In the present paper, the data on the MCD calculation are given both with and without the inclusion of nuclear particles emission: neutrons (n), electrons (β^-) and positrons (β^+). Calculations were carried out at the example of the uranium isotopes. The 2- fragments fission model was applied assuming the emission of 6 to 8 nuclear particles of each sort. When calculating the entropy term the statistical non-equivalence of nucleons present in different products has been taken into account.

The MCD calculation was performed for the uranium isotopes at the following assumptions:

The 2-fragment cluster and fission product (n, β^- and β^+) set is a canonical ensemble taken at the same temperature. The nucleon temperature is defined by the character of the initial nucleus excitation;

Elementary particles emission may effect the internal energy of clusters.

MCD for U236 is analysed in detail at different approximations of nuclear binding energy calculation with the use of the experimental values. A role of fission products with magic nucleons number and that of the initial nucleus excitation energy in the formation of heavy nuclei fission mass channels is discussed.

INFLUENCE OF METAL-SUBSTRATE INTERACTION ON MECHANISM OF CO ADSORPTION ON ALUMINA SUPPORTED PALLADIUM PARTICLES: XPS AND TDS STUDIES

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The adsorption of carbon monoxide on small alumina supported Pd particles has been studied by temperature programmed desorption (TPD) using molecular beam techniques and X-ray photoelectron spectroscopy (XPS). The results showed clearly different surface properties of clusters deposited on a- and g- alumina substrates. The XPS studies of Pd binding energy variation as a function of Pd particle morphology showed the different metal-substrate interaction (MSI) effects for both substrates. The CO-Pd interaction was investigated using C Is photoelectron spectra that exhibited two CO-related components. The CO dissociation was monitored as a rise of C Is signal at 285 eV while the molecularly adsorbed CO exhibited the intensity at 287 eV. The TDS method was used for the investigation of Pd particle size dependent variations of CO desorption activation energy and the CO dissociation activity (via $C + CO = CO_2$ reaction), respectively.

The effect of partial CO dissociation was observed in the case of Pd deposited on g-alumina, but not in the case of small Pd particles prepared on a-alumina substrate. The XPS results explained this behavior as an effect of MSI related to the cluster - substrate charge transfer.

ELEMENTARY PROCESSES AND PHENOMENA STIMULATED BY THE SLOW ELECTRON COLLISIONS

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The report will deal with the survey of experimental research on the studies of elementary processes and phenomena in atomic systems stimulated by slow (0-20 eV) electron collisions. The basic principles of experimental technique will be presented: the electron and atomic beam sources, the electron monochomators and analyzers, the methods of measuring the total and differential scattering, excitation and ionization cross sections, the problems of absolute scattering cross-section determination.

In addition, the most interesting data on the total scattering cross sections, excitation of the spectral line and energy level excitation, near-threshold ionization of atoms and the lower (metastable) level excitation some atoms will be discussed.

Among the phenomena observed in the electron collisions, the threshold scattering features will be considered at the example of the II group atoms, the role of the processes of the formation and decay of the negative-ion states (resonances), autoionizing atomic states and their contributions to the different elementary processes, as well as the post-collision interaction of scattered and ejected electrons will be discussed.

And, finally, the recent results on the electron scattering by single-charged ions and solid surfaces will be presented.

ACCOUNT OF THE TWO ELECTRON CORRELATIONS IN THE TWO-ELECTRON NEAR-THRESHOLD PHOTOIONIZATION

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Near-threshold double photoionization of atoms by one photon is nowadays an 'overheated' topic for both experimental and theoretical physics. The contemporary experimental setups based on third-generation synchrotron facilities and position-sensitive detectors with very high resolution have made it possible to measure even absolute triple differential cross sections for such processes with energies and angles of both ejected electrons being fixed in coincidence. This experimental situation has provided a challenge for theoretical studies. Although the initial and final states of the two-electron system can be fully determined, keeping track of the dynamical effects in the system is quite difficult in the near-threshold region where the triple differential cross sections are formed due to the extremely subtle correlation between the ejected electrons. The role of such correlation was very well-known after the fundamental paper by Wannier [1]. Albeit the Wannier conclusion regarding the threshold behaviour of the total cross section for double ionization seems to be confirmed with a number of theoretical and experimental studies, the problem of calculation of angular distribution and energy sharing between the ejected electrons is still on agenda of theoreticians. In this report a brief presentation of a novel approach [2,3] for complete ***ab initio*** calculation of the triple differential cross section is given. This approach unites the accurate R-matrix calculation of the electron pair wave function in a certain vicinity of the nucleus with the semiclassical routine [4] used for propagation of the wave function in the external region. The calculations do not contain any additional fitting parameters and give the results quite close to the experimental data. From the theoretical point of view, it is very important that in our latest calculations we have obtained the results which do not depend on the gauge used. This is achieved with very precise calculations of the electron pair wave function in the internal region. At the conference some new results of the calculations will be presented.

References:

1. G.H. Wannier. Phys. Rev. 90, 817 (1953).
2. L.Malegat, A.K.Kazansky, P.Selles. J.Phys.B 32, 4667 (1999).
3. L.Malegat, P.Selles, A.K.Kazansky. Phys.Rev.A 60, 3667 (1999).
4. A.K.Kazansky, V.N.Ostrovsky. J.Phys.B 27, 447 (1994).

ANALOGIES IN THE IONIZATION MECHANISMS INDUCED BY PHOTONS AND FAST IONS

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An overview is given over fundamental properties of ionization mechanisms by particles impact. The analogies between the interactions of photons and fast ions with matter are elucidated. The discussion is focused on the target atom Li which has a tightly bound 1s orbital and a weekly bound 2s orbital. Single ionization of the 1s and 2s orbitals as well as double vacancy production in the 1s orbital are studied. Experimental cross sections for single electron emission were determined in collisions of 95-MeV/u Ar^{18+} projectiles for electron energies ranging from 3-1000 eV and angles ranging from 25^0 – 155^0. Models based on the Born approximation are introduced to separate two- and three-body effects, which can be attributed to characteristic properties of ion and photon impact. Pointing out analogies in the impact by photons and ions, the two- and three-body processes are associated with Compton scattering and photoabsorption, respectively. The cross section for three-body collisions rapidly decreases with the electronic energy transfer involving a power law with an exponents of -3.5 in accordance with the corresponding photoabsorption cross sections. Two-body effects dominate at high electron emission energies. Remarkably large contributions from two-body collisions were also observed for the low-energy emission. For double vacancy production of the 1s orbital, sequential interactions of the projectile are considered. Furthermore, shake mechanisms and dielectronic processes produced by dynamic electron correlation are taken into consideration. Experimental results for fast ion impact and synchrotron radiation are suitable tools to obtain information about the importance the different mechanisms for double 1s vacancy production.

MOLECULAR SPECTROSCOPY PROBED BY SYNCHROTRON RADIATION AND ELECTRON SCATTERING

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Molecular spectroscopy is fundamental to many aspects of atmospheric and astrophysical science. Measurements of basic physical parameters in planetary atmospheres and in the interstellar medium (ISM), such as temperature, wind fields and number densities of the constituent gases, use remote sensing techniques. The raw data is typically a measurement of the intensity of the electromagnetic radiation emitted by the molecules themselves, or transmitted through the molecular environment from an external source such as the Sun. Monitoring instruments may produce spectra, as in the UV spectrograph on Hubble, or intensities of radiation over a relatively broad band, such as recorded by weather satellites. In all cases the required physical parameters of the molecular environment cannot be derived from the raw data unless spectroscopic knowledge of the molecules themselves (in appropriate physical conditions) is available. The construction of a 'Spectral Atlas' is therefore essential to our understanding of atmospheric and astrophysical sciences. However at present our knowledge of the spectroscopy of many molecular systems is incomplete, particularly in the UV spectral region.

In this talk I will review how modern experimental techniques using synchrotron radiation and electron impact are providing fundamental information on the UV spectroscopy of those molecules playing a key role in current environmental research and astrophysics. Opportunities for new research utilising recently developed apparatus will be outlined and a discussion given of the importance of UV spectroscopy in the new scientific discipline of astrobiology (and the search for possible existence of extraterrestrial life).

CREATION OF THE HETEROJUNCTION AND PERIODICAL STRUCTURES IN SOLID SOLUTION BY LASER ANNEALING

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A method using laser of segregation of impurities or interstitial mercury atoms (IMA) in solid phase $Hg_{0.8}Cd_{0.2}Te$ (MCT) is presented [1-2]. A theoretical model for this process is also proposed. The equation for the diffusion of impurities or IMA was completed by a term describing the influence of phonon flux on diffusion process.

Computer simulation of the laser annealing process reveal the possibility of obtaining a sharp maximum of Hg concentration for appropriately chosen parameters of laser pulse.

This was verified experimentally with MCT specimens annealed by using a YAG: Nd3+ laser 2. Photoresponse and voltage-ampere characteristics show that heterojunction is created in laser annealed HgCdTe [3].

Concentrations of Hg, Cd, Te as a function of the depth from the irradiated surface, for samples with the same composition, but with different initial concentration of intrinsic defects (vacations and interstitial Hg atoms) were measured before and after laser annealing. Unexpected oscillations regularly repeated in each sample can be noticed. The possibility of interpreting these results based upon the thermodynamic theory of decomposition of solid solution having two thermodynamic potential minima with different values has been considered [4].

References:

1. M.Kuźma, M.Pociask, A.Wal, E.Sheregii, J.Smela, Simulation processes of laser annealing of $Hg_{0.8}Cd_{0.2}Te$, *Modeling Simul. Mater. Sci. Eng.*, **2**, 329-336 (1994).
2. R. Ciach, M.Faryna, M.Kuźma, M.Pociask, E.Sheregii, Segregation of impurities and defects in $Hg_{0.8}Cd_{0.2}Te$ by laser annealing, *Thin SolidFilms*, **241**,151-154 (1994).
3. E.Sheregii, M.Kuźma, C.Abeynayake, M.Pociask, Creation of a p-n heterojunction in $Cd_xHg_{1-x}Te$ (x=0.2) by laser annealing, *Can. J. Phys.*, **73**,174-176 (1995).
4. R.Ciach, M.Faryna, M.Kuźma, M.Pociask, E.Sheregii, Oscillations of the composition of HgCdTe solid solution after laser annealing, *Journal of Crystal Growth*, **161**, 234-238 (1996).

IONISATION OF ATOMS BY HIGHLY CHARGED IONS AND STRONG ELECTROMAGNETIC FIELDS

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The following topics are discussed:

Similarity of ionisation processes (by HCI and SEF);

A single non-stationary approach for description of both processes;

- Gordon-Volkov-Keldysh states and their generalization for one-and two-electron continuum wave functions;

Complete and orthogonal set of basis wave functions, importance of orthogonality;

Close coupling equations including the continuum, unitarity of S-matrix;

- Single- and double- electron removal in collisions of atoms and negative ions with HCI, charge transfer and ionisation;
- Ionisation of atoms by SEF, role of close coupling effects in the continuum, physical model and related mathematics;
- Interactions of atoms with short and super short laser pulses;
- Comparison with experimental data available and other theories
- Future developments.

TERNARY ELEMENTAL ZINC BLENDE TETRAHEDRA SIZE, SHAPE, PREFERENCES AS DEDUCED FROM EXAFS OBSERVATIONS

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Zinc Blende (ZB) fcc $A_{C-x}B_xZ$ (or AY_xZ_{1-x}) ternary semiconductors present both fundamental and practical interest. They are currently studied by EXAFS and FIR lattice vibration. The talk presents a 5 axiom model to deconvolve EXAFS observations of the variation with dilution x of the average coordination number and average inter ion distance. Site occupation preferences (SOPs) were FIR reported for $GaAs_xP_{1-x}$ [1] and $CdSe_xTe_{1-x}$ [2]. EXAFS confirmed SOPs in quaternary GaInAsSb[3] and CdMnTeSe[4] and ternary ZnMnSe[5]; the three were discussed using our probabilistic model[6]. A new probabilistic approach[7] applied to ZB ternary compounds has been checked for the following GaInAs, GaAsP, CdZnTe, ZnMnSe, ZnMnS, ZnMnTe, CdMnTe, HgMnTe ternaries. In all ZB fcc ternary materials, of the five tetrahedron configurations two have regular binary tetrahedra, while the strictly ternary three preserve symmetries but are distorted. SOPs repeatedly reported in literature can be interpreted as differences of enthalpy of formation $^{AZ}\Delta_fH^0$ of the two binary constituents AZ and BZ, random distribution resulting when both are equal. Deconvolution of data retrieved from literature (12 articles covering 8 materials) is carried out assuming as per model axioms: ***1***) Weight biased $\{W_k\}$ Bernoulli binomial polynomials describe the populations. ***2***) NNN site fills are determined by the three NN SOP preferences of the Z ion. ***3***) Conservation at all dilutions of the total coordination number delimit the range of validity within the $\{0\le W_1\le 4; 0\le W_2\le 2; 0\le W_3\le 4/3\}$ space. ***4***) The 19 inter ion distances of the 3 ternary configurations and 7 pairs respect 9 tetrahedron constraints. ***5***) Relaxation of each configuration sublattice tetrahedron volume pair to common values (3 constraints). The reduction from 50 (=31+19) parameters to 10 (=3+7) degrees of freedom consents deconvolution of literature reported data. For the model credibility, validation is done at three levels. ***I***) Evaluated curves and corresponding *virtual crystal approximation* (VCA) curves are graphically compared with the 152 retrieved values and corresponding Vegard Law lines. ***II***) *Coordination number* curves evaluated from *distance observations* are graphically compared with those experimentally observed, giving credibility to SOPs derived from distances (universally observed) in the absence of direct observations. ***III***) Obtained SOP values reveal a direct correlation with i) Enthalpy of formation $^{AZ}\Delta_fH^0$ of component binaries value differences, ii) Configuration T_3 rejection in materials with monophase structure disruption (not attributable to odd magnetic coupling or superexchange in all 5 retrieved DMS's). Neither enthalpy nor disruption are *known* to the model.

References:

[1]. H.W.Verleur, A.S.Barker, *Phys.Rev.* **149** 715 (1966); [2] Ibidem **155** 750 (1967);
[3] Sh.M.Islam, B.A.Bunker, *Phys.Rev.Lett.* **156** 247 (1991),
[4] A.Kisiel et al. Acta Phys.Pol. A**90** 1032 (1996); J.Phys.IV France **7 C2** 1197 (1997);
[5] W.-F.Pong et al., *Phys.Rev.B,* **41** 8440 (1990-II);
[6] B.V.Robouch, A.Kisiel, Acta Phys. Pol. A **94** 497 (1998); and *J. Alloys Compounds* **286** 80 (1999); [7] Ibidem, submitted to *Phys.Rev.B1* (18.v.2000).

MODIFICATIONS INDUCED BY ULTRAVIOLET LIGHT IN NON-CRYSTALLINE CHALCOGENIDES

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Arsenic sulfide and arsenic selenide glassy samples with plane natural surface have been irradiated by ultraviolet light with the wavelength situated in the range 330 - 360 nm, for various time intervals and various temperatures: from room temperature up to glass transition temperature.

Structure of the non-irradiated and irradiated samples was investigated by X-ray diffraction.

Irradiation in ambient atmosphere leads to the formation of As_2O_3 (arsenolite) crystallites, which show a (111) crystallographic orientation at the sample surface. Some chalcogen effusion was revealed. The crystallization proceeds at around softening temperature and the non-stoichiometric crystalline phases are formed. For example, at the surface of As_2Se_3 bulk glass are formed AsSe crystallites.

The changes induced by thermal annealing and UV irradiation in complex glasses were interpreted in the frame of the structuro-chemical theory developed by Myuller.

ELASTIC AND INELASTIC ELECTRON SCATTERING BY ATOMS AND MOLECULES IN THE BACKWARD DIRECTION

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In this report progress made recently in the studies of electron scattering by atoms and molecules in the region of large scattering angles up to 180^0 will be presented. Measurements of elastic and inelastic scattering in the backward direction are important for determination of the respective differential cross sections over the complete angular range from 0^0 to 180^0. Such studies are especially significant in the developing adequate models for the short- and long-range correlation (polarization) and exchange interactions. It is also expected that new cusp structures and resonance negative-ion states will be discovered in observations of scattering under large scattering angles. In the report recent experimental developments, the electron-mirror spectrometer [1] and magnetic angle-changing technique [2,3] will be described. Results obtained for large scattering angles $120^0 - 180^0$ for elastic electron scattering by molecules [4,5], vibrational excitation [4], electronic excitation of helium [6] and resonance elastic [7,8] and inelastic scattering [9] will also be discussed.

References:

[1] K.R.Asmis and M.Allan, J.Phys.B **30**, 1961 (1997)
[2] M.Zubek, N.Gulley, G.C.King and F.H.Read, J.Phys.B **29**, L239 (1996)
[3] F.H.Read and J.M.Channing, Rev.Sci.Instrum **67**, 2372 (1996)
[4] M.Zubek, B.Mielewska and G.C.King, J.Phys.B in press
[5] H.Cho, R.J.Gulley and S.J.Buckman, J.Phys.B **33**, L309 (2000)
[6] D.Cubric, D.J.L.Mercer, J.M.Channing, G.C.King and F.H.Read, J.Phys.B **32**, L45 (1999)
[7] M.Zubek, B.Mielewska, J.Channing, G.C.King and F.H.Read, J.Phys.B **32**, 1351 (1999)
[8] B.Mielewska, G.C.King, F.H.Read and M.Zubek, Chem. Phys. Lett. **311**, 428 (1999)
[9] M.Allan, J.Phys.B **33**, L215 (2000)

COLLISIONAL PROCESSES INVOLVING NEGATIVE HYDROGEN IONS

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The recent interest in collisions involving negative hydrogen ions was mainly stimulated by the possible application of the energetic beams of H^- ions in the technology of auxiliary heating of magnetically confined fusion plasmas. One of the promising methods of neutralization of H^- ions necessary to obtain the beam of neutral hydrogen is based on the mechanism of electron detachment in collisions of H^- ions with multiply charged ions in the plasma neutralizer [1]. The following processes are quite important for the calculations of neutralization efficiencies and stability of H^- beam :

$H^- + X^{q+} \rightarrow H^0 + \ldots$
$H^- + X^{q+} \rightarrow H^+ + \ldots$
$H^- + H^0 \rightarrow H^0 + H^- + e^-$
$H^- + H^- \rightarrow H^0 + H^0 + 2e^-$
$H^- + e^- \rightarrow H^0 + 2e^-$
$H^- + e^- \rightarrow H^+ + 3e^-$

Rearrangement collisions of ions with neutral atoms have been studied in detail during the last decades. The experimental studies of collisions between negative and positive ions required development of crossed-beam and merged-beam techniques [1] which stimulated the development of reliable theoretical methods for calculations of various related cross sections in a wide range of collision energies and ion charge states. From the theoretical point of view negative hydrogen ions are "exotic" atomic species having very low ionization potential and the outer electron in many cases can be considered as being bound by a short-range forces. The theory presented in the present report makes extensive use of the methods developed in the theory of multiphoton ionization by a strong electromagnetic field [2]. Extension of these methods to the rearrangement collision problems [3,4] allowed to perform calculations of various cross sections in very good agreement with recent experimental data and to predict rather reliable scaling properties of some collision cross sections [5-7].

References:

1. F.Melchert, W.Debus, S.Kruedener, R.Shulze, R.E.Olson and E.Salzborn., Suppl. Z.Phys D21, S 249 (1991)
2. L.V.Keldysh, Sov. Phys JETP 20, 1307 (1965)
3. L.P.Presnyakov, D.B.Uskov, Sov. Phys JETP 59, 515 (1984)
4. L.P.Presnyakov, D.B.Uskov., Sov. Phys. JETP Letters 66, 22 (1997)
5. F.Melchert, M.Benner, S.Kruedener, R.Shulze, S.Meuser, K.Huber, E.Salzborn, D.B.Uskov and L.P.Presnyakov., Phys.Rev.Lett. 74, 888 (1995)
6. D.B.Uskov, Physica Scripta., T73, 133-136, (1997)
7. F.Melchert, E.Salzborn, D.B.Uskov, L.P.Presnyakov, C.Gonzales and J.H.McGuire., Phys. Rev. A 59, 4379 (1999)

ELASTIC AND INELASTIC ELECTRON SCATTERING BY ATOMS AND MOLECULES IN THE BACKWARD DIRECTION

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[1] K.R.Asmis and M.Allan, J.Phys.B **30**, 1961 (1997)
[2] M.Zubek, N.Gulley, G.C.King and F.H.Read, J.Phys.B **29**, L239 (1996)
[3] F.H.Read and J.M.Channing, Rev.Sci.Instrum **67**, 2372 (1996)
[4] M.Zubek, B.Mielewska and G.C.King, J.Phys.B in press
[5] H.Cho, R.J.Gulley and S.J.Buckman, J.Phys.B **33**, L309 (2000)
[6] D.Cubric, D.J.L.Mercer, J.M.Channing, G.C.King and F.H.Read, J.Phys.B **32**, L45 (1999)
[7] M.Zubek, B.Mielewska, J.Channing, G.C.King and F.H.Read, J.Phys.B **32**, 1351 (1999)
[8] B.Mielewska, G.C.King, F.H.Read and M.Zubek, Chem. Phys. Lett. **311**, 428 (1999)
[9] M.Allan, J.Phys.B **33**, L215 (2000)

ORAL PRESENTATIONS

SELECTIVE IONIZATION OF ATOMS AND MOLECULES BY ELECTRIC AND LIGHT FIELD. AUTOIONIZING RYDBERG RESONANCES IN HEAVY ATOMS. OPTIMAL ISOTOPE-SEPARATION SELECTIVE IONIZATION SCHEMES

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On the basis of the quantum mechanical perturbation theory calculations it has been considered the optimal scheme for the selective ionization of atoms method [1], based on the selective resonance excitation of atoms by laser radiation into states near ionization boundary and further autoionization decay of excited states under action of external electric field [2,3]. It's given the exact numeral solution for atomic autoionization under the external electric field action . There are presented the numeral data for autoionization of states with n=7-12 for the Rb atom in electric field (10(4) V/cm). There are presented the results of the theoretical study of the autoionization resonances (AR)in complex multielectron heavy atoms (rare-earth atom: Yb, Tm etc) in the external electric and laser field .There have been analysed the unusual especialities of their behaviour in a field, in particular, an effect of giant broadening of the AR widths in the relatively weak external field. There are considered 2 main channels for the AR decay. One of them is the traditional Beutler-Fano channel. Another one is a new decay type (the reorientational decay (RD) .An appreciable dependence of the RD velocity at the moderately weak (~100 V/cm) electric field has been analysed. Detailed information about the AR is needed to optimize the excitation and ionization of atom. The optimal scheme presumes the compromise between the high excitation probability and high decay rate that determines the lower and upper boundaries for AR decay rate. The use of the RD channel essentially increases the possibility of such a compromise. New possibilities of the optimization for the laser resonance ionization scheme with account of these effects are indicated. The problem of the search for optimal isotope-selective vibration levels excitation scheme (for UF6) is also considered [4].

References:

[1] V.S.Letokhov, Nonlinear Selective photoprocesses in atoms and molecules. - Moscow, 1983.
[2] A.V.Glushkov , L.N. Ivanov, J.Phys.B.26 L376-386 (1993).
[3] A.V.Glushkov, Ambrosov S.V., Malinovskaya S.V. J.Techn.Phys. 38 211 (1997).
[4] S.V.Ambrosov, Proc.25th EUCMOS, Caimbra, 2000.
[5] S.V.Ambrosov, I.M.Shpinareva, Abstr.EGAS 32, Vilnus (Litva), 2000; Proc. 5th ICAP, Firenze, 2000; Int.Conf."Atoms, Molecules, Quantum Dots in Strong Laser field", Pisa,2000.
[6] S.V.Ambbrosov, A.V.Glushkov, Chem.Phys.Lett., to be pubI.

ENERGY STATES AND THE TYPE OF THE GaAs/AlAs SHORT-PERIOD SUPERLATTICES

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Recently, the photoluminescence experiments at different pumping levels proved, that the asymmetric short-period superlattices (GaAs)n/(AlAs)m, n=2m, n<12 are materials with the direct forbidden gap [1,2].

We present results of our investigation of the energy states by the envelope function method which confirm our experimental data concerning the type of the superlattices [3]. To obtain sufficient numerical agreement with the experimental values of energies of interband transitions, we introduced an adjustable parameter in the boundary conditions.

The introduction of this parameter is based on the assumption that the lattice constant mismatch between input materials or some defects in the superlattice, which appear during its growth, may change the bottom profile of the well, which in turn may influence the energy states.

Our investigation of the photoluminescence polarization [4] and calculations show that the lattice constant mismatch is important for the GaAs/AlAs because it leads to the mixing of states for heavy and light holes, and changes the energy of interband transitions. However, the type of superlattice does not depend on the mismatch for the certain model of the boundary conditions in every considered superlattices.

References:

1. D.V. Korbutyak, S.G. Krylyuk, V.G. Litovchenko et all, Ukr. Fiz. Zh., **43**, 116 (1998).
2. V.G. Litovchenko, D.V. Korbutyak, S. Krylyuk, H.T. Grahn, and K.Ploog, Phys. Rev. B **55**, 10 621 (1997).
3. A.I. Bercha, D.V. Korbutyak, V.G. Litovchenko et all, in Proceedings of XXVIII International School on Physics of Semiconducting Compounds, Jaszowiec '99, Editor W. Szuszkiewicz, Polish Academy of Sciences, Warsaw 1999, pp. 70-72.
4. I.V. Bercha, A.I. Bercha, L.Yu. Kharkhalis, Functional Materials Vol.6, No.3, 514 (1999).

SILVER JUBILEE OF LASER-PLASMA INVESTIGATIONS IN UZHGOROD STATE UNIVERSITY

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In the report there are the results of twenty five years investigations of laser plasma conducted in "Laser Plasma Investigations" Laboratory founded in Quantum Electronics Chair in Uzhgorod State University.

The work carried out gave the possibility for the first time to:

1) conduct complex investigations of nano-second laser films deposition with simultaneous mass-spectrometer and probe control of the main process parameters.

2) use MCI (multi-charged ions) of laser plasma to investigate the light at its interaction with the surface.

3) investigate and widen laser mass-spectrometry possibilities that include: mass-spectrometry with the use of ion clusters, resonance and non-resonance absorption of irradiation, laser stimulated electron beams.

4) use pulse-periodic lasers on self-terminated transitions in mass-spectrometry, to create and prove experimentally the model of surface heating, to find and classify characteristic ionisation regimes and non-linear processes that accompany them.

5) propose and create analytical device of new generation i.e. laser mass-spectrometer- projection microscope and also to use QLA (quantum light amplifier) on the basis of Cu-vapour laser to investigate optical properties dynamics in laser irradiation range.

6) propose and realize the methods of production the complex and layered films, super-lattices and other from components of laser plasma and to create the processes models.

7) investigate processes that accompany illuminator's laser layers separation that the got results.

The ways and perspectives of the following scientific investigations are discussed.

MAGNETOPHONON SPECTROSCOPY OF $Zn_XCd_YHg_{1-X-Y}Te$

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MPR was observed on three samples of $Zn_xCd_yHg_{1-x-y}Te$ (ZMCT) (I-x=0.08 and y=0.11, II-x=0.12 and y=0.10, III-x=0.17 and y=0.08). The measurements were performed in pulsed magnetic fields. The second derivation of transverse magnetoresistance $d^2\rho_{xx}(B)/dB^2$ as a function of a magnetic field B was registered up to 6.5 T at different temperatures within the range of 77 – 200 K. The example of experimental records obtained for specimen III at temperature 99K are shown in Fig. 1. The structure of wide maximums – which are clearly visible on experimental curves, corresponds to four series of peaks. These series are connected with four kinds of phonons. Measurements Raman Spectra [1] of several compositions confirms three-mode behaviour of phonon spectra. The cluster mode has also been observed. 4 kinds of LO-phonons (of HgTe-like, CdTe-like and ZnTe-like sublattices and ZnTe-clusters) participate in the electron-phonon interaction.

From these general considerations it follows that the series *a* is caused by the absorption of LO-phonons of HgTe-like sublattice. The peak $a1^+$ is the strongest and the most distinguishable at 124 K≤ T ≤ 158 K, whereas peak $a1^-$ is most distinguishable at T > 158 K. These peaks are correspondent to their harmonics *a*2, *a*3 and *a*4 because *a*2, *a*3 and *a*4 are observed in the fields which are approximately equal to 1/2 B_0, 1/3 B_0 and 1/4 B_0, respectively (B_0 - resonance magnetic field for peak $a1^+$).

Calculating the theoretical positions of MPR-s peaks, we have applied the best fit procedure to the experimental positions of peaks $a1^+$ and $a1^-$, thus obtaining the value of energy E_g = 350 meV at temperature: T =99 K.

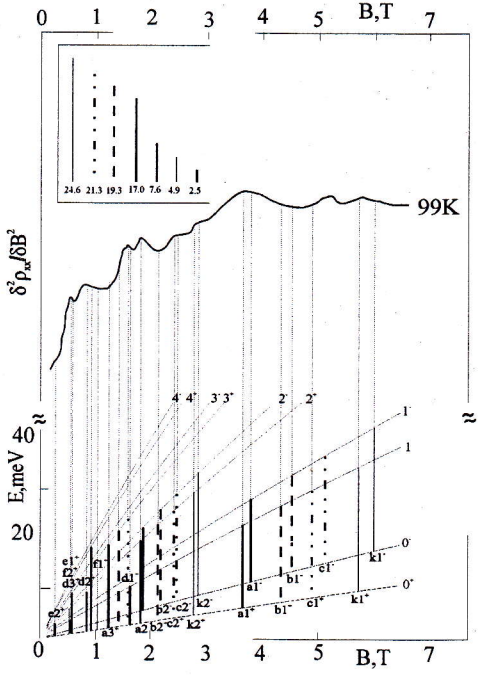

Fig.1. Experimental record of $d^2\rho_{xx}(B)/dB^2$. The electron transitions between Landau levels corresponding observed MPR's are shown lower. The inset shows the energy transitions appropriated to phonon energies or difference of phonon energies (the values are given in meV).

Now, it is possible to interpret another series of peaks, namely: *b, c* and *k*. Since the positions of peaks $b1^+$, $c1^+$ and $k1^+$ are characterised by a consequent increase in magnetic field, these peaks may be expected to be caused by electron transitions $0^+ - 1^+$ (Landau levels) with the assistant absorption of LO-phonons of consequently increasing frequencies. This sequence of increasing frequencies corresponds to the LO-phonons in CdTe-like, ZnTe-like sublattices and ZnTe-clusters. The interpretation of series *d, e* and *f* (magnetophonon resonance on the difference of phonon frequencies (MPR DPF)) is performed by using the values of phonon energies and band-structure parameters based on values of E_g equal to 350 meV . The theoretical positions of three kinds of MPR DPF (on $\hbar\omega_{LO}$ (ZnTe-cluster)-$\hbar\omega_{LO}$ (HgTe-like), $\hbar\omega_{LO}$ (CdTe-like)-$\hbar\omega_{LO}$ (HgTe-like) and $\hbar\omega_{LO}$ (ZnTe-like) - $\hbar\omega_{LO}$ (HgTe-like) are shown by arrows 7.6, 4.9 and 2.5.

A conclusion can be drawn that there is a good agreement between the experimental positions of peaks of series *d, e* and *f* and MPR DPF attributed to them.

Reference:

[1] J. Polit, E.M. Sheregii, E. Szczecinska, J. Szczecinski, V.I. Ivanov-Omskii, *phys.stat.sol.(b)* **208**, 21 (1998)

INTERACTION OF LOW-ENERGY OXYGEN ION BEAM WITH SILICON SURFACE: TRANSITION KINETICS OF PHASE AND STRUCTURAL TRANSFORMATIONS

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A wide spectrum of secondary ions at the initial stages of near normal $O_2^+ \rightarrow$ Si sputtering was studied experimentally for *in situ* control of the ion-beam induced oxidation. Computer modeling was used to describe the secondary ion kinetics and to simulate the dynamics of structural and compositional changes in subsurface silicon caused by interaction with implanted oxygen. The model takes into account a detail mechanism of oxidation and allows us to obtain the Short-Range-Order statistics and phase content evolution under the surface. Such processes as ion beam mixing, (including ballistic relocation and chemically guided bounding), diffusion, sputtering, phase separation and oxygen segregation are considered in the framework of phenomenological quasi chemical approach. For crystalline silicon the model predicts the amorphisation of subsurface layer at definite fluence, which leads to the change of the mode of oxygen incorporation into the matrix. We calculated the observed secondary yields as the sum of contributions from different atomic configurations: $Y^+(t) = \Sigma_p A_p W_p(z, t)|$. Here $W(z, t)|_{z=0}$ is a statistical weight of p-th configuration on the surface *under sputtering,* A_p is the partial yield i.e. the contribution of the p-th local atomic configuration (*precursor*) $Si\text{-}Si_{4-p}O_p$, (p = 0,1,2,3,4) to the total observed one. The relative values A_p were estimated from data processing for SiO_x films. Good accordance (Fig. 1) between theory and experiment is observed both for the slope of transient yield kinetics (within about 1.5-2 order of magnitude) and for characteristic time of transient stage. At the end of transient stage SiO_2^+ yield is about 10% higher then predicted. The last may be caused by enhancing role of dangling bonds ≡Si-O…-Si≡ (i.e. some lack of oxygen in SiO_x phase) in formation of large secondary $Si_nO_m^+$ clusters.

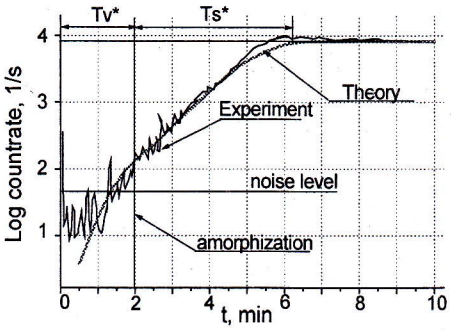

Fig. 1. SiO_2^+ yield kinetics. In calculations it is assumed that A_0: A_1 A_2: A_3: A_4= = 0:1:10:10:100 in equation for $Y^+(t)$

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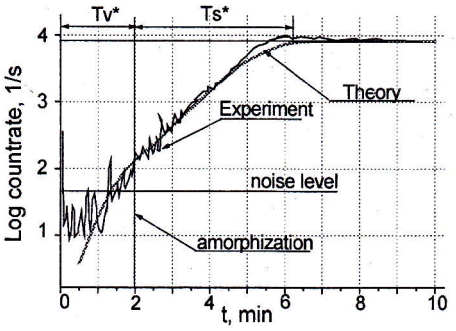

Fig. 1. SiO_2^+ yield kinetics. In calculations it is assumed that A_0: A_1 A_2: A_3: A_4= = 0:1:10:10:100 in equation for $Y^+(t)$

CONTINUUM RADIATION DURING ION BOMBARDMENT OF METALS

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The study of ion-photon emission during ion bombardment of metal surfaces remains an area of active research for purpose of understanding the basic collision mechanism leading to excited- state formation of escaping particles or collective excitations. At present time only one of the components of ion-photon emission (IPE) of metals is considered to be investigated sufficiently enough. This component is the radiation of spectral lines from excited secondary atoms and ions, which is produced when these particles escape from the surface. One more component of radiation is observed in IPE spectra. This is continuum radiation (CR), which consists of molecular bands or wide continuum. Evidently this radiation is emitted by complex molecules M_nX_m type, where M is target atom and X is an atom of adsorbed gas. The indexes n and m point the number of atoms in molecules. It was found that there was no band emission of molecules when the target surface was not covered by adsorbed particles. In this cases it was observed only weak band radiation of Mo_2 and Nb_2 dimmers.

The component of IPE which is conditioned by the radiation of the surface itself, i.e. ionoluminescence, has not been practically studied yet. Only in the case of ion bombardment of Ag, Al and Mg was founded radiation of surface plasmon. An apart from of singularities of a spectrum, the angular, energies, polarizing performances of this radiation are investigated Especially for silver surface the influence of a coverage by oxygen adatoms on the form of a spectrum and intensity radiation of surface plasmons is revealed force. Is established, that the excitation of surface plasma oscillations of electrons happens in an outcome of a neutralization processes of a bombarding ion by electrons of conduction band of the target. As the energy of surface plasmon of silver is rather small (~3,6 eV) between other metals, plasmon radiation of silver surface was observed by us during bombardment by various ions, except K^+. In the case of bombardment by ions of a potassium, the energy transmitted to electrons of conduction bands in an neutralization processes, is insufficient for excitation of silver surface plasmons. The most interesting experimental results of investigation of broad band emission and continuum radiation will be discuss in the report.

RELATIVISTIC MODELS IN DYNAMICS OF INTERACTION FOR ATOMS, ATOMIC IONS, MOLECULES ELECTRON SHELLS WITH NUCLEI NUCLEONS: NEW EFFECTS

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Paper is devoted to the studyng of the cooperative dynamical phenomena due the interaction between atoms, ions, molecules electron shells and nuclei nucleons. The following problems are considered: relativistic calculation of the mixed Y-optical quantum transitions; use of this effect in nuclear–atomic-molecular studies with use of lasers; spectroscopy of Y resonances, creation of additional satellites and narrow resonances inside the Doppler contour of Y-line; governing by the intensity of the complicated Y-transitions due to the changing of the molecular excited states population under action of laser radiation, relativistic quantum calculations of the complex "laser-electron-nuclei" systems [1-4].

Under emission or adsorption of the nuclear Y-quantum in atom or ion (molecule) there is changing of the electron (vibration-rotation molecular) states. Probability of the vibration or rotation state changing (in difference from the atomic electron state changing) is not small and must be taken into account even in '0' approximation [1]. We present the consistent QED approach to calculation of the electron-nuclear Y transition spectra (set of vibration satellites in molecule) of nucleus in atom and molecule. The intensities of satellites are defined in the relativistic version of the energy approach (S-matrix formalism) [3-4]. Decay and excitation probability are linked with imaginary part of the 'nuclei nucleons-electron shells-field' system. For radiate decays it's manifested as effect of retarding in interaction and self-action and calculated within QED perturbation theory. Calculation results of the electron-nuclear Y-transition spectra (set of electron satellites) of the nucleus in a multicharged atomic ion FeXIX are presented [4]. To calculate the spectra of the ion FeXIX the relativistic perturbation theory with model zero-th approximation has been used (version [5,6]). It's predicted situation when electron satellites are not overlapped by the Doppler contour of the Y line (plasma source) [4].

References:

[1] V.S.Letokhov, Laser Spectroscopy. N.-Y., 1977; Phys.Lett.A 46 (1974) 257.
[2] A.V.Glushkov, L.N.Ivanov, Phys.Lett.170 33 (1992); J.Phys.B.26 L376 (1993).
[3] A.V.Glushkov, S.V.Malinovskaya, J.Quant.Spectr.Rad.Transfer, to be publ.
[4].A.V.Glushkov, S.V.Malinovskaya, Proc.EGAS'32, Vilinius,2000; Proc. ICAP, Firenze, 2000; Proc.XXV Congr. on Molecular Spectroscopy, Caimbra, 2000;
[5].E.P.Ivanova, L.N.Ivanov, A.V.Glushkov, A.E.Kramida, Phys.Scr.,32, 524 (1985);
[6]. E.P.Ivanova, A.V.Glushkov, J.Quant.Spectr.Rad.Transfer, 36, 127-145 (1986).

ACCURATE QED PERTURBATION THEORY CALCULATION OF THE HEAVY AND SUPER HEAVY ELEMENTS ATOMS AND IONS Z=110-114 AND MULTI-CHARGED IONS STRUCTURE WITH ACCOUNT NUCLEAR SIZE EFFECT AND QED CORRECTIONS

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A consistent theoretical approach, based on the quantum electrodynamics (QED) perturbation theory is developed for investigation of the spectroscopic characteristics for heavy and super heavy atomic systems, multi charged and negative ions. Zero-th approximation is generated by the effective *ab initio* model functional, constructed on the basis of the gauge invariance principle. The wave functions zero-th basis is found from the Dirac equation with potential which includes the core *ab initio* potential, the electric and polarization potentials of a spherically symmetric nucleus the gaussian form of charge distribution in the nucleus and the uniformly charged sphere are considered). The correlation corrections of the high orders are taken into account within the Green functions method (with the use of the Feynman diagram's technique. There have taken into account all correlation corrections of the second order and dominated classes of the higher orders diagrams (electrons screening, particle-hole interaction, mass operator iterations). The magnetic inter-electron interaction is accounted in the lowest (on α^2 parameter), the Lamb shift polarization part - in the Uling-Serber approximation, self-energy part of the Lamb shift is accounted effectively with the use of the 'exact' calculation for H-like ions with point nucleus. The nuclear size effect is accounted in the electric and polarization potentials. Method is applied in calculations of the:

1) 1s(2)2lj,3lj,4lj energy levels for Li-like ions in interval (nuclear charge) Z=20-100;
2) energy levels, hyperfine structure intervals, E1-,M1-transitions amplitudes in heavy atoms of Cs, Sn, Pb;
3) energy spectra of the super heavy elements atoms with Z=110,112,114;
4) bond energies in heavy elements ions (Sn, Pb). Method developed is testing in comparison with methods [1-7].

References:

[1] L.N.Ivanov, E.P.Ivanova, E.V.Aglitsky, Phys.Rep. 164 317-372 (1988)
[2] E.P.Ivanova, L.N.Ivanov, A.V.Glushkov,A.E.Kramida, Phys.Scr. 32 512 (1985)
[3] A.V.Glushkov, E.P.Ivanova, J.Quant.Spectr.Rad.Transfer (US) 36 127 (1986);
[4] A.V.Glushkov, L.N.Ivanov Phys.Lett A. 170 33 (1992);
[5].A.V.Glushkov , JETP Lett. 55 108 (1992), .J.Phys.Chem. **65**,N9 (1991); **66,** N10 (1992); Optics and Spectr. **76**,N6 (1994); 84 , N5 (1998);
[6]V.A.Dzuba,V.V.Flambaum,P.Silvestrov,O.Sushkov, Phys.Rev.A 44 2828 (1991).
[7] W.R.Johnson, J.Sapirstein, S.A.Blundell, Phys.Scr.46 184 (1993).

FURTHER DEVELOPMENT OF MULTI-PARTICLE, MULTI-CHANNEL AND FIELD METHODS IN ATOMIC PHYSICS PROBLEMS

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A brief review of methods which during last ten years were intensively developed and used by the collaborators of the Department of Elementary Interactions Theory of the Institute of Electron Physics is presented. Among this methods we name the method of hyperspherical coordinates known in nuclear physics as the method of K-harmonics. For the exact quantum mechanical three-particle system, this method was used previously in the adiabatic approach (reducing it to an one dimensional equation) and after that it was used in more exact approach which reduces the method to a Sturm - Liouville problem in two dimensions. It is named also strong interacting channel, R-matrix, diagonalization, overlapping of configurations, optical potential methods and the functional density theory. The methods, named were used for precision investigations of atoms, positive and negative ions electron states structures. They were used also for description of such processes as photoionization, recombination, electron, positron and atomic collisions with different atomic systems.

A next brief review of same achievements in general field theoretical investigations is presented. These ones were dealing with some problems of constructing the QED in terms of field strengths (without potentials) with wide classes of symmetries of some field equations, with different relationships between the Dirac and Maxwell equations. The main interesting consequence of the connections mentioned is following: the states of the bosonic object - the system of specifically connected electromagnetic and scalar fields - exactly reproduce all the states of the fermionic object - the massless spinor field. The last result was a basic one for the purely classical electrodynamical model of atoms.

Some details about the results mentioned here are the subjects of reports of collaborators of the Department of Elementary Interactions Theory.

SPIN EFFECTS IN QUARKONIA

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The spin – spin mass splitting and leptonic decays of heavy and mixed mesons are described within a good accuracy in the potential model with screened potential. We conclude that the long – distance part of the potential cannot be pure scalar and that a vector – scalar mixture is favoured. With the same parameters which give correct average mass spectrum excellent spin – spin splittings of heavy quarkonia is obtained. The results are obtained by going beyond usually used perturbation method, namely using "configuration interaction approach". It is known, that the first term of CIA method is in fact just a perturbative method result. CIA expansion better takes into account the interaction between particles. A similar approach was suggested in paper [1], where expansion was carried in basic function of oscillator potential. The suggested method is of considerable interest, since the perturbation method is still used as the practical method [2–4]. We turned to use realistic potential, namely, screened potential. The concrete form of such screened potential was previously suggested in [5].

We choose screened potential, because it gives excellent description of mass-spectrum in nonrelativistic potential models for heavy mesons. As pointed out [6] the QCD calculations on lattice indicates that the spin-spin forces are rather short range. Exactly the screened potential satisfies this condition.

1. I. M. Narodetskii, R. Ceuleneer, C. Semay J. Phys. G: Nucl. Part. Phys.18, 1901 (1992).
2. T.Mat- suki, T. Morii Phys. Rev. D, Vol 56, №9, (1997).
3. L. Burakovsky, T. Goldman Phys. Rev. D,Vol 57, №5, (1998).
4. A. M. Badalyan J. Nucl. Phys. Vol 46, №4(10), (1987).
5. Z.Chikovani, L. Jenkovsky, F. Paccanoni, Mod. Phys. Lett. 6A, 1401 (1991).
6. S.Gerasimov, Proceedings of the International Conference "Hadron Structure-98", Stara Lesna, Slovak Republic, 7-13 Sept. 1998, p.179.

THRESHOLD PECULIARITIES OF ELECTRON-IMPACT DISSOCIATIVE IONIZATION IN POLYATOMIC MOLECULES

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Present paper deals with the results on the systematic studies of ionization and dissociative ionization of polyatomic molecules by slow (E=10–120 eV) electrons. The experiments were carried out in the crossed electron and molecular beams by means of a mass-spectrometric technique using the quadrupole mass-analyzer.

The energy dependences of ion yield resulted from the interaction of electrons with complex molecules differing in the isotope composition (i.e. H_20 and D_20; C_6H_6 and C_6HD_5; C_5H_5N and C_5D_5N) have been measured with the 1.3 eV energy increment, while their threshold areas – with the enhanced 0.26 eV energy step.

The use of the double-differentiation technique has allowed the threshold energies of ion product appearance to be determined with the 0.5 eV energy resolution. For all the ion fragments produced the threshold energies for the deuterated product appeared to be less than those for the protonated ones.

The possible mechanisms of such shift in the threshold energies should be discussed in detail at the conference.

THE ADIABATIC THREE-PARTICLE SHELL-MODEL OF NUCLEUS

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Taking into account the pairing effects of one kind nucleons in the theory of nucleus of, which play the important role in forming the excited states of nuclei, for example, so-called superconductive states of nuclei of ret. [1,2] and investigation of angular and radial correlations of nucleons leads to the necessity in calculation method for stationary states, which going out of framework of traditional singleparticle approximation of Hartree-Fock type.

The hyperspherical adiabatic approach (HAA) was suggested in papers [3-5] for using for these purposes, which is yield from the framework of single-nucleon approximation.

The energy spectrum of stationary states of nucleus in the framework of new adiabatic threeparticle shell-model of nucleus in which the middle selfconjugated field is modelling by Woods-Saxon potential with taking into account spin-orbital interaction of two valence nucleons is found after corresponding choosing in ret. [3,4] of hypershperical basis and separation of angular variables $\{\alpha, \theta_i, \varphi_i\}$ by method of numerical solution of the system of coupled differential equations for radial functions $F_\mu(R)$

$$\left\{-\frac{d^2}{dR^2}-\frac{1}{4R^2}+U_\mu(R)-2E\right\}F_\mu(R)+\sum_{\mu'}\left\{H_{\mu\mu'}(R)F_{\mu'}(R)+Q_{\mu\mu'}(R)\frac{d}{dR}F_{\mu'}(R)+\frac{d}{dR}\left[Q_{\mu\mu'}(R)F_{\mu'}(R)\right]\right\}=0 \qquad (1)$$

The adiabatical potential terms of nucleons $U_\mu(R)$ and corresponding basis functions $\Phi_\mu(R,\Omega)$ are found with the help of numerical solution of the system of coupled differential equations on the hyperangle α

$$\left[\frac{d^2}{d\alpha^2}-\frac{l_1(l_1+1)}{\cos^2\alpha}-\frac{l_2(l_2+1)}{\sin^2\alpha}+U_\mu(R)\right]\varphi^{(\mu)}_{j_1j_2l_1l_2}(R,\alpha)+R^2\sum_{j_1'j_2'l_1'l_2'}V^{j_1j_2l_1l_2}_{j_1'j_2'l_1'l_2'}(R,\alpha)\varphi^{(\mu)}_{j_1'j_2'l_1'l_2'}(R,\alpha)=0 \quad (2)$$

In equation (2) the explicit form of matrix elements of potentials is presented in ret. [3-5]. The residual interaction of valence nucleons is modelling by the zero range potential with taking into account of their repulsion on small distances for the simplification of the procedure of numerical calculations. The theoretical calculations presented in ret. [5-7] are well correlated with the existing experimental data of ret. [8].

References:

1. Bogolyubov N.N. The Reports of Acad. Sci. USSR, 1958, v.119, №1, p.52-55.
2. Solovjov V.G. The Influence of coupled correlations of superconductive type in characteristics of atomic nuclei.- Moscow: Atomizdat, 1963.- P.76.
3. Kapustey M.M, Pojda V.Yu., Khimich I.V. Ukrainian Physical Journal, 1995, 40, №11, p.1166-1170.
4. Kapustey M.M, Pojda V.Yu., Khimich I.V. The Reports of National Academy of Sciences Ukraine, series of mathematics, 1995, №10, p.71-74.
5. Kapustey M.M, Pojda V.Yu., Khimich I.V. Ukrainian Physical Journal, 1999, 44, №11, p.1330-1336.
6. Kapustey M.M, Pojda V.Yu., Khimich I.V. Ukrainian Physical Journal, 43, №10, 1998, p.1215-1219.
7. Plekan R.M., Kapustey M.M, Khimich I.V. The Scientific bulletin of Uzhgorod State University, series of physics, 1999, №4, p.50-54.
8. ENSDF (National Nuclear Data Centre, Broukhaven National Laboratory, New York).

MEASUREMENT OF CROSS SECTION OF SUPERELASTIC ELECTRON SCATTERING FROM MAGNESIUM

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The given thesis depicts the essence of our experiments and the obtained results of superelastic electron scattering by metastable magnesium atoms within the limits of incident electron energy 0.5-3.0 eV for the scattering angle close to zero. The experiments have been carried out on conditions of crossed electron and atomic beams.

The monoenergetic beam of electrons was generated by trochoidal electron monochromator (TEM), constructed at the basis of [1, 2]. The heterogeneity og the beam TEM was $\Delta E_{1/2} \sim 0.1$ eV for energies 2 eV at the current force was $\approx 5 \cdot 10^{-8}$ A.

The analyzer of scattered electrons energies is of the retarding type. It is the system of three flat electrodes with round diaphragms. The middle electrode is given the retarding potential. The relative distribution of the analyzer at the 2 eV energy is equivalent to $5 \cdot 10^{-2}$.

The discharge way of excitation was used to obtain the beams of metastable magnesium atoms. The methodology of the obtaining of metastable atom beam is described in [3]. The parameters of the atomic beam in the region of its interaction with the beam of electrons were the following: the concentration of atoms of Mg in the states $3\,^3P_{0,2}$ and $3\,^1S_0$ was $\approx 6 \cdot 10^{15}$ m^{-3} and $\approx 5 \cdot 10^{16}$ m^{-3}, the angle divergence of the atomic beam was $\sim 8.7 \cdot 10^{-2}$ rad. The researches have been carried out at the vacuum $\sim 6.5 \cdot 10^{-6}$ Pa.

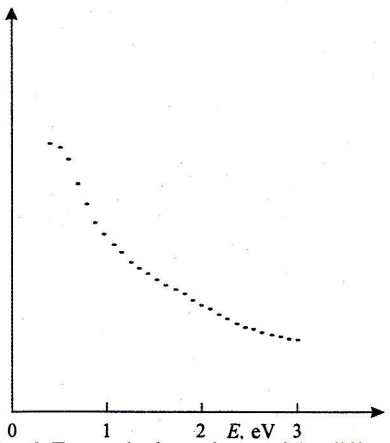

Fig. 1. Energetic dependence of the differential cross section of superelastic electron scattering by the metastable $3\,^3P_{0,2}$ states of magnesium atom

In the process of the experiments performed we have find out the energetic dependence of the cross section of superelastic electron scattering by the metastable magnesium atoms for the first time. Fig. 1 shows the results. The abscissa axis is the energy of electrons E in eV, the ordinate one is the value of Q cross section in the arbitrary units. Taking into account that the difference between the energies of the states $3\,^3P_2$ and $3\,^3P_0$ is 0.01 eV, it must be said that the result shown at Fig. 1 reflects the average cross section of superelastic electron scattering on the meta stable states $3\,^3P_{0,2}$.

References

[1] A. Stamatovic, G. J. Schulz, Rev. Sci. Instr. **41**, 423 (1970).

[2] O. B. Shpenik, V. V. Szoter, A. N. Zavilopulo, I. P. Zapesochny, E. E. Kontrosh, JETP **69**, 48 (1975).

[3] I. I. Shafranyosh, M. O. Margitich, Zeitsch. Phys. D **37**, 97 (1996).

DISCHARGE IN INDIUM IODIDE VAPOR FOR LASER ON IN 451.1 nm SELF-TERMINATING TRANSITION

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In the combination with the Cu-vapor laser in green and Au-vapor laser in red an effective blue laser on self-terminating transition can be useful to elaborate color projection systems with brightness amplifiers of images. But the Bi-vapor and Fe-vapor blue lasers tested till now do not satisfy the required average power and efficiency requirements.

An indium atom has an appropriate energy level structure, demonstrating the self-terminating transition 451.1 nm originated from an isolated resonance $6^2S_{1/2}$ level to the $5^2P_{3/2}$ metastable level. The quantum efficiency of this transition is more than 90%. But a small energy distance between the ground and metastable levels (0.274 eV) makes impossible to use pure indium metal probe as a lasant.

In our investigations aimed to search for the laser action on indium atom an InI salt was used. Discharge zone was confined by the 12 mm diameter ceramic O-rings and 40 cm long interelectrodes distance.

An integral in time emission spectra of discharge demonstrate the dominating feature – a prevailing role of the indium atom emissions. A→X and B→X molecular emissions of InI have also been observed. In the absorption spectra the X – A, X – B and X – C bands are observed. The resonance indium line 410.2 nm lies in the region of X – A transition absorbtion band.

Unfortunately, no laser action was obtained in spite of a great variety of experimental conditions used. Especially the pulse frequency was established in three different regimes: 100 Hz, 3-10 kHz and pulse sequences (series of 10-20 pulses with interpulse distance 100 μs repeated with 10 Hz).

The largest intensity of indium lines was observed at 300 °C tube temperature. The additional efforts might be undertaken to use another indium chemical compound ($InBr_3$) with lower working temperature (not more than 200 °C) and to shorten the pumping pulse duration.

THE MECHANISM OF PARTLY REGULARIZATION OF POSITIVE ION MOTION IN MONOCRYSTALS

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It is known that atoms and ions with an ordinal number Z_1, falling on a monocrystal plate at angles exceeding Lindkhard one (medium is considered to be quasiamorphic) and having velocity $v_0 < v < Z_1^{2/3}v_0$ (here $v_0=e^2/h$ is a Bohr velocity) at the first stage of a flight are loosing electrons and having a charge $Z_1^* \sim Z_1^{1/3}v/v_0$. Fulfilling the condition $2Z_1^* Z_2e^2/hv>>1$ (here Z_2 is a number of atoms media) we use classic mechanics for such particles.

For the angles $\theta \approx 2Z_1^*Z_2e_2/m_1v^2a << 1$ (m_1 is moving ions mass, a – a radius of media atoms screening) a mechanism of Rutherford dissipation is used as well. It is considered that dissipation and braking of positively charged particles on nucleus and electronic crystal subsystems don't promote their motion regulation. The given paper proposes a new ionization-recombination mechanism of ions channeling in monocrystals based on simultaneous increase of interaction ion potential with a concrete plane or axis and its transverse impulse decrease on left electron impulse magnitude at the moment of electron loss. For transverse energy is stable, i.e. if in a previous discharge ion state it was an energy of a continuos spectrum super-barrier state then now it characterizes a discrete spectrum channeling level. However, to make this motion regulation true, the possibility of electron loss should considerably exceed electron capture possibility. Since electron loss σ_l and capture σ_c crossing relation is $(v/v_0)^5Z_2^{1/3}/4Z_1^6$, the situation may be realized at $v >> v_0$, $Z_1 \leq Z_2$. At $Z_1>>Z_2$ the channeling effect is impossible as in this case $\sigma_l/\sigma_c \sim Z_2^{-3}$. It is evident that a middling case should take place when the possibilities of electron loss and capture is equal (at $Z_2 \geq Z_1$ it will be $\sigma_l \approx \sigma_c$). A unique situation when more dense while crystallographic plates will possess a channeling regime while less dense ones a dechanneling is possible. These simple considerations coincide with experimental data shown in [1]. Note that shadow effect contributes greatly as well. In rechanneling case it plays a regularization role while in another one it amplifies a dechannelization process (especially for more dense directions). To sum up we should note that given channeling may be considered as a partial regularization by transverse energies of an initial dynamic chaos due to transverse energy preservation low at a certain balance between electron ionization and recombination processes in a moving ion field.

Reference:

1. W.Assmann et. al //private communication.

S-MATRIX FORMALISM IN CALCULATION OF OSCILLATOR STRENGTHS, RADIATION AND AUTOIONIZATION WIDTHS FOR COMPLEX ATOMS AND MULTI-CHARGED IONS

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In the theory of radiative and nonradiative decay of the quasistationary states of multielectron atom it's well known an energy approach (c.f. [1-3]), based on the adiabatic Gell- Mann and Law formula for the energy shift with electrodynamic scattering matrix. This approach represents the decay probability as an imaginary part of energy shift dE. The method is a consistently electrodynamic one, allowing for the uniform consideration of a variety of induced and spontaneous processes. Their contributions, interference effects are represented by successive corrections of the electrodynamic perturbation theory (EDPT).

Here we present new calculation scheme for the atomic oscillator strengths (OS), radiation and autoionization widths , based on the energy approach with the use of the new *ab initio* method for construction of the wave functions in the transition matrix elements [4]. It refines the analogous method developed in [2]. In the "4" EDPT order there are diagrams, whose contribution into imaginary part of radiation width ImdE accounts for the core polarization effects. This contribution describes collective effects and it is dependent upon the electromagnetic potentials gauge (noninvariant one).The minimization of the corresponding functional ImdE leads to the integrodifferential equation which can be solved using the standard numerical code (c.f.[2-5]). In result one can receive the optimal basis. The quantum electrodynamical density functional theory version can be naturally developed. The gauge problem in quantum theory is considered from the point of view of construction of the optimal one-electron bases and exactness of calculation results for the spectroscopic characteristics of the elementary processes in atomic systems.

To check efficiency of new procedure there have been calculated the oscillator strengths for some Na-, Rb-,Cs- and Fr-like ions. It is shown that calculation of the radiation widths and oscillator strengths within traditional approach in the forms of "length" and "velocity" are practically equal for chosen representation. It's proved the theorem, generalizing the known Grant theorem [5].

References:

[1] M.N.Driker , L.N.Ivanov , Opt.Spectr. 49 231 (1980).
[2] A.V.Glushkov, L.N.Ivanov, Phys.Lett.A. 170 33 (1992).
[3] A.V.Glushkov,S.V.Malinovskaya,S.Ambrosov, Proc.5'ASOSALP,Meudon,1995.
[4] A.V.Glushkov, S.V.Malinovskaya et al, J.Techn.Phys. 38 211, 219 91997).
[5] P.Grant, J.Phys.B: At.Mol.Opt. Phys. 7 1458 (1974).

ELASTIC CROSS SECTION CALCULATIONS FOR ELECTRON SCATTERING ON POLYATOMIC MOLECULAR TARGETS: XY_4 (X = C, Si, Ge; Y = H, F, CL), XF_6 (X = S, W, U), C_2F_6, AND C_6Y_6 (Y = H, F)

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We report calculations of differential and integral cross sections for elastic electron scattering from polyatomic molecular targets for intermediate energy range of incident electrons (from tens of eV up to 3 keV). The calculations have been carried out using an independent atom model (IAM) [1] with static-polarization model potential. In this approximation the electron-molecule integral elastic cross section, σ(E), is given as a direct sum of the elastic cross sections for each constituent atom of the molecule, $\sigma_i(E)$,

$$\sigma(E)=\sum_{i=1}^{N}\sigma_i(E),$$

where E is an energy of incident electron.

The differential cross section (DCS) in IAM approximation is given as

where $f_i(\theta,k)$ is scattering amplitude for i-th atom, r_{ij} is the distance between

$$\frac{d\sigma}{d\Omega} = \sum_i \sum_j f_i(\theta\theta k) f_j^*(\theta\theta k) \frac{\sin(sr_{ij})}{sr_{ij}}$$

i-th and j-th atoms, θ is scattering angle, k is wave number of electron and $s = 2k\sin(\theta/2)$.

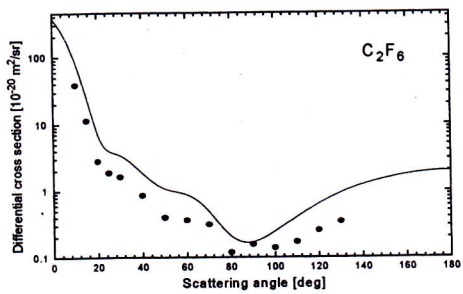

Fig. 1. Differential cross section for elastic electron collisons with C_2F_6 molecules at 100 eV:
—, present results;
(•), experimental results [2]

In figure 1 we compare DCS for electron collisions with C_2F_6 molecule at 100 eV with experimental data of Takagi et al [2].

This work was sponsored in part by Polish Committee for Scientific Research (under contract No. KBN 215/P03/99/17).

References:

[1] D. Raj, Phys. Lett. 160, 571 (1991).
[2] T. Takagi, L. Boesten, H. Tanaka, M.A. Dillon, J.Phys. B27,5389 (1994).

ELECTRON IMPACT EXCITATION OF NITRIC OXIDE

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In the present abstract we present studies of electron impact excitation of nitric oxide (NO) in the electron energy region below 15 eV. In the measurements the excitation has been detected by the optical method using an electron spectrometer equipped with a trochoidal electron selector to monochromatize the incident electron beam [1,2]. Molecular fluorescence produced in the scattering region is transmitted via a quartz lightguide to the entrance of a 0.25 m Ebert grating monochromator and then is detected by a photomultiplier. In figure 1 we show the cross section for excitation of v=0 vibrational level of the $A^2\Sigma^+$ state obtained in the electron energy range from threshold to 15 eV. The energy dependence of the cross section has been obtained from measurements of the intensity of the (0,1) line of the γ-system at 236.3 nm.

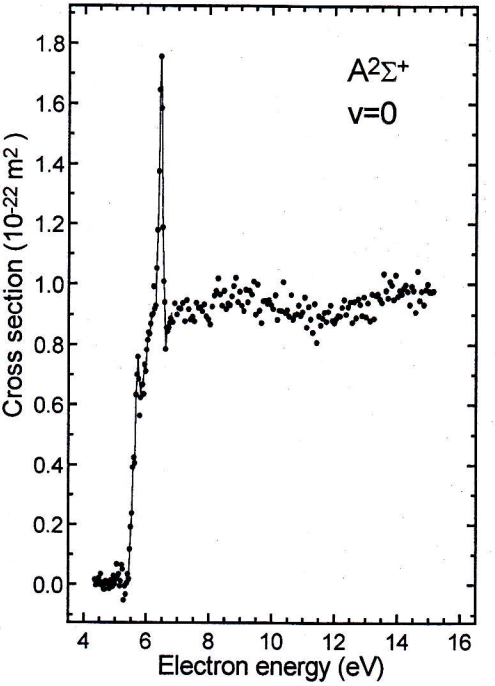

Figure 1. Cross section for excitation of the v=0 level of the $A^2\Sigma^+$ state of nitric oxide measured from threshold to 15eV.

The absolute value of the cross section has been determined by normalization of the photon intensities of the (0,v") bands of the γ-system to that of the (0,0) band of the second positive system of nitrogen and using its emission cross section determined previously [1].

The cross section shows resonant variation in the energy region close to excitation threshold but is quite flat in the energy region above 7eV.

References:

1. M. Zubek, J. Phys. B **27,** 573, (1994)
2. R. Olszewski, P. Woliński, M. Zubek, Chem. Phys.Lett. **297**,537, (1998)

APPLICATION OF THE WAVE-PACKET PROPAGATION APPROACH TO SOME PROBLEMS OF INTERACTION BETWEEN ATOMIC PARTICLES AND METAL SURFACE

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A brief review of the results obtained recently with the wave propagation method in the problems related with Resonance Charge Transfer between atomic particles and metal surfaces is a subject of this report. The Resonance Charge Transfer between atomic particles colliding with Cu(111) surface and the long-lived states induced by adsorption of alkali atoms on Cu(111) surface are considered.

The wave-packet propagation approach is a quite universal tool for investigation of number of problems in contemporary theoretical studies in atomic physics, chemical physics, etc. Its application to the problems of interaction between atomic particles and metal surfaces was initiated recently [1]. Then this approach has been applied for calculation of the parameters of the resonance negative ion (H-) state in front of Cu(111) surface in [2] and of the resonance Li(2s,2p) atom states in front of the same surface in [3]. The importance of Cu(111) surface is due to the fact that it presents a projected band gap along the surface normal (the L-gap), i.e., in a certain domain of their transversal energy, electrons cannot propagate free in the metal bulk. If the energy level of an atomic particle located at some distance in front of the metal surface is inside the gap, the electron from the atomic center cannot tunnel into the metal along the easiest path and this would cause substantial difference between the Resonance Charge Transfer to Cu(111) surface and to the corresponding model jellium metal surface. Quite often the blocking of the easist decay path leads to substantial decrease of the resonance width [4], although in some cases its result can be opposite [5]. The calculations with the wave-packet propagation approach have lead us to some conclusions which are directly related to the experimental findings [6-9].

References:

1. V.A.Ermoshin, A.K.Kazansky, Phys. Lett. A 218, 99 (1996).
2. A.G.Borisov, A.K.Kazansky, J.-P. Gauyacq, Phys. Rev. B 59, 10935 (1999).
3. A.K.Kazansky, A.G.Borisov, J.-P. Gauyacq, NIM B 157, 21 (1999).
4. A.G.Borisov, A.K.Kazansky, J.-P. Gauyacq, Surf.Sci. 430, 165 (1999).
5. J.-P. Gauyacq, A.G.Borisov, G.Raşeev, A.K.Kazansky, submitted.
6. A.G.Borisov, A.K.Kazansky, J.-P. Gauyacq, Phys. Rev. Lett. 80, 1996 (1998).
7. L.Guillemot, V.Esaulov, Phys.Rev.Lett. 82, 4552 (1999).
8. T. Hecht, H.Winter, A.G.Borisov, J.-P. Gauyacq, A.K.Kazansky, Phys.Rev.Lett. 84, 2517 (2000).
9. M.Bauer, S.Pawlik, M.Aeschliman, Phys.Rev.B 60, 5016 (1999).

METAL VAPOR LASERS ON SELF-TERMINATING TRANSITIONS

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Lasers on self-terminating transitions demonstrate some unique parameters and therefore have vast applications in practice and scientific investigations. The best of them is Cu - vapor laser (510,6 + 578,2 nm). The best laboratory samples have an efficiency up to 3 % and average power of 200 W.

We have performed a series of investigations of active medium of Cu - laser, especially of those phenomena, which limit laser parameters through discharge nonuniformities.

In detail the average gas temperature in laser discharge tube for He, Ne and Ar buffer gas dependence upon gas pressure was studied. It was established, that in selfheated Cu - laser gas to temperature is defined by radial nonuniformity in distribution of pumping energy putting into discharge and by carring out of energy from discharge. Nonuniformity degree increases with buffer gas pressure growth.

It was established that evolution of Cu – metastable states concentration in time and space at interpulse period is controlled by processes occurring at the restoration of Cu atoms in a ground state in discharge tube and the relaxation of electron temperature. Nonuniform time dependence of Cu – metastables concentration was observed for neon buffer gas pressure over 75 mm Hg. A critical value of pulse repetition frequency was established which when exceeded than the deficit in Cu ground state atoms concentration in central zone of discharge is obtained limiting lasing parameters.

For the blue Bi - vapor laser (427,2 nm) it was established the spatial discrepancy of bismuth atoms and molecules when Bi_2 dimers are concentrated predominantly at the discharge tube walls. Laser action in Bi - vapor laser occurs predominantly through nontraditional mechanism of pumping - dissociative excitation of Bi_2 dimers by electron impact. Photodissociation Bi_2/Bi^* laser pumped by ArF excimer laser was elaborated.

The ways to create an effective blue laser on self-terminating transition especially on Ti and In atoms were outlined. The first experiments were performed.

THERMOSTIMULATED LUMINESCENCE AND X-RAY LUMINESCENCE OF UNDOPED $Li_2B_4O_7$ SINGLE CRYSTALS

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Lithium tetraborate (LTB) single crystals possess a complex of significant physical properties and, thus, find a wide application in different fields of science and technology. Up to now, the principal crystallographic parameters of the LTB structure are well studied by X-ray, NMR and RS methods, however, a series of experimental data are available being explained with the assumption of the existence of the incommensurate phase in LTB. We have suggested the explanation of these phenomena on the basis of the crystalline structure defects and related local levels.

It is well known that one of the most sensitive methods of studying the crystalline structure defects is the thermostimulated luminescence (TSL). Tharefore we have carried out the luminescence studies of LTB single crystals of more than 20 technological batches grown in different laboratories, at different time, with different drawing and rotation rates, with the use of different initial raw materials in order to cover a wide range of possible structural imperfections. The details of LTB single crystal production are discussed in [1].

TSL in nominally pure LTB single crystals is negligible. It is almost three orders lower than that in the LiF-based and copper-doped LTB dosimetric samples. The TSL curves for the single crystals of different technological batches differ significantly testifying the essential effect of various technological factors on the LTB single crystals quality. It has been found that the TSL intensity is the lowest for the most high-quality parts of single crystals. The lower parts of single crystals have 2-3 times higher TSL intensity and this should be explained by a considerably higher concentrations of point and macroscopic defects. It is obvious that the TSL intensity serves as a criterion of the LTB single crystal defectness, similarly to the case of more studied Al_2O_3 single crystals. It should be noted that almost no discrepancies have been observed in the X-ray luminescence (XL) spectra for single crystals taken from the different technological batches. It has been found, as a result of the studies on the XL temperature dependence for the LTB single crystals, that above the 300 K the temperature damping of luminescence is observed with the activation energy of E_a=0.32±0.01 eV. The differences between the curves obtained at cooling and heating are due to the existence of single crystal defects.

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Reference:

1. Holovey V.M. Single Crystal Lithium Tetraborate Production //Quantum electronics.- 1993. v. 44. - p. 103-110.

STUDY OF DIRECT AND RESONANCE PROCESSES IN COLLISIONS OF ELECTRONS WITH ATOMS AND IONS

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High-resolution experimental investigations of direct and resonance processes have been carried out in collisions of electrons with the alkali, alkaline-earth, zinc, cadmium and thallium atoms and with their singly-charged ions by using the electron and photon spectroscopy methods combined with a crossed beam technique.

The experimental setups comprise the following innovated elements: a high-temperature metal vapour beam source, a high resolution electrostatic cylindrical electron monochromator and analyzer, a low voltage ($U_d \leq 12$ V) discharge ion source, the spectral monochromator for the 40-830 nm region, a modulation system for the detection of extremely weak photon fluxes; a PC-based unit for controlling of the experimental procedures and data processing.

The attention has been paid to: the role of resonances in the excitation of atoms (including that of the autoionizing states (AIS)) and ions; the elucidation of new regularities and phenomena in the dynamics of electron-atom and electron-ion scattering related to the excitation and decay of the negative-ion states and atomic AIS; the search for and study of the emissions related to the radiative decay of AIS.

The following results have been obtained:

the energies of the negative-ion resonances, their probable decay channels and effective excitation cross-sections of AIS;

the wavelength of the spectral lines corresponding to the radiative decays of quasi- metastable AIS with their tentative assignments; excitation functions and analysis of excitation mechanisms;

the absolute cross-sections of the threshold and near-threshold excitation and dielectronic recombination processes and their energy dependences;

the resonance contribution to the electron-impact excitation cross-sections for the optically allowed, intercombination and forbidden transitions in ion, as well as the energies and widths of the observed resonances;

the role of relativistic, electron-correlation effects and configurational mixing in the probability redistribution for electron and radiative AIS decay channels.

High-resolution measurements of the atomic constants and the fundamental knowledge on new mechanisms of different collisional processes (including the resonance phenomena) have a substantial effect on other fields of science: plasma physics, fusion, astrophysics, upper atmosphere physics, quantum electronics, and in particular, laboratory and astrophysical plasma diagnostics, radiative plasma cooling in fusion applications, spectroscopic data interpretation and the development of new theoretical models for the processes occurring in the astrophysical objects, active experiments with artificial plasma clouds in the outer space, in the detailed analysis of kinetics of the processes in laser systems and in the search for active laser media operating in the short-wave spectral region.

ABSOLUTE DIFFERENTIAL CROSS SECTIONS FOR ELECTRON SCATTERING IN NITROGEN IN THE ANGULAR RANGE FROM 120° TO 180°

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Absolute differential cross sections for elastic electron scattering and vibrational excitation in nitrogen have been measured in the angular range from 120° to 180° in the energy region below 10 eV. In the measurements the newly developed *magnetic angle-changing* technique [1,2] has been employed which allowed observation of electron scattering in the region of high scattering angles. The absolute differential cross sections for elastic scattering have been measured using the relative flow technique with helium as a reference gas. The cross section for vibrational excitation v=0→1 of nitrogen has been determined from ratios of the vibrational to elastic cross sections obtained from energy loss spectra measured at fixed scattering angles.

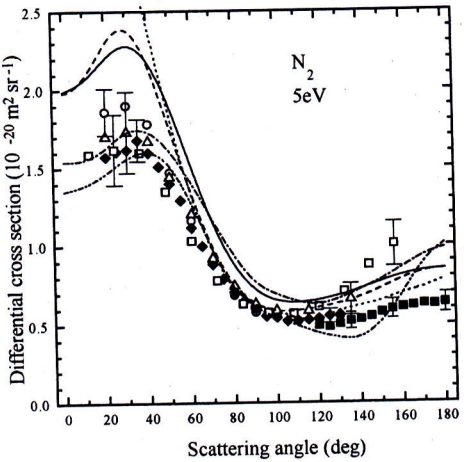

Fig. 1. Differential cross sections for elastic electron scattering in nitrogen at 5 eV: ≡ Brennan et al (1992), ∝ Sun et al (1995), o Shyn, Carignan (1980), ' Srivastava et al (1976), ν present, – – – Sun et al (1995), —— Chandra, Temkin (1976), Gillan et al (1987), π↓↓π Huo et al (1987), π↓π Siegel et al. (1980).

The cross section for elastic electron scattering obtained at 5 eV is shown in figure 1 together with theoretical calculations [4,7-9,12] and existing experimental data [3-6] obtained at lower scattering angles. There is a reasonably good agreement within the experimental error of 10% with the results of Sun *et al* (1995) and Brennan *et al* (1992) in the region of the overlap of the data 120-130°.

1. F.H. Read, J.M. Channing, Rev. Sci. Instrum **67**, 2372 (1996). **2.** M. Zubek et al., J. Phys. B **29**, L239 (1996). **3.** M.J. Brennan et al., J. Phys. B **25**, 2669 (1992). **4.** W. Sun et al., Phys. Rev. A **52**, 1229 (1995). **5.** T.W. Shyn and G.R Carignan, Phys. Rev. A **22**, 923 (1980) **6.** S.K. Srivastava et al., J. Chem. Phys. **64**, 1340 (1976). **7.** N. Chandra and A. Temkin, Phys. Rev. A **13**, 188 (1976). **8.** C.J. Gillan et al., J. Phys. B **20**, 4585 (1987). **9.** W.M. Huo et al., Phys. Rev. A **36**, 1632 (1987). **10.** H. Tanaka et al., J. Phys. B **14**, 2081 (1981). **11.** D.G.Truhlar et al., J. Chem. Phys. **65**, 2962 (1976). **12.** J.Siegel et al., Phys. Rev. A 21, 85 (1980).

THE REFLECTION - ABSORPTION SPECTROSCOPY AS METHOD OF THE SEMICONDUCTOR THIN FILMS CONTROLLING

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The study of bulk phonons in thin films is limited due to the low energy of far-infrared sources. The infrared reflection-absorption spectroscopy (IRAS) technique has, therefore, been developed. In the case of incidence deviating from normal two states of polarization of incident light should be taken into consideration. The application of approximation of ultra thin films enables to obtain the simple relations $\Delta R \setminus R_0$ between the change of reflectivity of a metal plate covered with a film and that of the metal substrate. $\Delta R \setminus R_0$ has been obtained for two polarizations, namely: s and p. The present research has demonstrated that this method proved to be particularly usable for the multimode crystals where the oscillator strength is distributed on several modes. The IRAS technique has been applied to the $Zn_xCd_yHg_{1-x-y}Te$ (ZMCT) thin films. The reflection spectra were experimentally obtained by infrared Fourier spectrometer *FTS-14 Digilab* in the region 30 -250cm^{-1} (λ=40-330μm) at 300 K. The CdTe substrates of the studied samples have been removed by mechanical grinding with the ensuing chemical etching. Thus separated ZMCT layers of d = 4 - 5 μm thickness were put on the gold mirror. The measurements of reflectivity were performed at an angle of incidence of 45°. The quantity $A = \log R/R_o$ – where R – intensity reflected from layer, R_o- intensity reflected from mirror without layer – was registered. The experimental curves for five composition of ZMCT are obtained. The obtained curves are similar to typical reflection spectra with much richer structure. It should be noted that five lines for composition I, six lines for composition II, seven lines for composition III, IV and 8 lines for composition V have been selected. Lines 1 to 6, however, remain the main lines owing to their intensity. For sample I – which contains x = 0.02, y = 0.2 – the peak corresponding to ZnTe sublattice on the experimental curve at 168.1 cm^{-1} is weak in comparison with the line at 145.4 cm^{-1} which corresponds to CdTe sublattice. For sample IV containing x=0.127, y=0.117 the intensities of corresponding lines are comparable, whereas for sample V intensity of line at 168 cm^{-1} is larger than one at 149 cm^{-1}

The frequencies of LO and TO phonons were determined by comparing the theoretical and experimental spectra.

HYPERSPHERICAL APPROACH IN FEW BODY SYSTEMS

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In hyperspherical approach there are some methods for correlation description between identical particles in few-body systems [1]. In this work we consider the sweep method with conditions of conjugation to obtain adiabatic potentials and two-dimensional channel functions in helium-like systems. For description of relative motion electrons in such systems let us choose the following independent variables: three Euler angles (δ,β,γ) which characterize the system as a whole and relative two Jacobi vectors ρ and τ [2].

In the rotation coordinates system for ^{1,3}S-states the equation for adiabatic potentials takes a form [2]

$$\left\{\frac{1}{\sin^2\alpha}\left[\frac{\partial}{\partial\alpha}\left(\sin^2\alpha\frac{\partial}{\partial\alpha}\right)+\frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right)\right]+\frac{R}{2}V(R,\alpha,\theta)\right\}\varphi_\mu(R,\alpha,\theta)=R^2U_\mu(R)\chi_\mu(R,\alpha,\theta) \quad (1)$$

where $R=\sqrt{\rho^2+\tau^2}$ is hyperradius, α=2 arctgρ/τ is hyperangle,

$$\theta=\arccos\frac{\rho\tau}{\rho\tau}$$

is angle between radius vectors $\rho$and τ, $V(R,\alpha,\theta)$ is operator of potential energies of system.

Equation (1) may be solved both by the method of approximate solution and its reduction to the solution of the system of algebraic equations using K-harmonics. To determine adiabatic potentials ($U_\mu(R)$) and channel functions ($\chi_\mu(R)$) with accuracy of 10^{-6} and 10^{-5} a.u. respectively, in the method of approximate solution it is necessary to perform four-five iterations for each value of hyperradius (R).

Received adiabatic potentials for negative hydrogen ion have potential holes, which ensure formation of bound state - in singlet and autoinizing states - in singlet and triplet states for basic ^{1,3}S-series. Such states are included into pseudo-state expansion for description of electron scattering by atomic hydrogen [3]. Parameters of pseudo-states and autoionizing states are discussed. Difference between energies for ^{1}S(1s2s) and ^{3}S(1s2s) may indicate the value of spin-spin interaction of electrons in negative hydrogen ion.

References:

1. Lin C.D. // Phys.Rep.**257**, 1, 1995.
2. Haysak M.I., Dovhanich M.M., Lengyel V.I., Onysko V.V. // J.Phys.Study.**1**, 521, 1997.
3. Burke P.G.,Webb T.G.//J.Phys.B **3**, L131,1970.

NATURAL GAMMA-ACTIVITY DYNAMICS MONITORING

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When solving a number of applied tasks (i.e. activation analysis, ecological, medical, physical etc.) one requires the reliable data on the spectral composition of natural γ-activity and its time correlation. Using the SBS-40 spectrometric complex with Ge(Li)- detector (100 cm^3) the systematic studies of γ-spectral composition of natural activity during 300 days have been performed. The single measurement time varied from 0.5 – 15 h. Then, measuring, the detector operated both with the combined protection and with no protection. The measuring efficiency was controlled by means of a standard Eu-152 source [1]. A typical γ-spectrum obtained as a result of measurements is shown in fig.1.

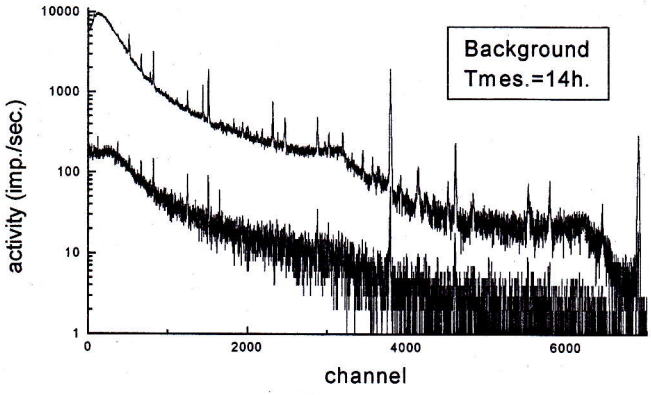

Fig.1. Natural γ-activity spectrum
(1- combined protection, 2- no protection)

As a result of the studies:

- the presence of the natural and artificial (technogenic) components in the γ-spectral composition of the natural background has been studied;
- the possible causes of their appearance (for the technogenic nuclides) have been analyzed;
- the stability and variability of the natural components of the spectral composition for the Th-232, U-235, U-238 chains and K-40 with natural background time variation have been estimated.

This work was supported by the STCU Grant # 576.

Reference:

1. Parlag O.O., Stets M.V., Maslyuk V.T. et al. About spectral components of environmental background gamma-activity. -Proc. Uzhgorod University, -Phys. Ser. №5, p.129-133.

CONTROLLING OF THE THERMAL STRESS IN THE MULTIPLE QUANTUM WELLS USING MAGNETOPHONON SPECTROSCOPY

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One of the methods to study the semiconductor layer strain is Raman scattering. However, there are two inconveniences concerning of this method: a) it makes possible to research the upper layer only; b) little sensibility of the phonon frequencies to compressive and tensile strain. This some inconveniences relate to X-ray diffraction method.

The band structure parameters changes more with deformations then phonon frequencies. Therefore, effects sensitive to the change of the band structures parameters in layers have advantage for the investigation of strain in layers. Such an effect is Magnetophonon Resonance (MPR) which appears every time when the phonon frequency ω_{LO} is equal to the cyclotron frequency ω_C of the electron in a magnetic field. MPR in parallel transport of three types Multiple Quantum Wells was studied. They consisted of ten QW of GaAs and ten AlGaAs barriers, and were obtained by the Metal Organic Vapour Deposition on semi-insulating GaAs at Warsaw Institute of Electronic Materials. The thickness of the well was 10 nm and 8 nm, the thickness of the barrier was 4 nm for all MQW. GaAs layers were doped with Si to about $5x10^{10}$ cm^{-3} and $5x10^{11}$ cm^{-3}.

The MPR research were performed in pulsed magnetic fields up to 30 T. The transverse magnetoresistance was measured between 77K and 340K and the MPR oscillations extracted by subtracting a voltage linear in magnetic field. The oscillating part of magnetoresistance $\Delta\rho_{xx}$ was recorded.

A fine structure of MPR peaks was observed. It is necessary to note that: a) the observed structure is characteristic for both the examined sample and samples of the given, MQW type, b) the subtle structure of MPR peaks reappears in each type of MQW, but its character in not the same. It follows that the occurrence of the observed peak structure depends neither on the two dimensional density of carriers, nor on the size of the Quantum Wells.

This effect could be attributed to two phenomena: contribution of barrier phonons and influence of thermostresses.

Stresses in MQW layers caused by mismatch between the QW lattice and the barrier should be accounted for when the measurement temperature is lower than the temperature of creation of the layers with MOCVD technology. Mismatch leads to a tension in the plane of QW layers. Because of their various distributions in the MQW their contribution, sign included, into the shift of the resonance field will vary. It is the effect that can explain the disintegration of magnetoconductivity in MQW during parallel transport

The MPR is very sensitive to the change of band structure parameters and can be used as a method of control strain in QW layers.

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ON THE QUESTION OF THE AGREEMENT OF EXPERIMENTAL DATA WITH THEORETICAL ESTIMATIONS OF THE CROSS-SECTIONS OF REACTIONS OF NON-ELASTIC GAMMA-QUANTA SCATTERING ON METASTABLE STATES

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One of the problems of quantum nucleonics is the question of the description of electromagnetic transitions in nuclear systems. The question concerning the estimation of the probability of such transitions is especially urgent.

The latest results of the conferences and the works on this problem gave rise to discussions both of experimental and theoretical nature. The results of the measurements and theoretical estimations stated in these works showed the data to be of a contradictory character.

In this paper the question was put forward concerning the correlation of the mechanism of interaction of gamma-quanta with atomic nuclei and the question of the observation of a stimulated gamma-emission. The authors believe that the problem is not the one connected with the urgent access of the agreement between the theoretical and experimental evaluations, but subsequent storage of the experimental material. The results of the works [1-4] are to be considered as the initial stage of the investigations in this direction. There is a need in the updating of the experimental measuring technique.

In the paper the ways of updating of carrying out experimental investigations are discussed. The attention is paid to the peculiarity of the obtaining of the cross-sections of reactions of the gamma-quantum non-elastic scattering, when the experiment is conducted with the beams of.

In particular the necessity of the obtaining in experimental investigations of the so-called the curves of the yields of photo-nuclei reactions is discussed.

The methods of conduction of the experiments with the aim of obtaining absolute cross-sections and the information on the levels widths through which the process of the induced gamma-emission is to pass is discussed.

References:

1. C.B. Collins et. al., Laser Physics, **9**, 1(1999).
2. C.B. Collins et. al., Phys. Rev. Lett. **84**, 2544(2000).
3. S. Olario, A.Olario, Phys. Rev. Lett. **84**, 2541(2000).
4. D.P. McNabb et. al., Phys. Rev. Lett. **84**, 2542(2000).

FURTHER DEVELOPMENT OF THE CLASSICAL ELECTRODYNAMICAL MODEL OF ATOM

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New results in construction of classical electrodynamical model of atom are presented.

The basic statement of the model is the gently generalized electrodynamical equations

$$\begin{aligned} &\mathrm{rot}\vec{H} - \partial_0 \varepsilon \vec{E} = \vec{j}_e, \quad \mathrm{rot}\vec{E} + \partial_0 \mu \vec{H} = \vec{j}_{mag}, \\ &\mathrm{div}\,\varepsilon \vec{E} = \rho_e, \quad \mathrm{div}\,\mu \vec{H} = \rho_{mag}, \end{aligned} \tag{1}$$

where

$$\vec{j}_e = \mathrm{grad}E^0, \quad \vec{j}_{mag} = -\mathrm{grad}H^0,$$

$$\rho_e = -\varepsilon\mu\partial_0 E^0 + \vec{E}\,\mathrm{grad}\varepsilon, \quad \rho_{mag} = \varepsilon\mu\partial_0 H^0 + \vec{H}\,\mathrm{grad}\mu, \tag{2}$$

$$\varepsilon(\vec{x}) = 1 - \frac{\Phi(\vec{x}) + m}{\omega}, \quad \mu(\vec{x}) = 1 - \frac{\Phi(\vec{x}) - m}{\omega}, \tag{3}$$

and, moreover, where $(\vec{E}, \vec{H})$ are the electric and magnetic field strengths, (2) are the corresponding densities of currents and charges, E^0, H^0 are two scalar fields generating the gradient-like currents (2), and (3) are the electric and magnetic permeabilities of the medium in Sallhofer's form ($\Phi \equiv -Ze^2/r$, the system of units $\hbar = c = 1$ being used).

The electrodynamical equations (1) are solved here directly by means of separation of variables method without any appealing to the Dirac equation and to the relationship with solutions of Dirac equation as it was firstly done in our previous publications. We suppose here the harmonic time dependence and search for the solutions of Eqs. (1) in the harmonic form. The d'Alembert Ansatz and the transformation for spherical coordinate system are using. The Sommerfeld–Dirac formula for the hydrogen spectrum

$$\omega^{hyd} = \frac{mc^2}{\mathrm{h}\sqrt{1 + \dfrac{\alpha^2}{(n_r + \sqrt{k^2 - \alpha^2})^2}}}, \tag{4}$$

and the Bohr's postulates are found here as a direct consequences of Eqs. (1).

This result means that together with Dirac or Schrodinger equations we have now the new equation which can be used for finding the solutions of atomic and nuclear physics problems. The limits of the model, in which the interaction with external field and the interaction with media are vanished, are investigated.

POSTER SESSION

THE MAGNETRON SPRAYING EQUIPMENT FOR OBTAINING FERROELECTRIC FILMS

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The lithium niobate crystals due to unique ferroelectric, piezoelectric, nonlinear properties attract broad attention of the researchers and technologists. Last years the special urgency was gained with a problem of a miniaturization of optoelectronic devices, and consequently obtaining of films of different compounds. A number of successes in obtaining films of lithium niobate is reached. But the problem on obtaining high-performance $LiNbO_3$ films of a demanded structure remains opened. One of actively used methods of obtaining of films is the method of a magnetron sputtering. It is successfully applied to composition of different matters.

The device for magnetron deposition of films was designed and manufactured by us. More fundamentals the device described in is taken [1]. This device has a number of advantages before others: the small size (small consumption of a material), low temperature of the target (target can be cooled down to temperature of liquid nitrogen), two zones of erosion of the target (high performance), capability of sputtering at pressure of residual gas 10^{-3}-10^{-4} torr, capability of making of a multicomponent atmosphere in work volume.

As a material of the target the z-cut of a lithium niobate crystals was utilised. The basic working gas at realization of experiments was argon.

At a sectional stage the conditions are completed and composition on a metallic substrate was carried out (temperature of a substrate is conducted did not exceed 500 °C). A polycrystalline film of lithium niobate were obtained, which one had a good adhesion.

Reference:

1. E.T.Kucherenko, A.E.Lushkin The magnetron spraying equipment for a vacuum universal post VUP-5 // Works of 3-rd international symposium " Vacuum techniques and equipment ".

RHEED INVESTIGATION OF NON CONTINUOUS BIMETALLIC LAYERS

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Pd/Al alloys have very interesting properties from the point of view of their possible application in heterogeneous catalysis. Preparation of small heteroepitaxial Pd/Al alloy particles opens a new way in studies of the influence of Pd/Al crystallographic structure on the alloy catalytic properties.

Pd/Al alloy particles were grown by molecular beam epitaxy method. Their crystallographical structure was controlled by reflection high energy electron diffraction (RHEED). It was found that Pd deposited on epitaxial 3-D Al particles grown on KCl is intermixing with Al. This process is accompanied by the variation of lattice parameter from the Al value to the Pd one.

RHENIUM DOPED ALLOYS OF Pb-Sb-O SYSTEM : SYNTHESIS, ANALYSIS AND SOME PHYSICO-CHEMICAL PROPERTIES

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The scientific and technical progress is hardly concerned with the materials technology development, the main problem of which is the searching for new perspective materials with desired physical, physico-chemical and chemical properties. Semiconducting materials occupy the relevant place in a solution of these problems.

In this work the results of synthesis, analysis and some physico-chemical properties of rhenium-doped alloys in a system Pb-Sb-O are present.

We have used PbO and Sb_2O_5, taken in a stoichiometric ratio 1:1 with addition of 1-5 mol.% Re, as starting materials to synthesize the samples. The synthesis was carried out in the conducting air. The temperature of the synthesis did not exceed 750°C. The obtained samples represented dusts of brown color with different tones.

The X-Ray diffraction technique was used for identification of the phases present in the obtained samples.

The density of samples was established by pycnometry measurements.

Dielectric permeability ε was found from experimental studies of capacitance of a sample. For our measuring a tested sample was made as a tablet of round cut by a diameter of 5-7 mm and thickness of 1 mm. The relative error of measuring of temperature was 1 %, measuring error of dielectric permeability was 1-2 %.

The concentration of rhenium in the samples has been determined using the photometry as ionic associates of the rhenic ions with cyanine dyes - 5-nitroindostyril.

For determination of rhenium in the obtained samples the different ways of decomposition of samples were tried. The best results were found at melting samples with hydroxide and peroxide of sodium in nickeliferous crucibles during 2,0-2,5 hours at temperature 300-350°C with consequent leaching.

RESONANT INTERACTIONS AND DISORDER EFFECTS IN $CdS_{1-X}Se_X$ MIXED CRYSTALS RAMAN SPECTRA

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Resonant interactions between vibrational excitations due to third- and fourth-order anharmonicity can reveal in Raman spectra of crystals as essential redistribution of intensities of interacting excitations and "repulsion" of the corresponding levels [1]. Mixed semiconductor crystals are suitable objects for studying such resonances due to the possibilities of variation of energy difference between the interacting states by changing the crystal composition as well as in view of disorder-induced selection rules breakdown. Additional disordering can be achieved by high-energy particle beam irradiation of the crystals under investigation [2].

We report the studies of resonant interactions in Raman spectra of $CdS_{1-x}Se_x$ ($0 \le x \le 0.35$) single crystals and the effects of additional disordering due to 10-MeV electron irradiation with the fluence up to 10^{18} cm^{-2}. Raman spectra were measured at DFS-24 LOMO monochromator using He-Ne (λ=632.8 nm) and Ar+ (λ=457.9, 488.0, and 514.5 nm) lasers at 77 and 300 K.

In the phonon spectra of $CdS_{1-x}Se_x$ mixed crystals with two-mode compositional transformation type we have observed anomalous behaviour of compositional dependences of two-phonon and one-phonon mode frequencies in the range of 150 to 220 cm^{-1}. This effect as well as the redistribution of the mode intensities and characteristic antiresonance dips are discussed in the framework of Fermi resonance between one- and two-phonon excitations of the mixed crystal lattice. Electron-beam irradiation did not induce any noticeable changes in the spectral manifestation of Fermi resonance in $CdS_{1-x}Se_x$.

However, resonant Raman processes, involving the electron subsystem of the crystals, have appeared more sensitive to radiation-induced additional disordering. For example, in $CdS_{0.88}Se_{0.12}$ the increase of the electron fluence up to 10^{18} cm^{-2} results in the increase of the $2LO_2$- to LO_2-intensity ratio by two orders of magnitude with respect to the non-irradiated sample, what is accompanied by the red shift of A_1 exciton recombination band. These effects are related to the disorder-induced density-of-states tails changing the resonant conditions in the irradiated crystals. Note that in this range of x the disorder-induced density-of-states tails are known to be maximal for $CdS_{1-x}Se_x$ [3].

References:

1. M.P.Lisitsa, A.M.Yaremko. *Rezonans Fermi*. (Naukova Dumka, Kiev, 1984).
2. V.G.Malesh, Yu.M.Azhnyuk, D.B.Goyer, and A.V.Gomonnai. Phys. Stat. Sol. (b), 154,. K197 (1989).
3. A.G.Abdukadyrov, S.D.Baranovskii, S.Yu.Verbin et al. JETP 98, 2056 (1990).

THE INFLUENCE OF ELECTRON PROCESSES AT ADSORPTION ON THE THERMOELECTRIC PROPERTIES OF Tl_4TiS_4 SINGLE CRYSTALS

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Tl_4TiS_4 crystals have a high coefficient of thermo-EMF (α~2.8 mV/K) and thermoelectric efficiency (z~10^{-3} K^{-1}). That is why it is a perspective material for the transformers of energy at middle temperatures. It is possible to obtain EMF~170 mV in the interval of 550-700 K on one thermoelement in the temperature levels~15-25 K/cm. Newly prepared samples in the vacuum at temperature range of 300-500 K have above zero thermo-EMF (α_{max}~1.8 mV/K) and below zero thermo-EMF ((α_{max}~1.8 mV/K) at T>550 K. The environment has a certain influence on thermoelectric parameters of syngle crystals samples, but the character of influence depends on adsorption temperature:

a) at T_{ads}=430 K the (x parameters is reducing and the temperature of thermo-EMF is decreasing.

b) at T_{ads}=530 K during the period of 5 min it changes from -1.6 mV/K to+1.6 mV/K with the following falling and thermo-EMF changing.

The lasting oxidation in the air atmosphere at 530 K causes the nearly disappearing of the above zero thermo-EMF and only at T>480 K starts the rapid growing of below zero thermo-EMF to (α_{max}~2-8 mV/K at 600 K. It follows from results obtained:

l) it is possible to stabilize and improve the thermoelectric parameters of crystals at T>500 K in the air atmosphere processing;

2) important influence of adsorption on electric subsystem samples at significant parameters (d~9mm, l~20 mm) testifies to its microporosity.

In the present work the investigation was done of adsorption influence of the air at different temperatures on temperature dependence of electron conducting and thermoelectric efficiency of samples investigated at ranges. The results are interpreted on the base of chemosorption electric theory.

STUDIES OF THE BILE CRYSTALLIZATION STRUCTURE FOR PATIENTS WITH LIVER PATHOLOGIES

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The studies of bile biophysical properties stimulate the development of new methods of liver diseases diagnostic. So, the detected infringements of bile structures at its crystallization into a solid state allow one to diagnose such liver diseases as hepatitis, cirrhosis etc. by using a crystal-optical method [1]. This work deals with the studies of peculiarities of liver and vesical bile crystallization structure .

Bile in a solid state was examined with the help of a polarization and conventional electronic microscopy. 17 patients of a control group, 53 patients with a hepatitis, 26 patients with a liver cirrhosis, 14 patients who have obtained small ionizing radiation doses, and also 27 patients with a chronic alcoholism were examined. It has been found, that at the presence of the liver and cholic ducts diseases the bile micellar is disturbed first, that is exhibited in the changes of bile crystallization process. Depending on the character of a pathology the different infringements of micellar are observed, being revealed in a form of the relevant microscopical inserts. Thus, the structure of a solid bile phase can vary from regulated, optically anisotropic, up to isotropic, completely regulated structure.

The studies of the bile absorption and luminescence spectra in a group of patients with chronic persistent hepatitis (27 persons) before the stationary treatment and after it have also been carried out. The detected features in the spectra (the presence of maxima, their spectral position and ratio intensity) explicitly testify to the diagnostic abilities of the method.

Reference:

1. Prima A.V., Kurik M.V., Poleshchuk A.P. *Vrachebnoye Delo*, 1986, No 9, p.59

NONRESONANT MIXING OF LOW METASTABLE LEVELS OF Ba ATOMS BY LASER RADIATION

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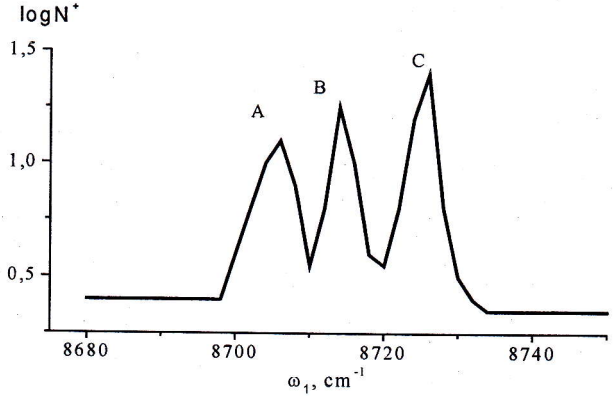
The investigation of perturbation of Ba atom under circumstances when shift of energy levels is comparable with difference between energies of levels was performed. In particular, the perturbation of 6s5d $^3D_1$ and 6s5d $^3D_2$ states by radiation of laser on colour centres (CCL) with frequency ω_1~8700 cm^{-1} was investigated. Perturbation of these levels by such radiation was strong as the



frequency of this radiation is close to frequencies ω_{mn}, corresponding to transitions from mentioned above states to 6s6p$^1P_1^0$. The polarizabilities of both mentioned above states are positive. Moreover, the polarizability of 6s5d $^3D_2$ is 50 times as much as polarizability of 6s5d $^3D_1$. I.e. under the increase of laser field strength 6s5d $^3D_2$ state must shift more rapidly than 6s5d $^3D_2$. At some values of field strength of CCL the variation of energy of 6s5d$^3D_2$ state will equal to the difference between energies of 5s5d $^3D_2$ and 5s5d $^3D_1$ states. In result the mixing of these states could set in.

For testing of the energies of these levels we used the excitation and subsequent ionization of them. We used the radiation of dye laser (DL) with frequency ω_2=17735 cm^{-1} for excitation. During simultaneous action of this radiation and CCL radiation the Raman processes of excitation of perturbed 5s5d $^3D_2$ and 5s5d $^3D_1$ states could be realized. We have measured the yield of Ba^+ ions as function of frequency of CCL radiation. The field strength of CCl radiation was $\varepsilon \sim 10^6$ V/cm. The typical results of these investigations obtained at $\varepsilon = 5\times10^6$ V/cm are shown in Fig. The analysis shows that maximum "A" is caused by excitation of unperturbed 6s5d $^3D_1$ state. Other two maxima ("B" and "C") are caused by excitation of mixed in result of strong perturbation of 6s5d$^3D_2$ and 6s5d$^3D_1$ states.

ON THE CONFIGURATION MIXING EFFECTS IN THE EXCITATION OF ZnII AND CdII LINES AT ELECTRON-ATOM COLLISIONS

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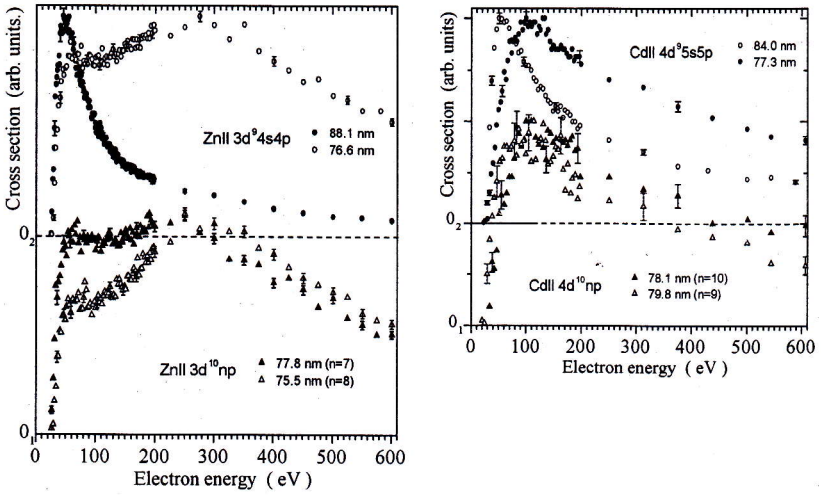
Recently we have investigated the ZnII and CdII spectra excitation in the 50-100 nm region at the electron-atom collisions. All these spectral lines correspond to the Zn^+ and Cd^+ ground-state combinations. Among them the lines arising from the d^9sp configuration levels dominate in intensity. The lines arising from the $d^{10}nl$ ($l = p, f$) configuration levels are weak. A considerable configuration interaction between the above two ionic level types is well known to cause the *np* and *nf* series perturbation [1].

Here we present the results on the excitation functions (EFs) obtained for some ZnII and CdII lines arising from both "perturbed" valence-electron levels and "perturbing" subvalence *d*-subshell-electron levels. The EFs for the corresponding ZnII (75.5, 77.8, and 76.6 nm) and CdII (78.1, 79.8, and 77.3 nm) lines have been obtained. Figure illustrates an unquestionable similarity in their general behaviour (for comparison the EFs of the most intense ZnII 88.1 nm and CdII 84.0 nm lines are shown). The above EFs similarity is, probably, also a demonstration of configuration mixing. The similar phenomenon was found when studying the electron-impact excitation of the alkali-earth atoms [2].



References:

1. Moore C.E. Atomic Energy Levels, NBS, (US), circ. 467, v.II (1952), v.III (1958).
2. Aleksakhin I.S., Starodub V.P. et. al. Optics and Spectroscopy, 35, 1037 (1973); 37, 20(1974); 37, 843 (1974); 38, 228 (1975) (in Russian)

TOTAL ELECTRON-IMPACT EXCITATION CROSS SECTIONS FOR LOW-ENERGY AUTOIONIZING STATES IN LITHIUM

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Recently we have reported the ejected-electron excitation functions for the lowest lithium atom $(1s2s^2)^2S$, $(1s2s2p)^4P_{1/2,3/2}$, $1s(2s2p^3P)\,^2P$ and $1s(2s2p^1P)\,^2P$ autoionizing states obtained at the magic angle of 54.7° [1]. Being of relative character such excitation functions correspond to the energy dependences of the total excitation cross section for these levels.

We have performed the PWBA calculations for the $1s^22s \rightarrow 1s2snl$ excitation process for the $(1s2s^2)^2S$ and $1s(2s2p^1P)\,^2P$ autoionizing states in lithium with the aim to normalize the experimental relative cross sections [1]. Figure shows a comparison of the experimental and theoretical results for the electron impact energies up to 600 eV. Above 200 eV there is a good agreement between both results. By normalizing our data for the $(1s2s^2)^2S$ state on a theoretical result at 600 eV we have obtained the absolute values of the total excitation cross section for all autoionizing states studied in [1]. The maximal values of the cross sections are given in table.

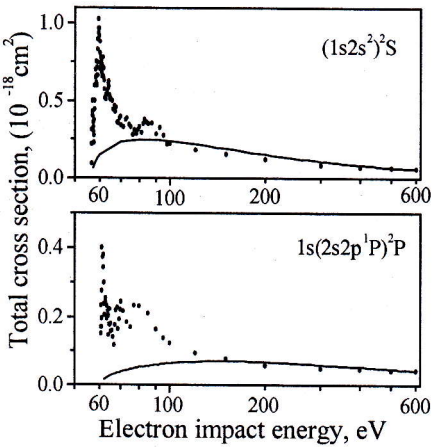

Figure. Total excitation cross sections for autoionizing states in lithium:
(•) - experiment [1],
(—) - PWBA calculation.

The quantitative analysis of the influence of the resonance and cascade processes on the electron-impact excitation of low-lying autoionizing states in lithium will be discussed at the conference.

AIS	σ_{max} (10^{-18} cm^2)
$(1s2s^2)^2S$	1.0
$(1s2s2p)^4P$	0.7
$1s(2s2p^3P)^2P$	1.0
$1s(2s2p^1P)^2P$	0.3

Reference:

1. A. A. Borovik and V. N. Krasilinec, J. Phys. B **32**, 1941 (1999).

CROSS SECTIONS FOR SLOW ELECTRON SCATTERING BY CADMIUM ATOMS

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The studies of electron collisions with atoms close to the relevant thresholds is of significant interest up to date. No data are available on the near-threshold excitation of the metal atom metastable states as well as on their contribution to the total scattering cross sections. The reliable data on the absolute cross sections for the above processes are also absent at all.

The goal of the present report is to show that the possibility to measure both the total electron scattering cross sections for the cadmium atoms and the ionization and excitation efficiency for the lower metastable levels at the constant scattering geometry as well as the efficiency of the detecting apparatus does exist symplifying, thus, their absolute normalization.

We have used the crossed electron and atomic beams method with the use of a hypocycloidal electron spectrometer to produce the electron beam and analyse the scattered electrons [1]. The cadmium atoms were formed by a compact stainless-steel effusion source with multichannel plate placed at the source exit.

Our results show a district structure in the energy dependence of the total electron scattering cross-section for cadmium atoms as well as in that of the energy dependence of differential elastic electron scattering cross-section at the angle 180^0 and the excitation functions for the metastable 5^3P Cd atom levels. The energy dependence of the ionization efficiency for the Cd atoms, besides the specific breaks close to the autoionization states, reveal a wide feature related to the excitation of the inner $4d^{10}$ shell in the Cd atom.

The energy dependences measured by us, the analysis of the experimental uncertainties and the identification of the fine structure in the curves will be presented at the conference.

This work was supported by the CRDF (prop.No 6435).

Reference:

1. Romanyuk M.I. et al. Sov.Phys. JTP 1993, V.63. P.138-147

RELATIVISTIC PERTURBATION THEORY CALCULATION OF THE Na-LIKE SPECTRA SATELLITES TO 2-3 Ne-LIKE IONS TRANSITIONS

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We present the results of the theoretical relativistic *ab initio* perturbation theory calculation results of energy spectra (excited and ground states energies, transition probabilities) of the 3-3,3-4 electron and 2-2 vacancy transitions for the Ne-like isoelectronic sequence (Z=21-96), the autoionization states for the Na-like ions: ClVII, ArVIII, Ti XII, FeXVI, Ge XXII, Se XXIV, Mo XXXII and others. Calculations are carried out on the basis of the new *ab initio* version [1-3], generalizing the known relativistic perturbation theory method with the zero-th *ab initio* and empirical effective potential approximation [4-9]. For construction of the optimal zero-th approximation it's used the *ab initio* QED procedure, within which the lowest order multielectron effects, in particular, the gauge dependent radiation contribution for the certain class of the photon propagator calibration is minimized . Such a minimization result in the construction of the optimal one-electron basis. As example, in table there are presented values of the energies [100(cm-1)] and probabilities [c(-1)] of electric dipole transitions into ground state for Ne-like ion of Ni. Dielectronic satellites to resonance 2-3 transitions of Ne-like ions are suggested as an instrument for the spectroscopic diagnostics of hot plasma. Comparison with experiment is carried out.

Level J=1	*	This work	*	This work
2p(3/2)3s(1/2)	71.280	71.261	7,6+11	8,4+11
2p(1/2)3s(1/2)	72.620	72.585	6,0+11	7,2+11
2p(3/2)3d(3/2)	78.130	78.115	1,4+11	1,6+11
2p(3/2)3d(5/2)	79.110	79.104	1,2+13	1,2+13
2p(1/2)3d(3/2)	80.520	80.518	3,2+13	3,6+13

(*- experiment and compillation: Grance M.).

References:

[1] S.V.Malinovskaya, Yu.G.Chernyakova, Preprint OHMI, N2-MAS,Odessa, 1998.
[2] S.V.Malinovskaya, Preprint OHMI N3-MAS, Odessa 1998.
[3] S.V.Malinovskaya, Yu.G.Chernyakova, Abstr.EGAS32, Vilnus (Litva), 2000.
[4] L.N.Ivanov, E.P.Ivanova, E.V.Aglitsky, Phys.Rep. 164 317-372 (1988)
[5] E.P.Ivanova, A.V.Gulov, Phys.Lett.A,140 39-43 (1989).
[6] E.P.Ivanova,L.N.Ivanov,A.V.Glushkov,A.E.Kramida, Phys.Scr.32,512 (1985).
[7] A.V.Glushkov, E.P.Ivanova, J.Quant.Spectr.Rad.Transfer (US)36 127-145(1986);
[8] A.V.Glushkov, L.N.Ivanov, Phys.Lett.A,170 33-38 (1992).
[9] A.V.Glushkov, Sov.JETP Lett, 55, 118-113 (1992).

DOUBLY-CHARGED ION FORMATION DURING MULTIPHOTON IONIZATION OF Ba ATOMS

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We peformed the detailed investigation of the mechanism of doubly-charged ions formation during multiphoton ionization of Ba atoms in visible spectral range (14900-18700 cm^{-1}) of field strength $\varepsilon=2\cdot10^6$ V/cm and pulse duration $\tau \approx 3\cdot10^{-8}$ s. It's known that the removal of two electrons can in general occur in two ways: by sequential ionization (step-wise mechanism) or by simultaneous removal of two electrons (direct two-electron mechanism).

For studying the mechanism of doubly charged ions formation we used the method of detection of yields of the singly and doubly charged ions as functions of dye laser frequency within wide spectral range. We observed many resonance maxima in the yields of Ba^+ and Ba^{2+} ions. The resonance maxima appearing in the yield of Ba^+ ions are due to two-photon excitation of bound states of Ba atom. The majority of resonance maxima in Ba^{2+} ions yield are identified in the spectrum of Ba^+ ion. We observed resonance transitions not only from ground ionic state but from excited ionic states as well. This fact indicates at the realization of step-wise mechanism of doubly charged ions formation.

At the same time some of the observed in the Ba^{2+} ions yield maxima couldn't be identified in the Ba^+ ion spectrum. We can suppose the realization of another, not step-wise, mechanism of Ba^{2+} ions formation at these frequencies.

PECULIARITIES OF SLOW ELECTRON SCATTERING BY Si-p(100) SURFACE

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Using the hypocycloidal electron spectrometer and the techniques developed earlier [1,2], the slow (0–5 eV) monoenergetic electron elastic (180°) reflection from Si-p(100) and the energy-loss spectra have been studied.

In comparison with [3] the spectrometer resolution was improved in the present experiment: for the elastic reflection it reaches 45 meV, while for the energy-loss spectra – 100 meV. This has allowed us not only to confirm the peculiarities found earlier but also to fix a series of new features. While in [3] the elastic reflection spectra have revealed the features only in a form of deviation from the smooth decrease in some areas of the curves within 0.5–2.0 eV and the exact determination of their energy position was somewhat problematic, the improvement in the spectrometer resolution has enabled the exact energy positions of singularities in the elastic reflection spectra to be determined (fig.1).

Side by side with the elastic reflection studies we have carried out the energy-loss spectra investigations at the incident electron energies from 0.5 to 5.0 eV. Figure 2 shows the most specific spectra at 1.0 eV (curve 1) and 3.0 eV (curve 2). The elastic scattering and loss spectra features below 1.14 eV are related to the excitation of surface electron states, while those above 1.14 eV – with the interband transitions in the Si bulk. It has been found that the excitation of surface electron states and the interband transitions are both of the resonant character. Therefore, the same features in the energy-loss spectra may be revealed differently depending on the incident electron energy.

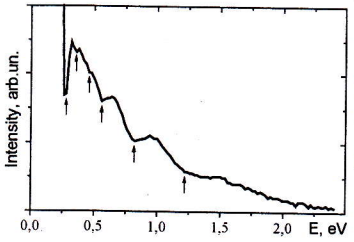

Fig.1

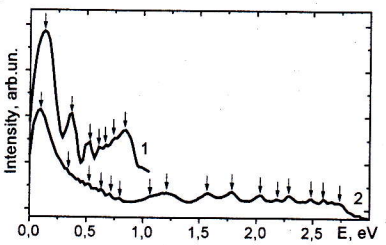

Fig.2

Finally, note a distinct correlation in the energy positions of the features in the elastic reflection (minima in the energy dependence, fig.1) and energy-loss spectra (maxima, fig. 2). Combination of such researches in the same experiment has allowed us to obtain an information both on the possible interband transitions and on the excitation of surface electron states in solids.

References:

1. O.B. Shpenik, M.M. Erdevdy, T.Yu. Popik. ZhTF, **67**, 103 (1997).(in Russian)
2. O.B. Shpenik, M.M. Erdevdy, M.I. Romanyuk et al. PTE, **41**, 66 (1998). (in Russian)
3. T.Yu.Popik, O.B.Shpenik, Yu.V.Popik et.al.// Proc. 8th Intern. Workshop Ion Beam Surf. Diagn. – Uzhgorod. – 1998. – P.36–39.

RYDBERG STATES OF DIATOMIC MOLECULES: *AB INITIO* PERTURBATION THEORY CALCULATION OF ALKALI DIMERS

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Within formally exact perturbation theory with *ab initio* two-center approximation, it has been carried out the calculation of the potential curves for the ground and excited states , spectroscopic characteristics for the whole number of the diatomic alkali dimers A2 (A=Li,Na,K,Cs,Fr). The high-order contributions (due to the polarization interaction between above-core" valence quasielectrons through polarizable core and mutual screening of "above-core" valence quasielectrons) are accounted effectively with the use of a new ab initio functionals. A semiempirical model of the Cohen-Schneider type is given for the treatment of the spin-orbit coupling effects. There have been predicted some unusual especialitites in the spectra of the heavy alkali diatomics. The new effect of giant splitting of the Fr dimer $2^3\Pi_g$ state due to the spin-orbit interaction has been predicted. The $2^3\Pi_g$ state is expected to be split into three different states: $2^3\Pi_{0g}$, $2^3\Pi_{1g}$, $2^3\Pi_{2g}$. One is now dealing with three separate electronic transitions rather than only one. Under availability of the a very narrow linewidth light source (laser) one may be able to detect these three electronic transitions separately. In table there are presented the calculated values of the spectroscopic constants [T_e –excitation energy (100 cm^{-1}); B_e, ϖ_e - rotation and vibration constants (cm^{-1})] for Rydberg states $n^1\Sigma_g^+$ (**n**=4-6) of Na_2 dimer, calculated by different methods: c- empirical pseudopotential (PP)+core polarization; b–Hartree-Fock *ab initio* PP+core polarization; d – this work; a – exp [1-3]. In paper there also considered the behaviour of Rydberg states studied in an external electric field.

		$4^1\Sigma_\sigma^+$	$5^1\Sigma_u^1$	$6^1\Sigma_u^+$		$4^1\Sigma_\sigma^+$	$5^1\Sigma_\sigma^+$	$6^1\Sigma_g^+$		$4^1\Sigma_\sigma^+$	$5^1\Sigma_g^+$	$6^1\Sigma_g^+$
A	T_e	283,3	317,7	325,6	B_e	0.0899	0,114	0,106	ω_e	108,7	109,4	123,7
B		285	319	327		0,0838	0,107	0,101		107	110	119
C		286	319	327		0,088	0,110	0,110		105	113	123
D		284	318	324		0,088	0,11	0,104		107	109	121

References:

[1] A.V.Glushkov, V.P.Kozlovskaya, Preprint ANMSC N3, Odessa,2000
[2] A.V.Glushkov, Opt. Spectr. **76**,N6 (1994); 84 , N5 (1998)
[3] A.Henriet, F.Masnou-Seeuws, J.Phys.B: 21 L339-348 (1988).

BOUND STATES IN QUARKONY AND SUPERATOMS SYSTEMS: ENERGY LEVELS SPLITTING. IONIZED SUPERATOMS SINGLE ELECTRONS COUNTER AND SUPERATOMS MASSIVE MEMORY CELLS

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In paper there are considered the problem of calculation of the bound states energies for following systems: heavy quarkony (bound stats of the quark-antiquark system) and superatom (spherical nucleus of some semiconductive material, alloyed selectively by donors and surrounded by the non-admixtured matrice of the material with less forbidden zone gap) [1-3]. Energy approach is developed for investigation of the spectroscopic characteristics for systems considered. Zero-th approximation is generated by the effective ab initio model functional, constructed on the basis of the gauge invariance principle. The wave functions zero-th basis is found from the Schrodinger equation with sphericaly symmetric potential which includes the potential of ionized donors, the Hartree-Foch-Kohn-Sham functional and the positive difference of minima for the nucleus and matrix conductivity zones. The correlation corrections of the high orders are taken into account within the Green functions method (with the use of the Feynman diagram's technique). There have taken into account all correlation corrections of the second order and dominated classes of the higher orders diagrams (electrons screening, particle-hole interaction, mass operator iterations) (c.f. details in ref.[4-7]). For superatomic system (Nucleus: $Al_{0.35}Ga_{0.65}As$; nuclei charge Z=20; Matrix: GaAs) it has been obtained the corresponding sequence of energy levels 1s2p3d.... . The superatomic radius is estimated as 390 A. There are fulfilled the energy splittings calculation for quarkony system with the use of the different forms of potential. In zero-th limit for E(2s)-E(2p) we have 800 MeV under m(Q)=45 GeV; under r□□ the 2s-2p and 2s-1s splittings resulted in ~140 MeV. There are considered and analysed the possibilities of creation of the single electrons counter on the basis of the ionized superatom and memory cells for computer systems on the basis of the superatoms massive [2,3].

References:

[1]. T. Inoshita , S.Ohnishi, A.Oshiyama, Phys.Rev.Lett.57, 2560 (1986).
[2]. H.Watanabe, T.Inoshita, Optoelectr.Device.Techn.1,33 (1986).
[3]. A.P.Silin, Phys.Solids (FTT) 29,331 (1987).
[4]. E.P.Ivanova, L.N.Ivanov, A.V.Glushkov,A.E.Kramida, Phys.Scr. 32 512 (1985)
[5]. A.V.Glushkov,L.N.Ivanov Phys.Lett A.170 33 (1992); P.Phys.B.26,L379 (1993).
[6]. A.V.Glushkov, JETP Lett. 55, 108 (1992); Opt.& Spectr. 66,31 (1989).
[7]. A.V.Glushkov, Ukr.Phys.Journ.(UFZh) 25,1422 (1989); 29, 583 (1993).

THREE-PHOTON IONIZATION OF NEUTRAL SAMARIUM

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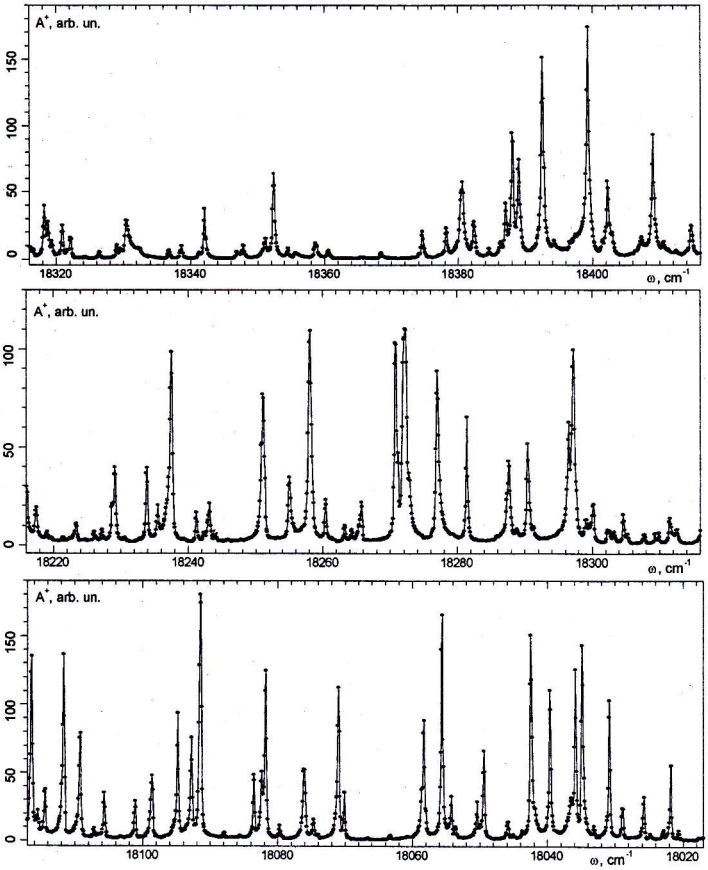
We have studied three-photon ionization of samarium atoms by laser radiation in the ω=17214÷18416 cm^{-1} spectral range. In the frequency dependence of three-photon ionization more than 400 maxima of different amplitude and shape have been found, most of them being due to the two-photon excitation of unknown up to date even bound states. Some of dependences obtained are shown in figures.



BOUND STATES IN CATALYSIS : NEW ELECTRODYNAMICAL AND QUANTUM CHEMICAL MODELS IN ELECTRON THEORY OF CATALYSIS

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A development of the comprehensive electron catalysis theory and a study of catalytic activity of the different materials (f.e., metal & semiconductors materials) is of a great importance,especially, under construction of the fuel elements, electrochemical and plasma chemical generators etc. In our paper we propose a new approach in the electron theory of catalysis, based on the electrodynamical and quantum-chemical modeling of catalytic processes on the metallic and non-metallic materials [1,2]. On the example of the model reactions: the hydrogen ionization reaction and oxygen electrorestoring there are found the electron structure parameters (the Fermi surface states density, the Fermi momentum and statical dielectrical permeability) which determine the catalytic activity of the metallic and semiconductive materials on relation to indicated reactions.

The key moment of models is in adequate choice of the effective potential field of materials medium and obtaining the direct link between electron structure parameters of materials and catalytic activity properties with further numeral solution of equations of the Schrodinger type and the bound states type analysis [1-3,]. Some catalytic activity predictions are made for different materials (transition metals and alloys, semiconductors [4-6], lanthanides perovskites ABO_3 [2,7]).

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References:

[1]. A.V.Glushkov, .Electrochemistry, 27,131 (1991); 29,369 (1993).
[2].A.V.Glushkov,Yu.A.Kruglyak,V.D.Parkhomenko,P.N.Tsybulev,A.S.Katashinsky Proc.REHE Workshop on "Spin-Orbit Coupling in Chem. Reactions".- Copernicus Univ.,Torun, Poland, (1998).
[3]. A.V.Glushkov, L.N.Ivanov, J.Phys.B.,26, L379 (1993).
[4]. A.V.Glushkov, Abstr. 5th European Workshop on QSChPh, Uppsala,(2000);
[5]. A.V.Glushkov, Proc.12th Int.Congress on Catalysis , Granada, (2000).
[6]. A.V.Glushkov, Proc. 220th National Meeting of Amer.Chem.Soc.(Catalysis and Plasma Technologies), Washington,(2000).
[7].A.V.Glushkov,Yu.A.Kruglyak,V.D.Parkhomenko et al, Cat.Lett., to be publ.

EXCITATION OF LASER TRANSITIONS FROM THE $4d^9 5s^2\ ^2D_{5/2,3/2}$-LEVELS OF Cd^+ ION IN ELECTRON-ION COLLISIONS

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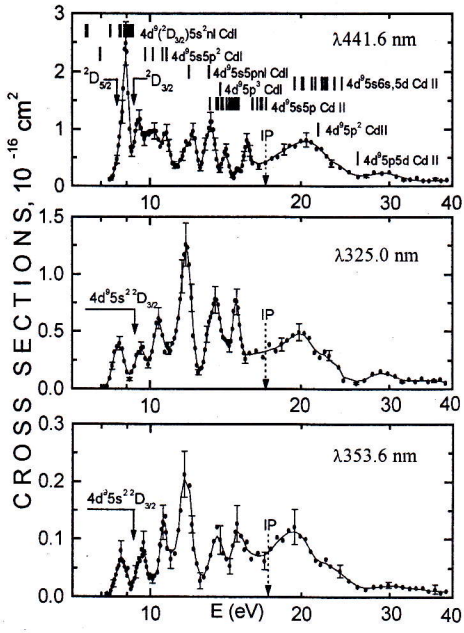
A precise investigation of the electron-impact excitation emission cross sections for the laser transitions of the Cd^+ ion have been carried out by the spectroscopic method using the crossed electron and ion beam technique. A significant role of the resonance processes was found near the excitation threshold up to the Cd II ionization potential. The following processes have been studied from the thresholds up to 40 eV

$$e + Cd^+ (4d^{10}5s)\ ^2S_{1/2} \rightarrow e + Cd^{+*} (4d^9 5s^2)\ ^2D_{5/2,3/2} \rightarrow e + Cd^{+*} (4d^{10}5p)\ ^2P^o_{1/2,3/2} + h\nu_n$$

The Cd^+ ions produced in the low-voltage discharge ($U_d < 12$ V) ion source were formed into a beam by an ion-optical system and separated from the Cd atoms by a 90° electrostatic capacitor. The ion beam (E_i=600 eV, $I_i = 6 \cdot 10^{-7}$ A) was intersected at right angle by a ribbon electron beam (E_e = =7÷40 eV, $I_e = (7 \div 10) \cdot 10^{-5}$ A, $\Delta E_{1/2}$=0.35 eV energy spread, FWHM) at a pressure of 10^{-8} Torr. The signal of (3÷0.5) s^{-1} magnitude at the signal-to-noise ratio of (1/15÷1/30) was distinguished against the background using a rectangular phase-shifted pulse modulation of both beams. The uncertainty of the relative emission cross section (bars in fig.) was evaluated to be about ±15÷20%. The absolute value of the excitation cross section was obtained by normalizing the experimental excitation function on the 15 states close-coupling calculation [1] at the 40 eV electron energy. The uncertainty for the absolute cross section determination was about ±15%.



The excitation functions have revealed the distinct resonance features not observed earlier [2]. A dominant contribution of the resonance processes via the Coster-Kronig decay of the $4d^9(^2D_{3/2})5s^2nl$ autoionizing states was observed between the $^2D_{5/2}$ and $^2D_{3/2}$ levels splitting (ΔE = 0.69 eV) for the λ441.6 nm line. The dielectronic satellites for the λ325.0 nm and λ353.6 nm lines were observed below their excitation thresholds.

1. O.I. Zatsarinny, L.A. Bandurina, Opt. i Spektr., 2000 (to be published). **2.** K. Hane, T. Goto, and S. Hattori, Phys. Rev. **A 27**, 124-131 (1983), J. Phys. **B16,** 629-637 (1983).

OPTICAL ABSORPTION SPECTRA OF X-RAY IRRADIATED $CdS_{1-x}Se_x$ QUANTUM DOTS

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In the recent decade $CdS_{1-x}Se_x$ quantum dots embedded in a glass matrix have been attracting extensive interest in view of wide possible applications as well as due to quantum-size effects resulting from the spatial confinement of charge-carrier motion. The parameters of the quantum dots embedded in a glass matrix can be varied by both technological conditions and external factors. Substantial changes in the quantum dots optical properties can be achieved by intense light [1], X-ray [2] and high-energy electron [3] irradiation.

Here we report the X-ray (molybdenum anticathode tube, 40 kV, 20 mA) irradiation effect upon the quantum-size levels revealing in optical absorption spectra of $CdS_{1-x}Se_x$ quantum dots, illustrated by Fig. 1.

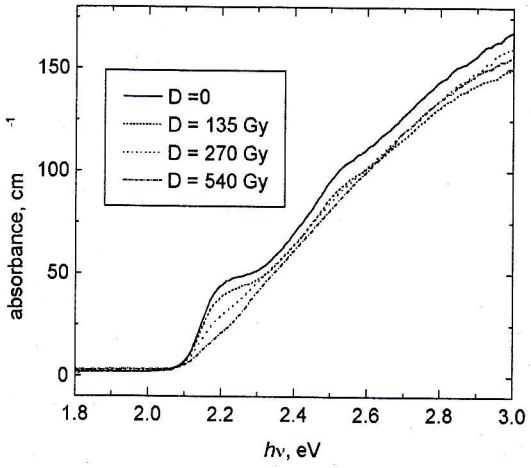

Fig. 1. Optical absorption spectra of X-ray irradiated $CdS_{0.32}Se_{0.68}$ quantum dots in a glass matrix

The quantum-size levels, revealing as below-gap absorption maxima in the non-irradiated $CdS_{0.32}Se_{0.68}$ quantum dots spectra, are seen to smear and vanish at the exposed dose D up to 540 Gy. Subsequent X-ray irradiation with up to 2700 Gy does not result in any essential changes.

The isochronal (20 min) annealing studies of the irradiated samples have shown the recovery of the quantum-size-related absorption features in the range of 510–560 K.

The mechanisms responsible for the observed changes in $CdS_{1-x}Se_x$ quantum dots absorption under X-ray irradiation are discussed.

References:

1. A.I.Ekimov and A.L.Efros. Phys. Stat. Sol. (b) **150**, 627 (1988).
2. T.Miyoshi, H.Furukawa, K.Nitta et. al. Sol. St. Commun. **104**, 451 (1997).
3. A.V.Gomonnai, Yu.M.Azhniuk, D.B.Goyer, and I.G.Megela, In: Optical Diagnostics of Materials and Devices for Opto-, Micro- and Quantum Electronics. Abstr. 4th Int. Conf. (SPIE, Kiev, 1999), p. 35.

POPULATION DENSITY OF THE $B^2\Sigma_{1/2}^+$- STATE OF MERCURY MONOBROMIDE AND MONOCHLORIDE IN EXCIMER SOURCES OF RADIATION

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The data on the populations of excited states of excimer molecules are actual in connection with the creation of effective gas-discharge sources of radiation. Without these data it is difficult to carry out the optimization of excitation of excimer mercury monobromide and monochloride molecules (HgBr* and HgCl*) in working mixtures of both lasers and lamps.

We have calculated the population of the $B^2\Sigma_{1/2}^+$-state in HgBr* and HgCl* molecules for weakly ionized (degree of ionization $\leq 10^{-6}$) gas-discharge plasma of a pulse-periodic discharge in binary mixtures of mercury dibromide and dichloride with helium and neon depending on the value of parameter E/p at the ratio $HgBr_2(HgCl_2)$:He(Ne)=0.5:99.5 and total pressure of the mixtures equal to 115 kPa. Such percent ratio was selected from optimal conditions of approaching to the most effective composition of mixtures by energy characteristics of discharge radiation, which were obtained experimentally in gas-discharge excimer lamp [1].

The populations of $B^2\Sigma_{1/2}^+$-state in mercury monohalides were found from the kinetic equation for the population of this state. In the equation the processes were taken into account, that result in the population and decay of this state: dissociative excitation of mercury dihalides by electrons, its spontaneous radiative decay and quenching by molecules of mercury dihalides [2].

The population of the $B^2\Sigma_{1/2}^+$-state in HgBr* molecules is equal to $3.25 \cdot 10^{13}$ sm^3 and it is 5.2 times larger than for HgCl* molecules in mixtures with helium and 4.6 times in mixtures with a neon at E/p=3 V $sm^{-1}(mm\ Hg)^{-1}$. The populations of HgBr* and HgCl* molecules in mixture with helium are larger than those in mixture with neon. Maximum populations of the $B^2\Sigma_{1/2}^+$-state in mercury monohalides are achieved with E/p=2-5 V $cm^{-1}(mm\ Hg)^{-1}$.

The obtained values of the population $B^2\Sigma_{1/2}^+$-state in HgBr* and HgCl* molecules in the gas-discharge excimer lamp [1] are high and they are close to the detected data on the population in active media of lasers at the same values of E/p parameter.

References:

1. A.N. Malinin, L.L. Shimon, N.N. Guivan, A.V. Polyak, Atmospheric and Ocean Optics. **12**, №11, 1024, (1999).
2. A.N. Malinin, Laser Physics.**7**, №6, 1177, (1997).

THE STUDY OF INTEGRAL EXCITATION CROSS-SECTION OF ISOMERIC STATES OF NUCLEI IN (γ,γ') REACTION

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Paper [1] shows that a series of maxima and minima is observed for all the isotopes at the cross section energy dependence which testifies to the fact of activation levels present at such energies.

The aim of the present paper is to study $A(\gamma,\gamma')^{m}A$ reaction excitation function for the ^{77}Se, ^{111}Cd, ^{179}Hf in 7-9.2 MeV range of energy and checking the availablity of activations levels in this range of energy . Activation method [2] at bremsstrahlung beam of M-10 microtron at the DNP of Uzghorod State University.

The samples being irradiated, the maximum energy of bremsstrahlung beam has changed with 0.1-0.2 MeV step. For monitoring of bremsstrahlung radiation the ionisation chamber has been used, its current has been transmitted upon integrating RC-chain. The given activity in the samples has been detected by the scintillation gamma spectrometer with 60*60 mm size NaI crystal.

The integral cross section has been estimated by the formula [3]:

$$\sigma_{int} = \int_{E_p}^{E_m} \sigma(E_\gamma)\cdot dE_\gamma = \frac{Y(E_m)\cdot(E_m - E_t)}{\int_{E_p}^{E_m} W(E_m, E_\gamma)\cdot dE_\gamma}$$

where $Y(E_m)$-yield, $W(E_m,E_\gamma)$-spectrum of a bremsstrahlung radiation with maximum energy E_m, E_t-energy of first activation level for the corresponding isomer.

Abrupt breaks have not been observed at the graphics of integral cross section dependence upon maximum energy of bremsstrahlung in $^{77}Se(\gamma,\gamma')^{77m}Se$, $^{111}Cd(\gamma,\gamma')^{111m}Cd$ reactions which might have testified to the presence in this range energy of separate activation levels with large cross section.

$^{179}Hf(\gamma,\gamma')^{179m}Hf$ reaction. When natural Hf has been irradiated by bremsstrahlung with maximum energy larger than 6 Mev, 4 isomers may. be formed with 1 sec, 4,3 sec, 18.6. sec and 5,5 hour half-life periods, their gamma spectra hardly differ. In order to avoid these influence of these isomers irradiation upon our measurement we have chosen the following regime: the sample has been irradiated for 100 sec, cooled for 20 sec. and the measurement time has been 100 sec. Thus, the interfering isomers activity at the beginning of measurement has been decreased to 0,5 % of ^{179m}Hf isomer activity. The yield measurements have been carried out at the most intensive line with 0,215 MeV energy. At the integral cross section energy dependence two breaks have been observed at 6,2 and 7,2 MeV energies, and they testify to the activation level presence with large cross section at 6.2 MeV energy. The break at 7,2 MeV is connected with $^{180}Hf(\gamma,n)^{179m}Hf$ reaction threshold.

References:

1. J.A.Anderson. Nuclear photoactivation cross section for short-lived isomeric states excited with a 6 MeV linac. // Nucl. Instr. Meth. in Phys.Res.- **B 40/41**, 452 (1989).
2. J.Perdijon. L'analys par activation. // Masson et c ,editeurs Paris.- 1967, p.256.
3. Antonov A.D. et al. Measurement of integral cross-section for (γ,α) reaction in the giant dipole resonance region. // Journal of nuclear physics.- 1991.- v.53, 1 pt, p.14-19.

THE RADIAL HARMONIC OSCILLATOR PROBLEM: SOME RESULTS

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Author will present some results obtained recently for the radial harmonic oscillator and their possible applications in rovibrating diatomic molecule.

THERMOSTIMULATED LUMINESCENCE IN THE Tb-DOPED LITHIUM TETRABORATE POLYCRYSTALS

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Lithium tetraborate (LTB) is one of the promising matrices for thermoluminescencent dosimeters [1,2]. The results of the studies on the thermostimulated luminescence (TSL) in polycrystals doped with Mn, Cu, Ag and their combinations are discussed in a series of papers. It has been found that the TSL curve intensity and shape vary considerably with the dopant type and concentration. In addition, an information on the lanthanide-doped $Li_2B_4O_7$ luminescent properties is extremely scanty. It is known that these elements reveal the distinct luminescence properties and often serve as the activators of numerous nonluminescent mineral [2]. The present work concerns the TSL studies of Tb-doped $Li_2B_4O_7$ polycrystals.

The experimental studies of the TSL curves were carried out by using an automated apparatus [3]. It has been found that the TSL curves for $Li_2B_4O_7$:Tb polycrystals have three maxima, i.e. the low-temperature (50-150°C), the intermediate-temperature (160-250°C) and the high-temperature (310-420°C) maxima denoted by A, B and C, respectively. At the minimal activator concentration, the maximum A is the less intense one. With the Tb concentration increase up to 5 mol%, its intensity rises, while the maximum itself is shifted towards the higher temperatures. At all Tb concentrations, the largest TSL intensity was observed for the maximum C. The fact that the release of the carriers from the local trapping levels for this maximum occurs above 300°C allows one to suggest $Li_2B_4O_7$:Tb for the use in the thermoluminescence dosimeters that may accumulate the dose at high temperatures. A large half-width of the TSL maxima, a considerable concentration dependence and some peculiarities in the TSL curves testify the complicated structure of the maxima, i.e., they are due to the presence of several local charge carrier trapping levels or their quasi-continuous distribution.

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References:

1. S.W.S. McKeever, M. Moscovitch and P.D. Townsend. Thermoluminescence dosimetry materials: properties and uses. – Ashford: Nuclear Technology Publishing, 1995. – 214 p.
2. Tarashchan A.N. Luminescence of minerals. K.: Naukova Dumka, 1978. - 296 p.
3. Hunda B.M. An Automated Experimental Apparatus for X-Ray Luminescence and Thermostimulated Luminescence Studies in Materials. // Uzh. State Univ. Bulletin. ser. Physics. 1999, No 5, - p. 198-212.

THE USE OF THE PHOTO- AND NEUTRON ACTIVATION ANALYSIS IN DETERMINING Eu CONTENT IN LITHIUM TETRABORATE

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Copper-doped crystalline lithium tetraborate $Li_2B_4O_7$ (LTB) is widely used as the material for the production of high-sensitive thermoluminescent (TL) detectors of ionizing radiation [1]. The works on the development of LTB-based TL-materials with enhanced characteristics, in particular, LTB:Eu are in progress [2,3]. In the present paper, the method of determination of europium content in LTB by means of photo- and neutron-activation analysis has been suggested.

Eu content was determined with respect to the final activation product Eu-152m produced in the following reaction:

Eu-151 (n_{th}, γ) Eu-152m

Eu-153 (γ, n) Eu-152m

The Eu-doped samples were activated at the fast neutron Pu-Be source with the $2.73 \cdot 10^6$ n/s neutron yield (activation time 144h) and at the M-30 microtron ($E_{\gamma max}$=17,6 MeV, activation time – 0,5-1,5 h). Neutrons were decelerated to the thermal energies by means of the conventional 6 cm thick „neutron-stop" blocks.

The spectra (analitical lines Eu-152m – 841,6 and 963,4) were measured by using the PC-interfaced certified γ-spectrometric SBS-40 complex and a cylindrical semiconductor high-resolution Ge(Li)-detector (100 cm^3 volume). The spectrometric information processing and γ-active nuclide identification were carried out with the help of a standard software with a database comprising more than 360 isotopes (within the 45-3100 keV energy range). The optimal regimes of activation, cooling and measurement have been chosen to determine Eu content in LTB. A statistical error for all series of measurements did not exceed 3%.

This work was supported by the STCU Grant #576

References:

1. Furetta C., Weng P.S. Operation Thermoluminescent dosimetry. London: World scientific. - 1998. - 250p.
2. Furetta C., Sanipoli C., Scacco A., Somaiah K. –Rad. Prot. Dosim. –1996. –v.65. – N1-4. –p.339-342.
3. Baumer V.N., Grin L.A., Dolzhenkova E.F., Dubovik M.F., Tolmachev A.V. – Functional Materials. –1999. –v.6. –N1. –p.154-157.

ON THE POSSIBILITY TO DETERMINE REPULSIVE POTENTIALS IN eV REGION FROM FAST MOLECULAR BEAM SCATTERING EXPERIMENTS

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It is not an easy problem to obtain the interaction potentials by fast molecular beam (energy ~ 1keV) scattering experiments. The collisions were traditionally considered as the elastic ones in such experiments. The concept is usually true for the rare gas scattering but if one of the colliding sides is a molecule the inelastic processes may take place. So it is necessary to make sure are the resulting collisions are elastic or not. To solve this problem we have designed and build up an experimental set up which permits not only to measure the scattering angle but gives the possibility to measure the energy of the fast particles. The differential cross sections and the energy loss spectra measured in such experiments allow to deduce the elastic and inelastic differential cross sections values. The procedure to find the interaction potential out of these differential cross sections is proposed. It also includes measurements of the absolute integral cross sections. Using the differential and integral cross sections one can obtain the scattering angle function of the impact parameters. The differential cross-sections are always measured within a limited range of scattering angles so the function is also available for the limited range of impact parameters. Yet to solve inversion problem it is necessary to have the scattering angle function of the impact parameter up to b= ∞. The known theoretical or experimental interaction potential describing the potential well and long range attractive part was used to overcome this problem. The scattering angle impact parameter function was calculated for large b for this potential. Experimental and calculated curves are aligned by the interpolation line and thus the united deflection function (experimental, interpolated, calculated) is used to restore the repulsive interaction potential with Firsov inversion formula. The potential determination results are illustrated by He-N_2, N_2-N_2 examples.

THE INFLUENCE OF DOMAIN WALLS ON THE PHYSICAL PROPERTIES OF SbSJ AND $Sn_2P_2S_6$ FERROELECTRICS

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The presence of domain walls in ferroelectric crystals is taken into account in the description of their physical properties according to the Landau thermodynamic theory. It is shown, that such account results in occurrence essentially new effect - renormalization of coefficient near P^2 and accordingly to displacement ΔT_c of Curie temperature.

Experimentally the influence of domain structure condition on temperature of phase transition in crystals *SbSJ* and $Sn_2P_2S_6$ was studied by measuring temperature dependences of complex dielectric susceptibility components measured along ferroelectric axis. The measurements were carried out on qualitative monocrystals, growing up from a gas phase, and having sharp express anomaly near phase transition with the maximum of dielectric susceptibility $\varepsilon'_{max} \cong (2 \div 3) \cdot 10^4$.

Width and surface energy density of domain walls of these crystals gives values $\xi = 1 \div 10$ nm, $W_\sigma \cong (2 \div 20) \cdot 10^{-3}$ J/m^2 which are near equal to the appropriate values for $BaTiO_3$ and for *TGS*. The dependence of temperature displacement of phase transition on the amplitude E_b of a pulse bias electric field during $10\text{-}10^2$ sec, applied to polidomain crystals in ferroelectric phase is investigated. With growth of E_b the difference between temperatures of phase transitions in mono- and polidomain crystals decreases and becomes equal to zero at the moment when the value of E_b became close to the value of coercitive field of the sample.

This fact is explained by integration of domains which polarization vector parallel to the direction of the field E_b. ΔT_c depends on quality of samples, and also on conditions of experiment, because it is determined by concentration of domain borders, which are sensitive to the different sort of external influences and to the crystal defects.

References:

1. Жирнов В.А. Ж. эксп. и теор физ., 1958, №5 (11), с. 1175-1180.
2. Иванчик И.И. Физ твердого тела, 1961, вып.3, №12, с.3731 – 3742.
3. Смоленский Г.А. и др. Сегнетоэлектрики и антисегнетоэлектрики. Л.: Наука, 1971. –476 с.
4. Градштейн И.С. Таблицы интегралов.– М.:Гос.изд физ.-мат.лит.,1963. – 1100с.

ASYMPTOTIC APPROACH TO THE PROCESSES OF TWO ELECTRON CAPTURE AT SLOW ION-ATOM COLLISION

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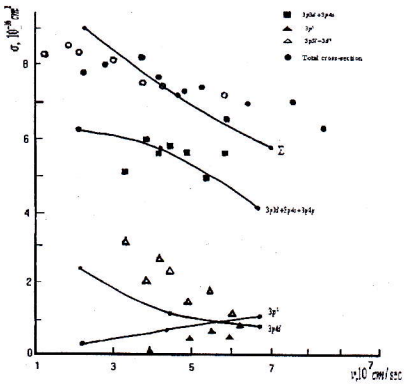
Two-electron capture at the slow ion-atomic collision is under consideration within the framework of asymptotic approach. Cross section of one- and two-electron processes at the separate final state is calculated using the method of close-coupling channels. Different ways of two-electron transfer (straight $A+B^{Zb+}\to A^{2+}+B^{(Zb-2)+}$ and step-by-step $A+B^{Zb+}\to A^{+}+B^{(Zb-1)+}\to A^{2+}+B^{(Zb-2)+}$) and relative contribution of them to the total cross section of process have been investigated. Two ways of representation for active tunneling electrons correlation interaction – multipole approximation and exact expression using the Fourier-image has have been considered. Described approaches were applied to the investigation of the two-electron charge-exchange

$$He\left(1s^2\right)+Ar^{6+}\left(3s^2\right)\to He^{++}+Ar^{4+}\left(3s^2n_1l_1n_2l_2\right).$$

The theoretical results on the total and partial cross-section are seen to be in a good agreement with experimental data (see fig.1).



An analytic expression of Coulomb one-electron, the three-center Green`s function, is derived within the asymptotic approach. Obtained result was used to calculate electron wavefunction of atomic ion at the vicinity of distant molecular ion, and furthermore for to obtain the analytic expression of the matrix element for two-electrons exchange interaction of the highly charged ion with molecular ion. Non center molecular field is taken into account using the exact expression (series expand) for one-electron two-center radial Green`s function.

Total cross-section of two-electron transfer for reaction $He^{++}+H_2\to He+2p$ was computed within the framework of close-coupling channels method and different nonadiabatic coupling models.

PHOTOREFRACTIVE PROPERTIES OF MODIFIED $Sn_2P_2S_6$

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Tin hypotiodiphosphate $Sn_2P_2S_6$ is a ferroelectric photorefractive material, suitable for photorefractive applications such as coherent beam amplification, phase conjugation and laser beam clean-up, image processing, etc. The photosensitivity of the crystal covers the range from 530 to 1300 nm.

In the communication the results of the investigations of optical and photorefractive properties of the $Sn_2P_2S_6$ crystals are presented. The experimental studies of two-wave mixing, photorefractive beam fanning and parametric scattering were performed using red (He-Ne) laser beams (633 nm). On the base of analyzing obtained data a set of the microscopic parameters responsible for the photorefraction were evaluated. It is shown that these parameters (two-beam gain coefficient, response time constant) can be effectively modified by post-grown treatment (light irradiation, thermal annealing), as well as by vapor-transport growth conditions. The best modified $Sn_2P_2S_6$ samples exhibit large values of the gain coefficient (up to 38 cm^{-1}) at the comparatively short response time (~100 ms).

Applicability of the proposed crystals as a material for real time image processing system was demonstrated on example of the novelty filters in one- and two-beam schemes, that give possibility to visualize moving objects and enhance their edges with high contrast and relatively high transformation rate.

STIMULATING THE SUPERPLASTIC DEFORMATION OF THE Al-Mg-Cu-Si-Mn-Zr ALLOY BY THE PRELIMINARY PULSE ELECTRON BEAM IRRADIATION

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Preliminary results of investigation of the influence of super-hard X-ray radiation on the indices of superplasticity of a low-doped aluminum alloy of the "avial" type are presented. Mechanical elongation tests were performed in the air in the creep regime at a constantly acting flow stress. Characteristic features of the development of the grain and porous structures in the course of superplastic deformation were studied by means of light microscopy, using standard methods of quantitative metallography. Irradiation of samples was performed at the pulse accelerator "Start" with the following parameters: the beam energy En=1 MeV, the current value In=10 kA, the current pulse duration (p=0 nanoseconds. The samples which had been exposed to the irradiation by 10-20 pulses of the braking X-ray radiation were deformed immediately after the irradiation. The results of investigation of the irradiated samples were compared with those for the samples which had not been exposed to irradiation. It has been established that under the same test conditions the deformation rate for the irradiated samples is almost two times higher than the rate for the ones which have not been irradiated. However, the optimal conditions for the superplasticity manifestation are shifted to the region of lower flow stress values. In the both cases the elongation up to fracture under the optimal conditions of the superplastic flow was of 200%. Investigations of the microstructure of the deformed irradiated samples have sown that it is analogous to the structure of the fractured samples which were deformed under the same conditions without irradiation.

Apparently, the increase of superplastic deformation rate which is observed after the irradiation and the decrease of the optimal flow stress could be caused by the increased extent of non-equilibricity of the grain boundaries due to the interaction of the material with the super-hard X-ray radiation and by the radiation-induced stimulation of the elementary deformation processes which occur under the conditions of superplastic flow.

ROLE OF CLOSE-COUPLING EFFECTS IN CONTINUUM FOR IONIZATION PROBLEMS

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Close-coupling equations for transition amplitudes are used for investigation of the ionization of hydrogenlike atom by intense monochromatic laser field [1]. The orthogonal and normalized basis in which the solution of the time dependent equation is expanded contains unperturbed wave functions of the discrete spectrum and generalized Coulomb wave functions of the continuum [2]. The latter takes into account the Coulomb potential of the atomic core and the additional momentum acquired by the electron in an external, time-dependent field.

For the investigation of the close-coupling equations the fact, that bound-free and free-free transitions are efficient in different regions of complex time plain, is used. Simplified equations are constructed. The equations for bound-free transitions are reduced to the ordinary differential equations. The equations for free-free transitions are solved by quadratures.

Results are obtained for ionization of a hydrogen atom from its ground state in strong and superstrong linearly polarized fields with the following parameters: the values of the light frequencies change from 0.01 to 0.3 atomic units, and the electric field values from 0.05 to 15 atomic units. Energy distributions and angular momentum distributions of electrons are also presented.

It is shown that in this case the ground state decays completely, and free-free transitions play a defining role in the dynamics of the process. The electron transitions from the continuum into the highest Rydberg states are also considered. The total population of all the Rydberg states is found to be less than 5%.

The range of applicability of the approach is discussed. A comparison with numerical results obtained by other authors [3] is given.

References:

1. N. B. Delone and V. P. Krainov, Usp. Fiz. Nauk **168**, 531 (1998).
2.L. P. Presnyakov, H. Tawara, I. Yu. Tolstikhina, D. B. Uskov, J. Phys. B **28**, 785 (1995).
3.E. Cormier, P. Lambropoulos, J. Phys. B **30**, 77 (1997).

USE OF WAVELETS IN POTENTIAL SCATTERING PROBLEMS

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Daubechies' compact support wavelets are applied for solving integral Lippmann-Schwinger equation describing particle scattering on a spherically symmetric potential. Structure of wavelet representation of physical operators is discussed. It is shown that for fast decaying potentials wavelets enable sparse approximation of the Lippmann-Schwinger equation kernel. Constraints for such potentials are derived.

INFLUENCE OF β-RADIATION ON OPTICAL ABSORPTION EDGE IN Cu_6PS_5I CRYSTALS

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Cu_6PS_5I crystals belong to an argyrodite family, being characterized by high concentration of disordered vacancies and known as fast-ion conductors and ferroelastics [1,2]. Below room temperature they undergo two phase transitions (PTs), one of them being superionic at T_s=(165–175) K, the other – ferroelastic at T_c = (269±2) K [2]. At room temperature Cu_6PS_5I compound crystallizes in cubic syngony (*F43m* space group) [1]. The low-temperature phase (at $T<T_c$) symmetry of Cu_6PS_5I crystals still remains undetermined.

Cu_6PS_5I crystals were obtained by chemical transport reactions method. Cu_6PS_5I crystal samples were irradiated with the fluence of 10^{15} cm^2 7-MeV electrons. Absorption edge spectra studies and isoabsorption measurements were carried out using the technique and setup described in [2].

The measurements have revealed the absorption edge in both non-irradiated and irradiated crystals at $T>T_s$ to be of Urbach shape, however, the Urbach edge convergence point coordinates increasing in the irradiated sample. The absorption edge analysis enabled its parameters to be determined as well as exciton-phonon interaction parameters. The irradiation is shown to result in the absorption edge blue shift by ≈ 0.003 eV (at T=300 K) and the absorption edge energy width increase from 21.0 meV to 22.4 meV (at T=300 K). Besides, a slight enhancement of the EPI is observed as well as the increase of the energy of effective phonon, participating in the absorption edge formation. Note that in the irradiated crystals the contribution of static structural disordering into the absorption edge energy width increases from 9.8 to 12.1 meV.

Irradiation results in the superionic PT temperature shift to lower temperatures as well as the PT smearing decrease. The ferroelastic PT temperature is shown to remain almost unchanged under irradiation.

References:

[1] W. F. Kuhs, R. Nitsche and K. Scheunemann, Mater. Res. Bull. **14**, 241 (1979).
[2] I. P. Studenyak, Gy. Sh. Kovacs, A. S. Orliukas, Ye. T. Kovacs, Izv. AN: Ser. Fiz. **56** 86 (1992).

THERMOGRAFIC AND X-RAY PHASE STUDIES OF UNDOPED AND DOPED LITHIUM TETRABORATE

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Lithium tetraborate (LTB) is a promising material for acousto- and optoelectronics, while the doped LTB is that for the production of tissue-equivalent structures, able to detect the ionizing radiation dose based on the thermostimulated luminescence (TSL) effect. It is also well known that the TSL efficiency depends to a great extent on the matrix phase state, deviation from stoichiometry as well as on the dopant nature and quantity. In view of the necessity to develop the optimal conditions of synthesis of undoped and doped LTB in different phase states with the controlled composition and reproducible TSL parameters, the thermogravimetric and X-ray phase studies of doped and undoped LTB are of high importance.

In the present paper, by using the thermogravimetric method, the conditions of LTB synthesis from the initial components (B_2O_3 and Li_2CO_3) by their melting at the 5°/min heating rate have been studied. It has been found that LTB synthesis proceeds in several stages. The synthesis thermogram reveals the endothermal effects of B_2O_3 dewatering within the 90-220°C interval, melting at 450°C and lithium carbonate decomposition at 620-630°C, two endothermal effects of LTB production at 640 and 745°C as well as the same effect of LTB melting. Based on these data the LTB synthesis regime has been suggested.

The effect of the LTB samples thermal prehistory on their structure has been studied. It has been shown that depending on the regime of LTB sample production from the melt (i.e. quenching and annealing) one can obtain the vitreous and crystalline LTB samples as well as those with coexisting vitreous and crystalline phases.

Since, according to the phase diagram [1], the Li_2O-B_2O_3 system allows the production of at least five compounds, we have studied, by using the thermogravimetry and X-ray phase tecniques, the influence of the deviation from stoichiometry within the LTB production region up to 9 mol.% Li_2O and B_2O_3 on the temperature transitions and the structure of the polycrystalline LTB. It has been found that at ≥ 3mol.% deviation from stoichiometry towards Li_2O and B_2O_3, the thermograms show the appearance of the additional endothermal effects, while the diffractograms – the redistribution of the intensity of the principal maxima in LTB as well as the occurrence of new maxima. Based on these data, one may conclude that at the Li_2O excess the LTB synthesis results in the production of $Li_2B_4O_7$- $LiBO_2$ mixed phase, while at the B_2O_3 excess - the $Li_2B_4O_7$-LiB_3O_5-LiB_8O_{13} mixed phase. These results may be used in estimating the deviation from stoichiometry in LTB.

References:

1. B.S.R. Sastry, F.A. Hummel, Journ. of the Americ. Ceramic. Soc., v. 41, No 1, p. 7-17 (1958).

PCI EFFECTS IN ELECTRON EXCITATION OF AUTOIONIZING STATES IN LITHIUM

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The near-threshold study of the electron impact excitation of autoionizing states is complicated by the post-collision interaction (PCI) effect causing the lines in the ejected-electron spectrum to shift in position and to obtain broadened non-Gaussian shapes [1].

In the present work, we report as the first observation of the PCI effect in the ejected-electron spectra of the $(1s2s^2)^2S$, $(1s2s2p)^4P_{1/2,3/2}$, $1s(2s2p^3P)\ ^2P$ and $1s(2s2p^1P)\ ^2P$ autoionizing states in lithium atoms. In order to reveal line shift, the spectra were precisely measured in the impact energy range from the excitation thresholds of levels up to 2 eV above with an energy resolution of the spectrometer of 0.2 eV and at an observation angle of 54.7°. The apparatus and measuring procedure were described earlier [2].

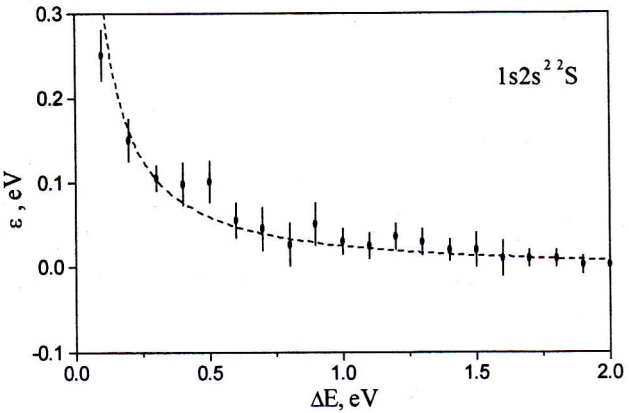

Figure shows a comparison between calculations using the formula $\varepsilon = A\Gamma(\Delta E^{-1/2} - E_e^{-1/2})$ [3] (broken line) and experimental data (full circles) for the $1s2s^2\ ^2S$ level (Γ=5 meV, E_e=51 eV). The results for other autoionizing states in lithium will be presented at the conference.

References:

[1] P.J. Hicks *et al*, Vacuum **24**, 573 (1974).
[2] A.A. Borovik and V.N. Krasilinec, J. Phys. B **32**, 1941 (1999).
[3] G.N. Ogurtsov, J. Phys. B **16**, L745 (1983).

H-LIKE AND He-LIKE SYSTEMS IN SUPERSTRONG MAGNETIC FIELD: NUMERIC CALCULATION

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The electron structure of atomic systems in strong magnetic field can be drastically changed (f.e.: white stars, pulsars etc.). The interest to this problem of the hydrogen atom in a static magnetic field has also been stimulated in last years by an experimental observation of complicated spectra with narrow resonances coexisting with broad one (c.f.[1-10]). Theoretical estimates of its spectrum have been performed in the frame of the different approaches, in particular, Random Matrix theory, the WKB approximation (c.f.[1-8]).It has been shown that the predictions of the theory in the immediate vicinity of the ionization threshold are to be improved. The present paper is devoted to a study of the structure of the quantum states of the H-like and He-like atomic systems in a static magnetic field (0.01-1.0; in units: $B_0 = m^2e^3c/h^3Z^3$). In calculation there are used representations for the wave function of problem hamiltonian (linear combination of the slater, hydrogen-like functions). The third variant is based on the correct numeral solution of the Schredinger equation with the use of the early developed method -the operator perturbation theory form and the well-known in the scattering theory "distorted -wave" approximation [1]. We have fulfilled the calculations of energy levels, dipole matrix elements and quadropole moments with arbitrary nuclear charge in the field interval 0,01 Z^2 <B< Z^2 . To calculate resonances widths G we have used the OPT method (see detailes in ref.[1]). Here we only note that the resonance width is defined by the imaginary part of the state energy in the lowest PT order:

$$\mathrm{Im}E = G/2 = \pi < \Psi_{Eb} | H | \Psi_{Es} >^2$$

with the total Hamiltonian. For interval (n-1/2)w<E<(n+1/2)w we have found that the resonances widths (H atom) are ~0.003-0.005 , which is reasonably agreed with the experimental data [4,5] and theoretical predictions [6,7]. For -1/2 w <E<1/2 w interval there has taken a place the regular dynamics, under the $E \sim w$ - chaotic one [8].

References:

[1] A.V.Glushkov, L.N.Ivanov, J.Phys.B:26 L379(1993);
[2] Atomic excitation,recombination in external fields. Gaithersburg, 1984.
[3] Rydberg states of atoms and molecules.-New-York.:Cambridge Univ.,1983.
[4] G.R.Welch et al Phys.Rev.Lett. 62 1975-1988 (1989).
[5] D.Kleppner, I.Chun-Ho, G.R.Welch, In: Irregular Atomic Systems & Quantum Chaos", 1990. Ed. Gay J.C.
[6] K.Dupret, J.Zakrzewski, D.Delande, Europhys.Lett.31 251(1995)
[7] A.V.Glushkov, Ambrosov S.V. et al, J.Techn.Phys. 37 211-219 (1997);
[8] A.V.Glushkov, I.V.Kuklina, Phys.Lett.A.,to be published.

COULOMB EFFECTS AT THE REACTION OF ONE-ELECTRON TRANSFER AT THE FRAME OF METHOD DISTORTED WAVES CONTINUES SPECTRA

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The processes of an one-electron charge-exchange

$$A^{Z_\alpha+} + B \to A^{(Z_\alpha-1)+} + B^+ \qquad (1)$$

recently became a subject of intensive experimental and theoretical study and in connection with making and operation of devices for realization of thermonuclear synthesis with a magnetic plasma confinement, development of new types of lasers, designing and use of accelerators of heavy ions of high energies, and also in view of necessity of exact ultra heavy rays interpretation. The items of information, necessary in these fields, on nuclear processes are not restricted about velocities of reaction, but include more detailed performances, such as spectra and angular distribution of products of reaction. It presence increased requirements as to completeness, and on the foreground is already telescoped not qualitative, but quantitative description of these processes, and to precision of theoretical and model calculations.

In present paper results of our investigation are given of process of an one-electron charge-exchange (1) at medial and high velocities of a relative motion. In particular, the basic attention is given to study of mechanisms of such reaction and their connection with angular distribution of products.

The updating of the Dodd-Greider`s integral equations is carried out for system of three charged particles, taking into account Coulomb asymptotic of wave functions in a problem of an inelastic dispersion with rearrangement. On this basis the theory of reaction of an one-electron capture is constructed at collision of a hydrogen-like atom with positive charged ion taking into account the effects multiple Coulomb re-scattering of an electron on the ion-residual of a target. The reaction of a resonant capture of a proton on atom of hydrogen $H^+ + H(1s) \to H(1s) + H^+$ is in more detail explored and is shown, that without correct accounts of a Coulomb interaction in a wave function of a final state it is impossible to reproduce Thomas`s peak in angular distribution of products. As a sequence of advantages (enough complete account post – collision interaction and prompt convergence of a series of a perturbation Dodd-Greider`s theory) the offered method gives in good conformity to experimental data as by total, and differential cross-sections.

WKB-METHOD IN THE TWO-CENTER PROBLEM FOR THE DIRAC EQUATION

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The modern achievements in heavy ion acceleration technology made it possible of experimental studies of heavy ion collision processes and in particular the one-electron capture process of highly charged ions:

$$A^{(Z_1-1)+} + B^{Z_2+} \to A^{Z_1+} + B^{(Z_1-1)+},\ Z_1, Z_2 >> 1 \qquad (1)$$

The theoretical description of such kind of processes reduces to correct determination exchange splitting $\Delta E = E_I - E_{II}$ of quasi-molecular terms of the system $(AB)^{(Z_1+Z_2-1)+}$, which correspond to the entrance and exit channels of the reaction (1). When Z_1 and Z_2 are very large, the relativistic effects on the motion of the active electron are not negligible and the determination of ΔE requires knowledge of the relativistic electron wavefunction. Since the Dirac equation with the potential of two Coulomb centers does not permit a complete separation of variables at any system of coordinates, the given problem does not have exact analytical solution. At the present paper we applied quasi-classical approach (WKB-method) for solving the two-Coulomb-center Dirac problem in a narrow region near the internuclear axis at asymptotically large internuclear distances R. Using this function we have derived several analytic formulae for the exchange splitting of the adiabatic potential curves $\Delta E(R)$ in the limit of long distances between interacting partners in all versions, ΔE is expressed through the known characteristics of disconnected atoms: charges of atomic (ion) cores Z_1, Z_2, asymptotic coefficients $A_{1,2}$, binding energies $\lambda_{1,2}^2/2$, and quantum numbers of the electron in the considered states of atoms (ions).

The results of the relativistic ΔE and analogous non-relativistic $\Delta E^{(n)}$ versions of the calculation of the exchange splitting between potential curves of the system (Z, e, Z) show that the relative contribution of relativistic effects amounts to about 50%, even at Z=48.

UNIFIED QUANTUM-MECHANICAL THEORY CALCULATIONS OF THE ELECTRON-POSITRON PAIR PRODUCTION IN INTENSE LASER FIELD AND IN HEAVY ATOMIC NUCLEUS COLLISIONS, ATOMIC PARITY NONCONSERVATION EFFECT

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A consistent unified quantum mechanical and quantum-electrodynamical approach (operator perturbation theory method and QED perturbation theory) is adapted to collision problem: The electron-positron pair production in collisions between two heavy nuclei and collisions between two atoms with the electron-ejection effect [1-5]. It is proposed the modified version of the many-body perturbation theory for calculation of the atomic parity nonconserving effect (it's applied to calculation of heavy atom of Cs). Method is in some details different from the other approaches (c.f.[7-8]). New calculation schemes for the electron-positron pair production in collisions between two heavy nuclei with near-threshold energy and in the intense laser field is considered. In first case a consistent quantum-mechanical approach (operator perturbation theory method) [1-4] to a electron-nuclear system as a whole is used account being taken of the relativistic nature of the electron subsystem. The model potential of the whole electron-nuclear system accounts the finite size of nuclei and possible resonances of the super-heavy compound nucleus formed from original nuclei [1]. Resonance phenomena in the nuclear subsystem lead to the structurization of the positron spectrum produced. To calculate the electron-positron pair production cross-section in both cases, we use modified versions of the relativistic energy approach, based on the S-matrix Gell-Mann and Low formalism (c.f.[1-5]). Some calculation results (U-U collisions etc.) are presented. New numerical calculation scheme for calculation of collisions process between two atoms with the electron-ejection effect has been proposed. There are presented the results of calculations for the energy levels, hyperfine structure intervals, E1-, M1-transitions amplitudes in heavy atoms of Cs, Sn, Pb (parity nonconserving 6s-7p dipole amplitude in Cs; calculation leads to the value: $<6s|Dz|7s>=-0.92xi10^{-11}i|e|ao(-Qw/N)$) and compared with other calculation [6,7].

References:

[1] L.N. Ivanov, T.V.Zueva,. Phys.Scr. 43, 374 (1991).
[2] A.V.Glushkov,L.N.Ivanov, Phys.Lett.A,170, 36 (1992); J.Phys.B:26,L379 (1993);
[3] A.V.Glushkov et al, J.Tech.Phys.38 213 (1997).
[4] L.N.Ivanov,E.P.Ivanova, L.V.Knight, Phys.Rev.A 48 4365 (1993).
[5] A.V.Glushkov, Ambrosov S.V., Malinovskaya S.V. J.Techn.Phys. 38 211 (1997).
[6] V.A.Dzuba,V.V.Flambaum,P.Silvestrov,O.Sushkov, Phys.Rev.A 44 2828 (1991).
[7] W.R.Johnson, J.Sapirstein, S.A.Blundell, Phys.Scr.46 184 (1993)

DYNAMICS OF POLARIZATION OF THE TWO-LEVEL MEDIUM IN LASER FIELD. PHOTON ECHO AND APPLICATIONS IN THE NEURAL NETWORKS THEORY

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In paper within the density matrices equations method and S-matrix formalism [1,2] there is considered the dynamics of populations and polarization of the two-levels medium under the coherent interaction of the laser radiation with medium. It has been solved the task on the propagation of amplitude-modulated laser radiation in the two-levels atoms gas. It's shown the possibility of the nonlinear transformation under definite conditions of the strong field energy to weak fields (c.f. [3]). It is considered the polarization of the resonant medium (medium is characterized by the distuning distribution) under effect of two separated in time laser radiation pulses. Induced dipole moment is defined by the square of both pulses. Diversity on the distunings resulted in the diversity of the oscillation phases for separated dipoles, creating the macroscopic medium polarization. The intensive radiation pulse is corresponding to the time moment of the restoring the synphase for microdipoles (photon echo). Multiphoton excitation realization of photon echo is also discussed.

At present time the photon echo effect can be considered as a new perspective physical principle for realization of the neural networks in optics, optical information processing systems, the operative memory systems in optical computers [4-7]. It is studied the possibility of operating the optical neural network, constructed with the use of the stimulated three-pulsed photon echo (multiphoton one). It has been fulfilled the modeling of the neural network with retarding for processing the complicated sequences of images. It is also considered the model dynamical system of the emitted oscillating dipoles and numerically studied the one-frequency synphase oscillations regime, multi-frequency synphase one and chaotic regime on the bifurcation diagram (physical example - a grid of the quantum generators connected through the general resonator).

References:

[1]. A.V.Glushkov, L.N.Ivanov , Preprint ISAN N3-AS-92, Moscow, 1992; Phys.Lett A.170 33 (1992); .
[2]. A.V.Glushkov, S.V.Ambrosov et al, J.Techn.Phys. 38, 213 (1997).
[3]. V.D.Tvorogov, V.G.Fedoseev, K.N.Ugay, Opt. Atm. 4, 625 (1991).
[4]. D.Psaltis, N.Farhat, Opt.Lett. 10, 98 (1985).
[5]. J.M.Goodman, A.R.Dias, L.M.Woody, Opt.Lett., 2, 1 (1978).
[6]. S.O.Elutin, S.M.Zaharov et al, JETP 88, 401 (1985).
[7]. E.N.Manykin, V.V.Samartsev, Optical Echo-Spectroscopy.-M.:Nauka, 1984.

PRODUCTION OF ZINC SULPHIDE- AND SODIUM FLUORIDE-DOPED LITHIUM TETRABORATE AND STUDIES OF ITS PROPERTIES

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Lithium tetraborate $Li_2B_4O_7$ (LTB) is a promising material for acousto- and optoelectronics and dosimetry. No data on LTB doping by I and II group element chalcogenides and halogenides are available in periodic literature.

We have performed a synthesis of LTB alloys in vacuum with argon supression of dissociation at $P=10^{-1}$ Tor with different percentage content of doping binary alloys, in particular, NaF and ZnS. It has been found that in order to produce the volume-homogeneous samples one has to obey the following technological regimes: vacuum - $5\cdot10^{-5}$-$1\cdot10^{-6}$ Torr, container temperature - 850÷900°C, synthesis duration – 20 min. A series of experimental samples in the amorphous state (based on the X-ray phase analysis data) were obtained with the doping component concentration being $5\cdot10^{-4}\div1\cdot10^{-5}$ mol (ZnS) and $1\cdot5\cdot10^{-4}$ mol (NaF). The character of the dependence of thermostimulated and X-ray luminescence in doped melts has been studied. The analysis of the TSL curves indicates their complicated nature. For the NaF–doped $Li_2B_4O_7$ alloys peculiar is the occurrence of a single peak at 283 K, while for the ZnS–doped samples – three peaks are observed at 350, 405 and 460 K, respectively.

The decrease of the dopant concentration results in the X-ray luminescence intensity rise. The analysis of the TSL and XL curves for obtained alloys indicates their promising nature in dosimetric applications.

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SUPERCONDUCTIVITY AT 100K IN CdBaCaCuO CERAMICS

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The last explored class of $ABa_2Ca_{n-1}Cu_nO_x$ HTSC homologous lines (A- Bi, Tl, Hg, n=1,2,3...) was the group of $HgBa_2Ca_{n-1}Cu_nO_x$ with crossover temperatures 94K (n=1), 123K (n=2), and 133K (n=3). It was associated with volatility, toxicity and difficult preparation technology of mercuric oxide. Cadmium is a candidate for inclusion in such system as analogue of mercury by chemical properties.

The similarity of the chemical properties and closeness of the ion radii of mercury and cadmium may prognoses the existence of homologous series $CdBa_2Ca_{n-1}Cu_nO_{2+2n+\delta}$.The attempt to make the $CdBa_2Ca_2Cu_3O_{8+\delta}$ was described in [1]. The multiphase samples was obtained and T_c =107 K was reported. Superconductivity was associated with $CdBaCaCuO_{4+\delta}$, $CdBaCa_2CuO_{5+\delta}$ and $Cd_2Ba_3Ca_3Cu_3O_{11+\delta}$ phases. The sample $Cd_{0.8}Ba_2(Y_{0.7}Ca_{0.4})Cu_{3.5}O_y$ with orthorhombic unit cell (type $YBa_2Cu_3O_7$) and T_c = 80 K was synthesized [2].

The samples of homologous series $CdBa_2Ca_{n-1}Cu_nO_{2n+2+\delta}$ (n = 0, 1, 2, 3, 4), $CdBaCaCuO_{4+\delta}$, $CdBaCa_2CuO_{5+\delta}$ and $Cd_2Ba_3Ca_3Cu_3O_{11+\delta}$ and $CdBa_2Cu_3O_{6+\delta}$ were prepared by solid state reaction. It was founded that samples $CdBa_2CaCuO_{5+\delta}$, $CdBa_2Ca_2Cu_3O_{8+\delta}$, $CdBa_2CaCu_2O_{6+\delta}$ have a superconducting transition at 90, 97 and 102 K, respectively. The presence of diamagnetic phases was confirmed by magnetic measurements. The presence of the original phases did not confirm, because all reflects was identified semiconducting $BaCuO_2$ and $CaCuO_2$. Superconductivity of samples we associate with changes of properties of aforementioned phases in result of Cd, Ba and Ca doping.

References:

1. N.Balchev, V. Lovchinov, E. Gattef et al. // J. Supercond. – 8, (1995) 329.
2. N.Balchev, K. Konstantinov, B. Kunev et al. // J. Supercond. – 12, (1999) 431.

BARIUM ISOTOPES AS THE OBJECT FOR STUDYING THE ISOMERIC RATIOS

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The cross-sections of excitation of isomeric states in (γ,n) reactions on barium - 129, 131, 135 isotopes in the energy range 8-17 MeV were investigated on a bremsstrahlung of the microtron M-30. The approximation parameters of the cross-section were as follows: σ_1 is the cross-section in maximum, E_1 is the energy of maximum, Γ_1 is the half-width (see in table):

*Tabl.*Lorenz curves parameters used for approximating the isomeric state excitation cross-section in the Ba isotopes.

Isotope	σ_1, mb	E_1, MeB	Γ_1, MeB	$(\pi/2)\sigma_1\Gamma_1=\sigma_{int}$mb·MeB
^{129m}Ba	68,6	15,6	3,26	351
^{131m}Ba	68,3	15,6	3,06	328
^{135m}Ba	62,1	15,5	3,19	311
^{137m}Ba	51,4	15,5	3,3	266

The following isomeric ratio values were obtained at the energy of 16 MeV:

^{129}Ba – R = 0,27
^{131}Ba – R = 0,25
^{135}Ba – R = 0,2
^{137}Ba – R = 0,14.

The estimated isomeric ratio determination error reaches ~ 15 %. It is seen from the above isomeric ratio values that isomeric ratios decrease with isotope mass: they are maximal for the lightest 129Ba isotope and minimal for 137Ba.

OPTICAL POTENTIAL MODEL FOR ELASTIC SCATTERING OF THE METASTABLE He(2 ^{1,3}S) ATOMS BY THE Na(3 ^{2}S) ATOMS IN THE 0.1 – 1000 meV ENERGY REGION

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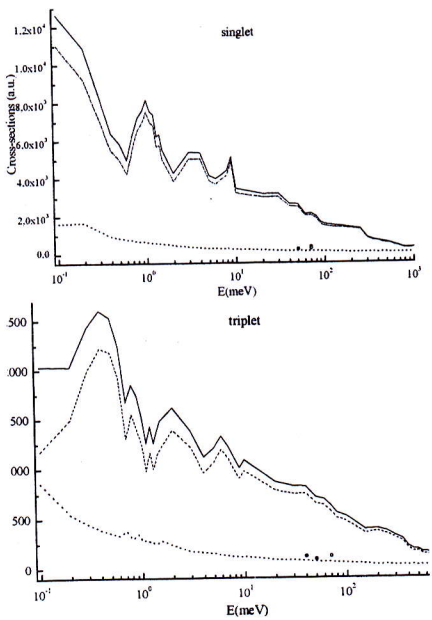
The theoretical method of the description of slow elastic atom-atom scattering in the optical potential approach, which has been tested for the metastable He* atom scattering by the ground state Na atoms at 68 meV energy [1] is presented. This method is applied for the investigation of the above process in the wide (0.1-1000 meV) atomic particle energy range. The description of the scattering process is based on the quantum and quasiclassical notions about the atomic interaction. The quantum description uses the phase function method for the scattering problem and for the phase analysis of the collision process. The quantum features play a decisive role in this process.



Optical potentials for these pair of atoms are known and their determination is based on the consideration of the He*Na quasimolecule as the autoionizing complex.

Figures present calculated quantum total (—), elastic (---) and Penning-ionization (···) cross sections together with the experimental (•) (error ±50%) and other theoretical (quasiclassical) (◦) data for the singlet and triplet helium scattering, respectively. The well defined structure of some cross sections require good explanation within the framework of the phase analysis.

Reference:

[1] Remeta E.Yu., Kelemen V.I., Zavilopulo A.N., Snegursky A.V. JETP, 2000, v.90, №2, 250-257.

OPTICAL POTENTIAL APPROACH FOR LOW-ENERGY ELECTRON ELASTIC SCATTERING BY THE Be, Mg, Ca, Ba AND Yb ATOMS IN THE FORWARD AND BACKWARD HEMISPHERES OF ANGLES

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The summarized material on the theoretical investigations of elastic slow electron scattering by alkaline-earth and Yb atoms to the interval of angles of forward and backward hemispheres depending on the collision energy E is presented. This interval is connected with the experimental conditions of the hypocycloidal electron spectrometer operation. The form of the analytical expression for the S(E) function (through the direct and interference terms) measured in such experiments results from the partial-wave expansion for the electron amplitude of scattering

$$S(E) = \frac{1}{2k^2}\sum_{l}(2l+1)[\eta_\ell^2 \sin^2 2\varepsilon_\ell + (1-\eta_\ell \cos 2\varepsilon_\ell)^2]Q_{\ell\ell}(E) +$$

$$+\frac{1}{k^2}\sum_{\ell,t>\ell}\sqrt{(2\ell+1)(2t+1)}[\eta_\ell\eta_t \sin 2\varepsilon_\ell \sin 2\varepsilon_t + (1-\eta_\ell \cos 2\varepsilon_\ell)(1-\eta_t \cos 2\varepsilon_t)]Q_{\ell t}(E),$$

where $k^2=2E$, functions $Q_{\ell t}(E)$ are connected with the Legendre polynomials $P_i(x)$:

$$Q_{\ell t}(E) = \frac{\sqrt{(2\ell+1)(2t+1)}}{2}\int_{x_1(E)}^{x_2(E)} dx P_\ell(x)P_t(x),$$

$$x_1(E) = \cos\theta_2(E), x_2(E) = \cos\theta_1(E).$$

Complex partial phase shifts $\delta_\ell(E) = \varepsilon_\ell(E) + i\cdot\overline{\eta}_\ell(E)$, $\eta_\ell(E) = \exp[-2\overline{\eta}_\ell(E)]$ are evaluated from the Schrodinger equation with the corresponding optical potential describing all complicated electron-atom interaction.

Special cases of the boundary angles of electron scattering in forward and backward hemispheres, are, respectively:

$$\theta_1(E) = \mathrm{Arc}\sin\sqrt{a/E}, \quad \theta_2(E) = \mathrm{Arc}\sin\sqrt{b/E},$$

$$\theta_{2,1} = 180^\circ \pm \mathrm{Arc}\sin\sqrt{c/E},$$

where constants a, b, c are given by the experimental conditions.

The influence of the P- and D-resonances on the S(E) function for the slow electron elastic scattering by atoms is analyzed and demonstrated in the various experimental conditions.

ELECTRON-IMPACT IONIZATION CROSS-SECTIONS OF Sr ATOMS FROM GROUND- AND METASTABLE STATES

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Present paper deals with experimental study of ionization of Sr atoms from ground- and triplet metastable states in the energy range from threshold up to 40 eV (for ground-state atoms) and to 20 eV (for metastable-states atoms). The process was studied in the normally crossed atomic and electron beams with ion detection in the analog mode. The idea of the experiment is presented in [1]. The ground-state and metastable-state concentrations in the region of interaction of the atoms with the electron beam were determined by an absorption method.

The results of the experiments are presented in the fig.1-2. The reliability of this method of investigation was confirmed by the fairly good consistency of our results on ground-state atom ionization with data of other papers [2]. The use of the electron monochromator allowed the structure in the energy dependence of ionization cross section for normal atoms (see fig.1) to be revealed in more detail within the 20-25 eV energy region. As is seen from curve 1 of fig.2, the energy dependence of the energy of the ionization cross section from the metastable state

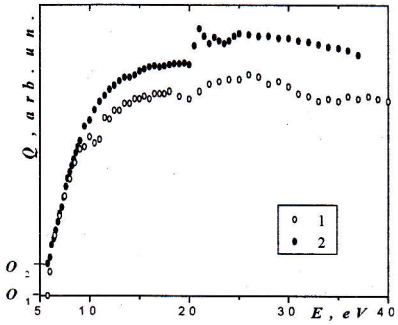

Fig.1. Effective ionization cross sections for Sr atoms from the ground state: Okuno [2] (1); present paper (2)

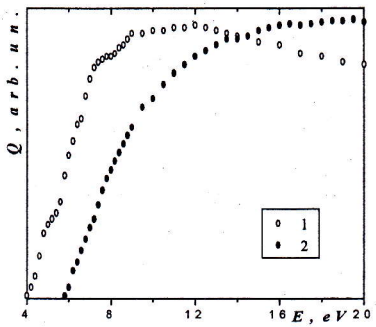

Fig.2. Effective ionization cross sections for Sr atoms from the triplet metastable states (1) and the ground-state (2)

reveals a flat maximum at E~11 eV, a structure at E~4.4-5.7 eV, shouldes at E~5.7 and 6.8 eV. The energy dependence of the ground-state atom's ionization coss section has the form a structureless monotonically increasing curve. Such discrepancy is mainly due to the different mechanisms of ion formation from the metastable and ground states.

References:

[1] Shafranyosh I.I., Margitich M.O.: Z.Phys.D. 37, 97 (1996)
[2] Okuno Y.: J.Phys.Soc.Jpn. 31, 1189 (1971)

ENERGY DEPENDENCES OF ELECTRON EXCITATION CROSS SECTIONS OUT OF METASTABLE STATES OF LOWER Mg, Ca AND Sr LEVELS

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A quite scarce opportunity to compare the experimental and theoretical results that, eventually, improves the reliability of the obtained information, has a great importance in studying the elementary processes of electron interactions with the excited atoms.

Here we report on some data on the energy dependences of electron excitation cross sections for spectral transitions to low-lying Mg, Ca, Sr levels (with minimal changes in the initial and final state quantum numbers) out of the metastable states and will compare them with the theoretical data [1,2] obtained earlier (the calculations were performed by the six-state close-coupling method).

The experiments were carried out by an optical method with the use of a crosses atomic and electron beam technique. The electron beam was produced by a five-electrode electron gun (beam current reached 30 μA at 30 eV, and the energy spread was 0.5 eV). The metastable alkaline-earth atom beam was produced by a discharge method, the metastable atom concentration was $(3\text{-}5)\cdot10^9 cm^{-3}$ (depending on the metal under study) based on the spectral line self-absorption data.

Figure shows the energy dependences of excitation cross sections (excitation functions, EF) for some spectral transitions (ST) – the first terms of the diffuse series. As is seen, for these ST, as a rule, are typical the smooth EF with maxima at few threshold units inherent in the dipole excitation. It seems quite reliable that the above EF are close (as a rule with no near-threshold features being taken

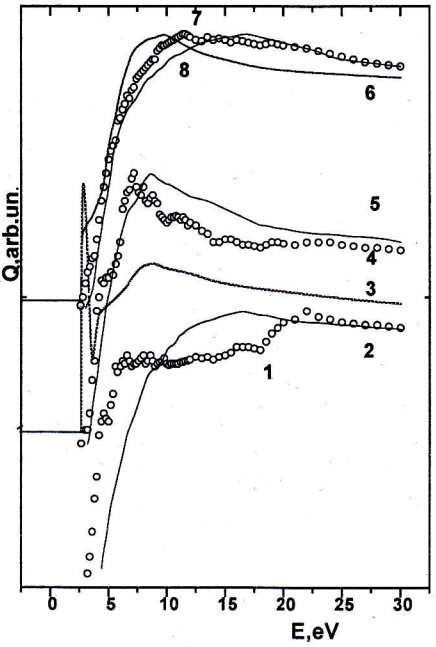

Figure. EF for some spectral transitions in Mg, Ca, Sr atoms out of the metastable (curves 1,3,4,7,8) and ground (curves 2,5,8) states.
Mg: $1 - 3^3P_J - 3^3D_J$; $2 - 3^1S_0 - 3^1P_1$;
Ca: $3,4 - 4^3P_2 - 4^3D_J$; $5 - 4^1S_0 - 4^1P_1$;
Sr: $6,7 - 5^3P_2 - 5^3D_J$; $8 - 5^1S_0 - 5^1P_1$

into account) to those for the resonant ST excited from the atomic ground states (see figure). It should be noted that the excitation cross section values are also quite similar (close to 10^{-15} cm^2 [1]). For the sake of completeness, the same figure illustrates also the theoretical data on EF for some ST out of the metastable states (curves 3, 6). For Ca atom the calculated EF (curve 3) indicates very clearly the presence of a near-threshold resonance observed first experimentally (curve 4). In general, it should be noted that the data obtained testify a fairly good agreement of the data for the lower states.

References:

1. I.I.Shafranyosh, T.A.Snegurskaya et al J.Phys. B: At. Mol. Opt. Phys. **30**, 2261–85 (1997)
2. V.I. Gedeon, V.I. Lengyel, O.I. Zatsarinny, C.A. Kocher, Phys. Rev. A, **56**, 3753–64 (1997)

ISOMER Hf-178M (16+) AS AN EFFECTIVE SOLID FOR THE REALIZATION OF A "HOT GAMMA-LASER"

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One of the major problems of realization of a gamma-laser is the maintenance of Mossbauer conditions for effective solid. As far as the effective solid undergoes the heating during the experiment mainly due to the nonresonance absorption of the gamma-quanta the preservation of the Mossbauer conditions is problematic: a number of problems, including those of technical nature arise regarding the heat abstraction and subsequent cooling of the reaction mass.

In this paper the possibility of the realization of a gamma-laser in conditions when the effective solid does not meet the Mossbauer temperatures conditions, i.e. the effective solid is in the so-called "hot state" is considered.

The possibility of the use of the 178m2Hf(16+) isomer nuclei as an effective solid for such a "hot gamma-laser" is examined.

In the paper the possibility of realization of the scheme of such gamma-laser is studied based on the hypothesis of one-nucleon interaction of the gamma-quanta with the nuclei and the nature of the isomers' nuclei is considered. The scheme based on 178mHf(16+) isomer is proposed. In particular the possibility of the observation of a non-coherent stimulated gamma-emission with the use of gamma-transitions from spontaneous decay of 178mHf(16+) isomer was studied.

QUASIMOLECULAR TERMS FOR SYSTEMS: "INERT GAS ATOM – HALOGEN ATOM", "INERT GAS ATOM – RARE EARTH ATOM"

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When studying the adrosbtion spectra on the magnetic dipole transitions of the rare earth atoms in the inert medium it is important to know the cross-sections of the depolarization and non-adiabatic transitions under atomic collisions. In the present paper there are presented the results of calculations of the quasimolecular terms (interatomic potentials) for the systems: "inert gas atom (Ne,Ar,Kr,Xe)-halogen atom in the ground state (F, Cl, I)" and "inert atom (He, Ar)- rare earth atom (Tm)". The calculations are carried out with use of a new effective pseudopotential method version (generalizing the known Baylis method) and the exchange perturbation theory [1-3]. To take into account the correlation-polarization effects , we propose a new form for polarization pseudopotential. It is obtained on the basis of the effective calculation for the main perturbation theory 'second order'polarization diagrams with the use of the Thomas-Fermi approximation and generalizes the known atomic polarization potential [1]. This DF has not any disadvantages,which are characteristic for the known Dalgarno potential. Some calculated parameters R (interatomic distance: in atomic units) and E (potential well depth: in meV) are presented in table 1 with some experimental data for the system: inert gas atom- Cl atom into ground state. In table 2 we present the calculated data for the interaction potential of the 4f-shell of the Tm atom with He and Ar atoms.

Table 1.

Halogen atom	Parameters	Inert atom Ne	Inert atom Ar	Inert atom Kr	Inert atom Xe
Cl (X1/2)	E [4]	-	-	-	35
	E this work	7,2	15	18	32
	R [4]	-	-	-	3,2
	R this work	3,2	3,3	3,4	3,6

Table 2.

R, a.u.	6	8	10	12
E:4f Tm-He/a.u.	0,98 10(-4)	0,73 10(-5)	0,44 10(-6)	0,24 10(-7)
E:4f Tm-Ar/a.u.	0,66 10(-3)	0,82 10(-4)	0,72 10(-5)	0,60 10(-6)

References:

[1] E.P.Ivanova, L.N.Ivanov, A.V.Glushkov, A.E.Kramida, Phys.Scripta, 32 (1985)
[2] A.V.Glushkov , Journ.Struct.Chem., ,**36**,N5, 608,615 (1996).
[3] A.V.Glushkov, V.N.Polischuk, et al, Opt.Spectr. (Rus.) 84 (1998) 501.
[4] A.A.Radtzig , Smirnov B.M. A handbook on Atomic and Molecular Physics, Moscow, Energoatomizdat, 1986.

FLUCTUATION EFFECTS IN HIGH-TEMPERATURE SUPERCONDUCTOR OXIDES

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Since the discovery of the high-temperature superconductors a lot of efforts have been undertaken to explain the different properties of these materials. One of them is the non-Gaussian thermodynamic fluctuation phenomenon near the superconducting phase transition. A different approach to this problem would be to develop a lot of models.

The amplitude fluctuation of the order parameter dominates above Ginsburg-Landau transition temperature T_c leading to paraconductivity. In the normal phase non-equilibrium Cooper pairs appear and decay, caused by change of density of states. The phase fluctuation of the order parameter below T_c generates resistance in thin wires and breakdown in fluxoid quantization of small rings.

The excess conductivity or paraconductivity is the additional conductivity caused by fluctuations. The study of temperature dependence of paraconductivity is a method to obtain parameters characteristic to superconducting phase. These fluctuations increase as the temperature approaches the critical one.

The first attempt to explain the excess conductivity which is the measurable manifestation of this kind of fluctuation was carried out by Aslamazov and Larkin (AL). They studied the permanent acceleration of Cooper pairs caused by fluctuations. In the case of cleaner films the experimental results were above the values predicted by AL theory. For this reason Maki and Thompson modified the original equation with an additional term, which originates from the indirect effect of the fluctuations on the quasiparticle conductivity. Lawrence and Doniach transformed the AL theory for anisotropic superconductors considering the two-dimensional fluctuation within layers and Josephson coupling between them.

The microscopic origin of high temperature superconductivity is still a major unsolved problem. Calculation of parameters like penetration depth and coherence length from fluctuation theories are extremely useful in uncovering some features of superconductors.

FORMATION OF NUCLEI ISOMERIC STATES IN THE PHOTOFISSION REACTIONS

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The excitation of isomeric states in the nuclei of ^{131}Te, ^{133}Te and ^{135}Xe is investigated. The independent isomeric yield ratios of ^{131}Te, ^{133}Te and ^{135}Xe have been determined in 16.5 MeV gamma induced fission of ^{232}Th and ^{238}U using gamma spectrometric techniques. The experiment was carried out on the variable energy microtron M-30 with the maximal energy of bremsstrahlung of 30 MeV at the Institute of Electron Physics in Uzhhorod.

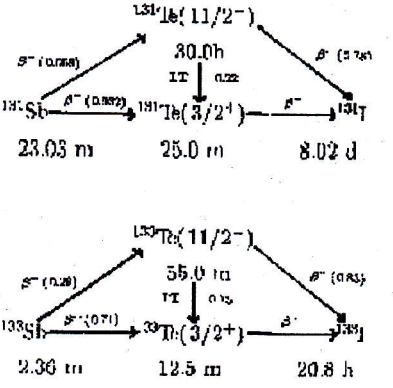

Figure 1. The isobaric decay chain for the mass number 131 and 133.

To obtain the independent isomeric yield ratio of the isotopes the precursor yield correction was done (see Fig.1).

Obtained data and the literature data for the same fragments show the following important features:

The value of the independent isomeric yield ratios depends on nuclear structure effects such as shell closure proximity.

The value of the independent isomeric yield ratios decreases with the decrease of the excitation energy. That might be a proof of predominating the cluster effects in the threshold energy fission.

ELECTRON SPECTROSCOPY STUDY OF METAL PARTICLE – GAS MOLECULE INTERACTION

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The changes of the physical properties occurring in the model system of the noble metal non continuous film deposited onto ceramic support and interacting with impinging gas molecules CO and O_2 exhibit a point of interest in a heterogeneous catalysis. Since an interaction of the gas molecules with the small metal clusters is influenced by a metal-support interaction, an electronic particle structure, and the supported small metal particles morphology, the really observed adsorption represents the interference of the different effects.

The non continuous Rh/films supported by γ-Al_2O_3 and ZrO_2 substrates have been prepared to investigate the structure influenced adsorption and particle reconstruction stimulated by the gas molecules adsorption. The samples were stabilised after the metal deposition by the high temperature and intensive adsorption affecting to avoid the non reversible changes of particle morphology during the adsorption experiments, that were performed later.

The combination of different methods, such as Auger Electron Spectroscopy (AES), Electron Energy Loss Spectroscopy (EELS) an Elastic Peak Electron Spectroscopy (EPES) allow to follow the studied systems behaviour, it means to determine the surface morphology, chemical state and an electronic structure of the metal deposit under the actual condition and furthermore to separate the particular operating effects. The experiments are completed by the Themodesorption Spectroscopy (TDS) experiments to measure the adsorption capacity of the samples.

INVESTIGATION OF THE WORK CONDITIONS AND CHARACTERISTICS OF MULTIWAVE EMITTERS ON RARE GASES CHLORIDES AND FTORIDES

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We present the results of a design and systematic investigation of spectral, temporary and resource characteristics of an electrodischarge excimer emitters, with radiation on: 175 nm ArCl (B-X) / 222 nm KrCl (B-X) / 236 nm XeCl (D-X) / 258 nm Cl_2 (D'-A') / 308 nm XeCl (B-X); 175 nm ArCl (B-X) / 193 nm (B-X); 222 nm KrCl / 249 nm KrF / 258 nm Cl_2^* / 308 nm XeCl / 353 nm XeF. An active medium of a lamp was formed on gas-mixtures: $Ar/Kr/Xe/Cl_2$, Ar/CF_2Cl_2, $He/Kr/Xe/CF_2Cl_2$, with the help of a powerful transverse discharge with a spark preionisation. The optimum pressure of the $Ar/Kr/Xe/Cl_2$ mixture is 15-20 kPa, whereas the partial pressure chlorine is 0,2-0,4 kPa. In order to obtain bands of comparable brightness, the partial pressure of Kr and Xe atoms should be in the range 0,2-0,5 kPa.

Using the CF_2Cl_2 molecules as unique carriers of Cl and F atoms, the multiwave operation mode of excimer emitters with brightness ration Kr and Xe clorides to fluorides as 9/1 is also realized. The optimal content of CF_2Cl_2 molecules was 0,008-0,01 kPa (Ar/CF_2Cl_2 mixtures). Correlation of B-X-bands brightness of ArCl and ArF was 10. The radiation expectacy in the multiwave mode reached $5x10^3$–$1x10^5$ pulses. Such emitters can be used in pulse photometry, high energy chemistry, biology and medicine.

THE ACTIVATION ANALYSIS OF ELECTRONIC SCRAP SAMPLE ELEMENTAL COMPOSITION

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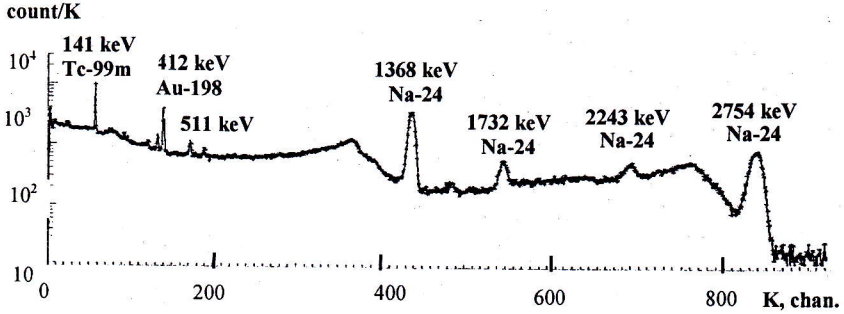
A series of aspects related to the problems of electronic scrap materials (lamp and semiconductor electronics, UHF-technique, etc.) utilization have been considered, namely:

— evaluation of the element composition of samples in the "black box" mode (lack of *apriori* information on the objects under study);

— estimation of profitability and expediency of extraction of different-type metals (first, Au and Ag, also W, Mo, Ni etc.);

— choice and ranking of methods of analysis and extraction during utilization.

The analysis of the problems was carried out on the basis of the activation analysis experimental data at the M-30 microtron (IEP UNAS).



Gamma-ray spectra of of electronic scraps samples
(E_e = 18 MeV electron energy; I_e = 5 μA average electron current;
1 hour irradiation; delay—160 min; measurement — 25 min;
100 cm^3-DGDK detector; NTA 512B analyzer)

GAMMA-SPECTROMETRY IN IDENTIFICATION OF ARCHAEOLOGICAL SAMPLES

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The abilities of semiconductor γ-spectrometry in solving some problems of archaeology, in particular, the geography of economical relations between different regions of Transcarpathia and adjacent areas during 5–6 millennia before Christ have been considered. Some models for the development of γ-spectrometric taxonomic patterns are discussed. These models are based on

— the ratios of relative specific activities (RSA) of γ-active nuclides (GAN) included into the Th-232, U-238, U-235, Np-237 series;

— the RSA ratios for GAN-representatives of different natural series (e. g. U-238 — GAN / U-235 — GAN);

— the RSA ratios not included in to the Th- and U-, Np-series (K-40, Cs-137, Na-22, Co-60 etc).

The analysis is done on the basis of experiment carried out at the 36 samples of pottery (100 cm^3 Ge(Li)-detector, passive Pb-Cd-Cu-Al protection, 4 hour exposure). The methodological questions, in particular, the correct account for the experimental background — have been considered on the basis of the analysis of the post-Chornobyl GAN (Cs-137, Ag-110m ets.) content.

INFLUENCE OF CATIONIC SUBSTITUTION ON OPTICAL ABSORPTION PROCESSES IN $CuMP_2X_6$ (M= In, Cr) LAYERED CRYSTALS

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$CuInP_2S_6$ layered crystals are ferroelectrics with two cation sublattices – indium and copper. They undergo a first-order phase transition (PT) of order/disorder type from paraelectric to ferroelectric phase (T_c=315 K), the symmetry reduction at the PT (C2/c→Cc) resulting from ordering in copper sublattice and displacement of cations from centrosymmetric positions in indium sublattice. In $CuCrP_2S_6$ crystals two PTs at $T_{c1}\approx$190 K and $T_{c2}\approx$150 K occur, separating three phases: unpolar paraelectric phase ($T>T_{c1}$), antipolar antiferroelectric ($T<T_{c2}$) and intermediate quasi-antipolar phase in the temperature interval $T_{c2}<T<T_{c1}$. The paraelectric phase symmetry is C2/c, antiferroelectric – Pc. $CuInP_2S_6$ and $CuCrP_2S_6$ single crystals were obtained by chemical transport reaction method.

In the ferroelectric phase of $CuInP_2S_6$ the absorption edge shape corresponds to direct allowed interband transitions, while in the paraelectric phase exponential Urbach shape is observed. In the atiferroelectric ($T<T_{c2}$) and paraelectric ($T>T_{c1}$) phases the absorption edge in $CuCrP_2S_6$ possesses exponential Urbach shape. In the intermediate phase ($T_{c2}<T<T_{c1}$) there is no convergence point, the exponential edge is shifted parallelly and the absorption edge energy width is temperature-independent. Such behaviour of the absorption edge in the intermediate phase of $CuCrP_2S_6$ is, evidently, the consequence of the structure modulation, typical for incommensurate phases. In the PT range the Urbach absorption edge parameters are changed, being determined by the influence of various types of disordering. The exponential Urbach tails, appearing in $CuCrP_2S_6$ crystals, like in $CuInP_2S_6$, can be related to the essential effect of dynamical structural disordering, occurring in copper cation sublattice.

While comparing the absorption edge of $CuInP_2S_6$ and $CuCrP_2S_6$ crystals, we have noticed In→Cr substitution to result in an essential decrease of the energy gap (~1.38 eV) and the absorption edge energy width (~52 meV). In→Cr substitution leads to the exciton-phonon interaction weakening and the increase of the effective phonon energy, participating in the absorption edge formation. The almost twice higher energy gap value in the paraelectric phase of $CuInP_2S_6$ crystal is probably related to the disordering in this crystal being additionally achieved due to the hopping motion of Cu^+ ions into the interlayer van der Waals space.

GROWTH AND OPTICAL PROPERTIES OF Cu_7GeS_5I ARGYRODITE-TYPE CRYSTALS

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$Cu_7GeS(Se)_5I$ compounds belong to argyrodite family and are structural analogues of Cu_6PS_5Hal, possessing high ionic conductivity and a number of other important physical properties [1]. At room temperature, similarly to Cu_6PS_5Hal, they crystallize in cubic syngony (space group $F\ 43m$). Some physical, chemical and electrochemical properties of Cu_7GeS_5I crystals were studied in [2]. There are no reference data available concerning phase transitions (PTs) in $Cu_7GeS(Se)_5I$ crystals.

Cu_7GeS_5I crystals were grown by chemical transport reactions method. The evaporation zone temperature was kept in the interval 973-1073 K, that of the crystallization zone – 873-1023 K. The temperature difference between the zones was 40-60 K. CuI was used as the transport agent in the amount of 10-20 mg per 1 cm^3 of the ampoule free volume. The obtained crystals were dark red distorted tetrahedra and platelets, $5\times3\times3(2.5)$ mm^3 in size. The obtained crystals were identified by X-ray technique, the composition was certified by chemical analysis. The calculated lattice parameters were close to the reference data, and the chemical composition corresponds to the formula Cu_7GeS_5I within the experimental error.

Isoabsorption studies have shown no phase transitions in the temperature range 77–373 K. Contrary to Cu_6PS_5I crystals, in Cu_7GeS_5I at low temperatures at the absorption edge no exciton bands are observed, and the absorption edge in the temperature range under investigation possessing the Urbach shape. From the absorption edge analysis the absorption edge parameters and the parameters of electron-phonon interaction (EPI) are determined. P→Ge heterovalent substitution is shown to tesult in the absorption edge blue shift by $\approx$ 0.05 eV (at T=300 K) and almost double increase of the absorption edge energy width. Besides, at the P→Ge cationic substitution almost double EPI enhancement is noticed as well as the decrease of the effective phonon energy, participating in the absorption edge formation. The absence of exciton bands at the absorption edge of Cu_7GeS_5I crystals is explained by the EPI enhancement and static structural disordering increase.

References:

[1] W. F. Kuhs, R. Nitsche and K. Scheunemann, Mater. Res. Bull. 14 (1979) 241.
[2] Yu.M.Stasiuk, O.P.Kokhan, V.V.Panko, S.K.Kovach, Uzhhorod University Scientific Herald, Ser. Chem. 4, 9 (1999)..

AN AUTOMATED SETUP FOR STUDYING THE ATOMIC SYSTEMS EXCITATION BY ULTRAMONOENERGETIC ELECTRONS

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The experimental apparatus has been developed for studying the excitation of atoms and molecules from the ground and metastable states by monoenergetic ($\Delta E \approx 20$ meV) electrons with the use of the photon spectroscopy technique. The principal units are as follows: a hypocycloidal electron monochromator (HEM) [1], an electron gun for the metastable state population, a collision chamber with a vapour-filled cell or an atomic beam source, a spectral monochromator, a photon detector, the controlled power supplies and detection units, the digit-to-analog and the analog-to-digit converters, a PC with the interface board for data input/output, the pulse counters (16/32 bit) and a timer.

HEM produces the electron beams with the 20–80 meV energy spread at the 0.5–30 eV energies. The vapour-filled cell is used for the substances with high vapour pressures at relatively low temperatures (Na, K, Rb, Cs, Hg or gases), while the multichannel atomic beam source for those with lower vapour pressures (Mg, Ca, Sr, Ba, Zn, Cd, Tl, etc.).

The process of measurement is fully automated by means of an IBM PC. The control and measurement algorithms have been developed for studying different processes. The Turbo Pascal V7.0-based program has been developed for measuring, data processing and visualization.

The program allows one to study the current-to-voltage characteristics of both electron beam sources and the energy dependences of excitation cross sections for the atomic systems within a wide energy range with the 2.5–500 meV step. The precise digital voltmeter, nano- and micro-ampermeter, pulse counter readings are written to the data files. In addition, the data on the experimental conditions (i.e. the electron source electrode potentials, atomic source temperatures, exposure time, etc.) are also recorded and can be easily reproduced.

The program graphics allows the experiment to be controlled in the on-line mode with the simultaneous control of a number of parameters in different combinations by using the monitor. The computer dialog is performed by means of a main menu with branched submenus. A program can easily be modified and extended depending on the demands that may vary.

The studies on the selective excitation of the 6^3P_1-levels of the Hg atoms by electrons produced both by an electron gun and HEM have been carried out for the first time.

Reference:

[1] O.B.Shpenik, N.M.Erdevdy, N.I.Romanyuk *et al.* PTE.– 1998.– V.41, – P.66–73.

THE ELECTRONIC SCREENING EFFECT IN IMPACT-PARAMETER CALCULATIONS

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In this work we focus on the electronic screening effect of the projectile on the amplitude of a target atomic transition in the framework of the semiclassical approximation (SCA).

The aim is to elaborate a general tool for accounting projectile electronic screening effect in impact parameter calculations, even when the target or projectile wave functions are numerical. Our calculation is based on Ref. [1]. The method is applicable when the projectile electronic wave functions are approximated by Slater-type orbitals [2]. Then the screening potential has the following form:

$$V_s\left(\boldsymbol{R}-\boldsymbol{r}\right)=\frac{N}{\left|\boldsymbol{R}-\boldsymbol{r}\right|}-\sum_{k=0}^{F} c_k\left|\boldsymbol{R}-\boldsymbol{r}\right|^{n_k-1} e^{-a_k\left|\boldsymbol{R}-\boldsymbol{r}\right|}$$

where N is the number of projectile electrons, $\boldsymbol{R}$ is the internuclear distance, $\boldsymbol{r}$ is the projectile electron and nucleus distance, F is an integer, c_k, n_k are real and a_k is a positive number. For numerical projectile wave functions we use a nonlinear least-squares fitting technique to estimate the parameters[3]. Following Ref.[1] we utilized the multipole expansion [1]:

$$\frac{e^{-a\left|\boldsymbol{R}-\boldsymbol{r}\right|}}{\left|\boldsymbol{R}-\boldsymbol{r}\right|}=\sum_{L=0}^{\infty}\frac{2L+1}{\sqrt{Rr}} I_{L+1/2}(ar_<)K_{L+1/2}(ar_>)P_L\left(\hat{\boldsymbol{R}}\hat{\boldsymbol{r}}\right)$$

where $I_{L+1/2}$ and $K_{L+1/2}$ are the modified Bessel functions of fractional order, and the identity:

$$x^n e^{-ax}=\frac{d^{n+1}}{d(-a)^{n+1}}\frac{e^{-ax}}{x}$$

We have elaborated closed expressions, recursive relations and integral representation routines for the n th order derivation of the modified spherical Bessel function of first and second kind and respectively for their products. The numerical stability against the arguments, the order of functions and the order of derivation has also been analyzed. Total cross sections are calculated and compared with experimental data and reference theoretical results.

References

[1] S. Ricz, B. Sulik, N. Stolterfoht, I. Kádár, Phys. Rev. A 47, 1930 (1993)
[2] E. Clementi and C. Roetti, At. data Nucl. Data Tables 14, 177 (1974)
[3] T. Mukoyama, G. Hock, Nucl. Instrum. Methods B 86, 155, (1994)

STUDY OF THE TRANSFER-LOSS PROCESS IN COLLISIONS OF Li-LIKE IONS WITH LIGHT TARGETS AT INTERMEDIATE ENERGIES

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The method of zero-degree projectile Auger spectroscopy was applied earlier to measure the state selective K-shell excitation of the *Li*-like F^{6+} ion incident with 3 – 10 a.u. velocity on *He* target [1]. In the present work we study the process:

$$F^{6+}\left(1s^2 2s\right) + He \rightarrow F^{6+}\left(1s2s2p\right) + He^{+} + e^{-}$$

For the projectile final state there exists three alternatives which can be marked with the spectroscopic notations : ^4P,$^2P_-[(^3P)^2P]$,$^2P_+[(^1P)^2P]$.

One of the possible mechanism resulting these final states is the so called transfer- loss process (TL) : the ionization of a *1s* electron of the projectile and the a transfer of a target *1s* electron to the projectile *2p* shell.

TL is the dominant process for producing the *1s2s2p* projectile configuration at intermediate (3 - 10MeV) impact energies. We calculate the transfer-loss probability using the independent particle model (IPM) by taking the product of the transfer (capture) and loss (ionization) probabilities.

$$P_{TL} = P_T P_L$$

The cross section for a specific *m* is :

$$\sigma_{TL}^{1s2s2pm} = 2\pi \int_0^\infty db\, b\, P_{TL}^{1s2s2pm}(b)$$

The electron transfer probabilities have been calculated within the framework of the continuum distorted wave (CDW) approximation [2]. Calculations for the projectile excitation and ionization probabilities were performed by a semiclassical approximation (SCA) code in first order [3]. Both the CDW and SCA results were corrected by the help of the unitarization method introduced by Sidorovich et al. [4]. Preliminary calculations for the TL cross section provide a general agreement with the experimental data.

References:

[1] T.J.M. Zouros, D.H. Lee and P. Richard, Phys. Rev. Lett. 62, 2261 (1989)
[2] Dz. Belkic, R. Gayet and A. Salin, Phys. Rep. 56, 279 (1979)
[3] G. Schiwietz and P.L. Grande, Radiat. Eff. Solids 130--131, 137 (1994)
[4] V.A. Sidorovich, V.S. Nikolaev and J.H. McGuire, Phys. Rev. A 31, 2193 (1985)

COMPARATIVE STUDY OF THE INTERACTION OF DIFFERENT TYPES OF SYNTHETIC SORBENTS WITH THE MICROQUANTITY OF RADIONUCLIDES IN THE WATER SOLUTION

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The interaction of titanium phosphate (two modifications) and absorbite with the radioactive microadditives in the water solution has been investigated using the gamma spectrometry of fission fragments. The fission fragments were obtained in the thermal neutron induced fission of uranium-235. To make the reaction under study the microtron M-10 has been used, being located at the Department of nuclear physics (Uzhhorod State University).

The sorbtion of the ions ^{93}Y, ^{97}Nb , ^{98}Zr, ^{99}Mo, ^{132}Te, ^{133}I, ^{143}Ce was investigated.

The sorbtion factors were calculated. The half-life time and irradiation conditions were taken into account.

Obtained experimental values show that the largest sorbtion factor is observed for $^{97}_{40}Zr$ and $^{143}_{58}Ce$ fragments.

Both modifications of titanium phosphate have got nearly equal factors. But the factor for the modification with the smaller ratio of titanium to phosphate group is obviously larger in the case of $^{97}_{40}Zr$ and $^{143}_{58}Ce$.

Obtained by us results as well as the literature data were compared and their most important features, as the possibility to change the cavity size and therefore inference the selectivity toward ions of different size and charge, have been discussed.

MASSES OF PSEUDOSCALAR MESONS IN THE LOW-ENERGY QUANTUM CHROMODYNAMICS (QCD)

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We have calculated the low-energy QCD with the 't Hooft interaction. We obtain satisfactory result for the pseudoscalar mesons. Our calculations have shown that the 't Hooft interaction allows us to describe the masses of pseudoscalar mesons masses and their singlet–octet mixing angle in satisfactory agreement with the experiment. In order to study the role of the $U_A(1)$ anomaly on the low- nergy QCD further, the studies of the η'- mesons properties are desirable.

The strength of the $U_A(1)$ – breaking interaction we have obtained is rather strong in comparison with the previous studies in the three flavor model. The contribution from the $U_A(1)$ – breaking interaction to the dynamical mass of the up and down quarks is about 24% of the from the usual $U_L(3)xU_R(3)$ invariant four – quark interaction.

STRUCTURAL CHARACTERIZATION OF PD THIN FILM GROWTH ON Al_2O_3 USING PHOTOELECTRON AND ION SPECTROSCOPY

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X-ray photoelectron spectroscopy (XPS) and low energy ion scattering spectroscopy (LEIS) were used to investigate catalyst thin film growth mode in the submonolayer region. Palladium was deposited step by step in situ using an electron beam evaporator on different aluminum oxide substrates. The Pd growth process was monitored by means of the $Pd3d_{5/2}$ binding energy, modified Auger parameter and Full Width at Half Maximum of the $Pd3d_{5/2}$ peak. The deposited layer morphology was determined using the QUASES software based on analysis of the Pd peak shape and background. The relative coverage and the thickness of Pd films obtained on the different substrates are compared. The results showed that the oxide structure and the metal-substrate interaction (MSI) influenced the particle shape and growth.

GAMMA-SPECTROMETRY OF THE SAMPLES FROM MUZHIYEVO MINE

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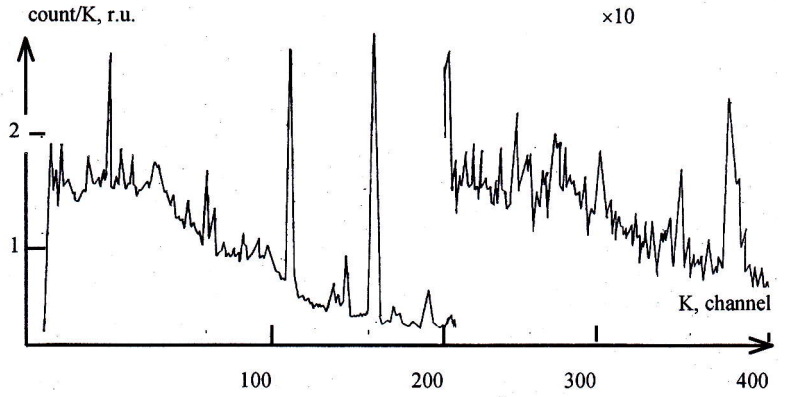
The experimental results obtained during the development of activation analysis of the samples of ores in Muzhiyevo are considered. Using the M-30 microtron (IEP UNAS) (E_e = 18,5 MeV electron energy; I_e = 5 μA average electron current; 2 hours irradiation exposure; 100 cm^3-DGDK detector; NTA 512B analyzer).

The qualitative and quantitative estimation of element composition of samples (As, Ag, Au, Br, Mn, Fe, Cn, etc.) was performed. The estimation of the expedient time modes for serial analysis was made. Based on the analysis of systematic and random errors, the estimation of the possible rank of activation analysis in the industrial ore production and preprocessing technologies.



Typical gamma-ray spectra of Muzhiyevo ore samples
(idientified gamma-active nuclides:
As-74; As-76; Ag-110m; Au-198; Mn-56; Zn-71m)

R-MATRIX CALCULATION OF THE ELECTRON-IMPACT EXCITATION OF Zn^+ AND Cd^+

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Our work presents the calculation of the excitation cross-sections for electron scattering on Zn^+ and Cd^+. The low-energy electron impact excitation of Zn^+ and Cd^+ was investigated using the R-matrix method. Electron collision excitation strengths have been calculated in a 15-state close-coupling approximation. Special attention has been paid for accurate representation of target wave functions. The close-coupling expansions include 15 target states of the $3d^{10}$ 4s, 4p, 5s, 4d, 5p, $3d^9$ $4s^2$,4s4p for Zn^+ and $4d^{10}$ 5s, 5p, 6s, 5d, 6p,$4d^9$ $5s^2$,5s5p for Cd^+ configurations. The presence of the open $3d^9$ shell for Zn^+ and $4d^9$ shell for Cd^+ causes the strong core-valence correlations and the accurate representation of $3d^{10}$nl, $3d^9$ nln'l' for Zn^+ and of $4d^{10}$nl, $4d^9$ nln'l' for Cd^+ states with a common set of orbitals is the main difficulty in presents scattering calculation.

All the target and scattering calculations have been performed in the *LS*-coupling with the inclusion of the relativistic shift terms in the atomic Hamiltonian. For Cd^+ ion discrepancies from HF calculation and our are even more large as compared to the case of Zn^+ ion. This indicates that the core-valence correlation and relaxation effects increase with nuclear charge. As expected, the relativistic effects also become more important for Cd^+. The corresponding corrections are very large, especially for the core-excited states, and strongly influence the relative positions of the target states.

Excitation cross section calculated in the 15 state R-matrix approximation are compared with the existing atomic-collision experiments. We have also analysed the convergence of the close-coupling expansions by comparing the 15-state, 6-state and simple 2-state results. The calculated date reveal a large resonance contribution in the low-energy region, which is more prominent in comparison with other one-electron-like ions. This can be attributed to the influence of subvalent 3d-shell for Zn^+ and 4d- for Cd^+.

MULTIPLE SCATTERING OF THE ELECTRONS EMITTED IN 150-250 KeV/U C^+ + INERT GAS COLLISIONS

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We report experimental signatures of consecutive projectile–target–projectile–etc. scattering of the emitted electrons before ejection at atomic targets. This type of multiple scattering is often referred as Fermi-shuttle mechanism [1-6], which provides "Ping-Pong" electrons. The experiment has been performed at the beamline of the 5MV electrostatic accelerator in ATOMKI in 150 and 233 keV/u collisions of singly charged He, C and O ions and inert gas (He, Ne, Xe) targets. The ejected electrons were measured by the ESA-21 electrostatic electron spectrometer in the 10-3000 eV energy region, in 13 angular channels simultaneously.

For C and O ions, our data provide evidence of double scattering at backward angles (at the electron energy corresponding to two times the projectile velocity, 2V). Moreover, for C+Xe and O+Xe collisions, we found a clear signature of triple scattering at forward angles in the spectra of the emitted electrons (see Fig. 1). PWBA calculations with realistic (RHF) wave functions provide quantitative agreement with the He^+ + Xe data, and a significant disagreement with the C^+ + Xe data at the expected electron velocity (4V). Preliminary CTMC calcula-

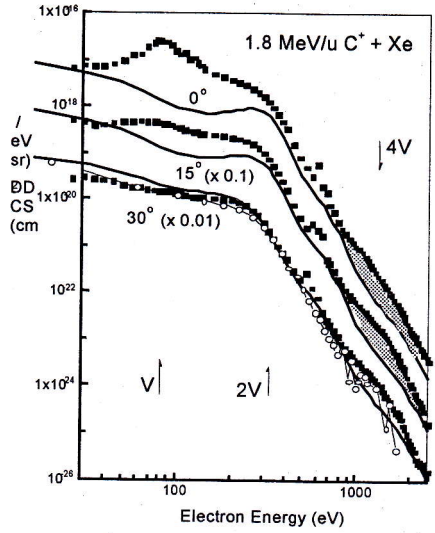

Fig. 1. Double differential electron emission cross section at forward angles in C^+ + Xe collisions. Full symbols: experiment. Lines: PWBA calculations for the target electron emission with HFS target wave functions. The shadowed areas are the yields associated with triple electron scattering. For the 30° spectrum, the results of a preliminary CTMC calculations are also shown (open symbols). We would like to call attention to the fact that more than 7 orders of magnitude in double differential cross section was measured at zero degree, without going into the background fluctuations.

tions also support the present interpretation. In the studied collision systems, the significant disagreement between theory and experiment at high electron energies seem to be mostly due to the structures belonging to multiple scattering processes. Accordingly, for high energy electrons, one might associate the main process with consecutive (P-T-P-..) multiple scattering beyond first order in the intermediate impact velocity region.

References:

[1] E. Fermi, Phys. Rev. 75, 1169 (1949).
[2] J. Wang, J. Burgdörfer and A. Bárány, Phys. Rev. A 43, 4036 (1991).
[3] S. Suárez et al., NIM B 67, 148 (1992).
[4] U. Bechthold et al., Phys. Rev. Lett. 79, 2034 (1997).
[5] S. Suárez, R.O. Barrachina, W. Meckbach, Phys.Rev.Lett. 77, 474 (1996).
[6] B. Sulik et al., NIM B 154, 281 (1999).

OPTICAL CHARACTERISTICS OF LASER EROSION PLASMA OF GALLIUM, INDIUM AND COPPER

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The results of investigation of emission laser plasma Gallium, Indium and Copper are presented in the given paper. Plasma was formed by means of a neodim laser with emission capacity of $(0,5\text{-}2)\times10^9$ W/cm^2 in the range of focussing. It was shown, that the most effectively were populated the low - lying excited conditions GaI, InI and CuI. The most intensive spectral lines GaII and InII were observed only for the ion-component of plasma emission. The population of the excited conditions of atoms and ions in a laser plasma resulted from the dielectronic recombination. Due to plasma emission the narrow space of recombination streams in the system of energy levels of GaII, GaI, InII, InI and CuI are defined. The obtained results are used for a spectroscopic diagnosis of erosion plasma crystal, which are used for a laser dustering of thin plates.

NEW VIEW ON THE INITIAL CAUSE OF THE APPEARANCE OF PATHOLOGICAL PROCESSES

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Based on the results of the experimental, clinical and theoretical investigations (1966-2000) the conclusion was made as to the chemical-energetical essence and initial cause (the starting mechanism) of the appearance of pathological, above all, ecopathological processes. It was found that the material bases for pathological processes serves the change in atomic-molecular composition of the tissue's microstructure. This regularity is obvious in cases of a hypertension, liver cirrhosis, pancreatitis, Altsheimer disease and many other pathological states.

The change in the atomic-molecular composition and, accordingly, the optical density and roentgenological contrastness of a biosystem is documented by microroentgenography and according to the Hounsfield scale on KT. Pathological chemical "filling" of small tissue volumes (lungs, CNS, liver etc.) forms the material basis of diagnostic images. This is due to the fact that in result of pollution of microstructures the concentration of the energy absorbers (atoms, molecules) grows in small volumes of tissue, increases the summary effective area of interaction (effective cross section) and correspondently the effectiveness of photons energy absorption. So, for example, the total absorption, roentgenocontrastivity of the microstructures of tuberculosis seat in lungs of 1 mm dimensions can correspond to effective area of interaction of normal lung tissue up to 10^{-20} cm^2.

Thus, pathological changes in a human organism are mostly a "chemical disease" due to material and energy overload with the correspondent consequences.

Our data need a certain correction in modern views (theory, conception) as to the initial cause of the appearance of pathological changes in tissue. With the aim of prevention of many deseases we must struggle against biosystem's pollution.

DESCRIPTION OF ANGULAR CORRELATION OF ELECTRONS IN POSITRON NEGATIVE ION BY HYPERSPHERICAL COORDINATES METHOD

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The energy of the ground ^{1,3}S-state of positron negative ion ($e^+e^-e^-$) in the hyperspherical coordinates method has been calculated in Born-Oppenheimer and adiabatic approximation accounting for the contribution of angle and radial correlation. In rotating system the relative motion of particles in such system is described by independent three variables – hyperradius (R), hyperangle (α) and angle (θ), which are defined by Jacobi vectors [1].

To obtain adiabatic potentials and channel functions we use eigen functions of square ground angular moment as the basis. They have a form

$$\varphi_{nm}(\alpha,\theta) = N_{nm}(Sin\alpha)^m C_n^{(m+1)}(Cos\alpha)P_m(Cos\theta), \qquad (1)$$

here N_{nm} is normalization factor, $C_n^{(k)}(x)$ and $P_m(x)$ are Gegenbauer and Legendre polynomials, respectively.

Quasi-crossing points for autoionizing adiabatic potentials were revealed, which form a structure in non-adiabatic potential. The structure of non-adiabatic potential is localized in the region of hyperradius value of 7-10 a.u.

The received energy values have been compared with results of calculations performed using other methods [2,3]. It was shown that in order to receive energy values with accuracy 10^{-4} a.u. it is necessary to include more than 70 elements into the basis for determination of adiabatic potentials or to use Pade approximation on the dimension of basis.

References:

1. Haysak M.I., Dovhanich M.M., Lengyel V.I., Onysko V.V. // J.Phys.Study.**1**, 521, 1997.
2. Haftel M.I., Mandelzweig V.B. // Phys.Rev.A, **39**, N6, 2813,1989.
3. Chattopadhyay R., Das T.K. // Phys.Rev.A, **56**, N2, 1281,1997.

SPECTROELLIPSOMETRIC STUDIES OF D^+ ION IRRADIATED W (110) AND (111) SINGLE CRYSTALS

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It is known that ion treatment of metal surface could improve its optical characteristics due to removal of the adsorbed layer as well as to deteriorate them according to surface roughening, subsurface layer disordering and its stoichiometry changes. Main aim of this work was to investigate the optical properties modification for tungsten single crystals after the high-dose treatment by deuterium plasma ions.

The tungsten specular surfaces were prepared by polishing of the W single crystal slabs with diamond paste up to obtaining the highest value of reflectance. Then surfaces were subjected to high-dose D plasma ion irradiation with energy in range E=0.1-1.77 keV with removal of 5.5 μm thick layer for (110) surface and 6.4 and 7.0 μm for (111) surface respectively. Modification of the spectral dependences of optical characteristics for irradiated mirrors has been studied by means of spectral ellipsometric technique for probing photon energy range 0.5-5 eV. Surface microrelief changes were determined by atomic force microscopy.

The measured optical conductivity values of the unirradiated W (110) single crystalline surfaces are different from the reference data [1]. In our case values of optical conductivity are lower and absorption bands have become displaced to the lower probing photons energy values. Long-term irradiation by deuterium plasma ions with given energy distribution led to enhancement of the optical conductivity values as well as to the sharpening of the absorption bands. It could be inferred that single crystal surface initially has adsorbed layer of contaminations and the subsurface layer structure was damaged in a consequence of mechanical polishing. Such ion treatment caused sputtering of the damaged layer and surface contaminations. The correlation of the optical characteristics of the single crystals of tungsten permits to ascertain that increase of the sputtered by deuterium ions layer thickness caused not only decrease of the optical conductivity values in the UV more than in the IR, but also broadening of the characteristic absorption bands near the 1, 1.7, 2.2 and 3 eV the greater the thicker was the removed layer. Inasmuch as the atomic force microscopy showed no significant changes for surface microrelief of W (111) after the irradiation by deuterium ions (the highest roughness is 6 nm), the changes in optical conductivity spectra could be explained by mirror subsurface layer disordering after such ion bombardment.

References:

1. L.V. Nomerovannaya, M.M. Kirillova, M.M. Noskov. Optical properties of tungsten single crystals. Zhurn. Exp. and Theor. Phys. – 1971. – Vol. 60., Issue 2. – P. 748-758 (in Russian)

CHERN-SIMONS FIELD THEORY AND THE HADRONS CONFINEMENT PROBLEM WITHIN A FADEEV YANG-MILLS FIELD DECOMPOSITION

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1.Chern-Simons Lagrangian and color confinement problem.

The Yang-Mills Lagrangian was taken by physicists to serve as a fundamental model of elementary high-energy particles called hadrons. Making use of the Feynman functional integration technique the model was for the first time quantized by Faddeev-Popov in 1967 and 1980. There was stated that Yang-Mills field model describes charged quasi-particles called colors (or quarks) whose stable quantum states can be realized by means of introducing some virtual gluing fields called \textit *Faddeev's ghosts*. But the main confinement problem of describing localized mass-energy spectrum states in the ambient space $\mathbf{R}^3 \times \mathbf{R}_t$ was not solved and remains such up to now. Nevertheless, some years ago Chern-Simons proved a very important statement about Yang-Mills field Lagrangian, which turned out to be extremely useful for treating the above confinement problem. Yang-Mills theory devoted to explain the internal structure of hadronic particles is based on

$$L_{YM} = \frac{1}{4}\int_{R^3\times R_t} Sp\,(F \wedge F) \tag{1}$$

where $F := dA + A \wedge A$, is the curvature 2-form, $A := \sum_{s=1}^{N=\dim G} A^{(s)} e_s$ Namely, they proved the following integral identity holds:

$$L_{YM} = \tfrac{1}{4}\int_{\partial\Sigma^4} Sp\,(A \wedge dA + \tfrac{2}{3} A \wedge A \wedge A) \tag{2}$$

where $\Sigma^4 \subset \mathbf{R}^3 \times \mathbf{R}_t$ is a simply connected compact smooth closed submanifold in $\mathbf{R}^3 \times \mathbf{R}_t$, $\partial\Sigma^4$ is its three-dimensional boundary and the Yang-Mills curvature 2-form is given. Based on the identity (2) one can now replace the Yang-Mills field theory defined on the whole subspace $\Sigma^4 \subset \mathbf{R}^3 \times \mathbf{R}_t$ by the following Chern-Simons Lagrangian

$$L_{CS} = \tfrac{1}{4}\int_{M^3} Sp\,(A \wedge dA + \tfrac{2}{3} A \wedge A \wedge A) \tag{3}$$

where the integration is performed only over a three-dimensional worldsheet $M^3 \subset \mathbf{R}^3 \times \mathbf{R}_t$ which is now assumed to be compact but not necessary simply connected. But in general, the general representation $A := \sum_{s=1}^{N=\dim G} A^{(s)} e_s$ appeared not to be sufficient for effective solving the color confinement problem. A partial remedy just recently, in 1999, was found by L. Faddeev who suggested a novel decomposition of the Yang-Mills gauge field for the four-dimensional representation of *SU(N)* connection:

$$A_\mu^{(a)} = \sum_i C_\mu^i m_i^a + \sum_i C^{abc} \partial_\mu m_i^a m_i^c + \sum_{i,j} p^{ij} C^{abc} \partial_\mu m_i^b m_3^c + \sum_{i,j} \sigma^{ij} d^{abc} \partial_\mu m_i^a m_j^c$$

where m_i, $i=\overline{1,r}$ =rank *(SU(N))*, are unit vectors, $(C_{\mu,\rho,\sigma})$, $\mu = \overline{1,r}$, are Higgs multiplets with scalar rho and sigma parameters. L.Faddeev has suggested that the field multiplets which arise in the above gauge field decomposition are the appropriate *order*-parameters for describing different phases of the Yang-Mills connection $A_p^{(a)}, \mu = \overline{0.3}$. In particular, he proposed that their using will shed new light to important open problems such as color confinement, since this decomposition can identify configurations responsible for it. Making use of the above Faddeev decomposition for the CS Lagrangian, one can get succeded in deriving special quantum phase states a priori enjoying confinement constraints. This work has just started, some preliminary results has been obtained by V. Schomerus and other, working with Faddeev's group, who considered a CS-model with a world-sheet submanifold M^3 swept by a 2-*dim* spherical brane. They also showed how a spherical brane can arise as a bound state from a stack of 0-*dim* branes.

ELECTRON-BEAM IRRADIATION BASED RECORDING ON ORGANIC DYE FILMS

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Thin organic films have rapidly evolved as potentially important materials in microelectronics. They are promising candidates for high density optical memories due to their optical and structural properties. Also they can be used as master disks for CD and DVD ROM replication because film pit shape possesses all properties needed for super high density compact disks. In this work we present the experimental results showing the effects of electron-beam heat process on the information recording parameters in dye films. Dye composite films were obtained by vacuum deposition method. The changes in the optical properties and the surface structure were studied. In our experiments we have irradiated organic dye films by electron beam at different time to modify the structure and morphology of the surface. The changes observed in the structural properties have been studied by high-resolution electron microscopy. The one main broaden ring is observed for amorphous dye film in initial state on the diffraction pattern. Annealing the dye films by electron-beam irradiation during 2-5 sec leads to grain formation whose size varies between 2 and 5 nm. It was found that organic dye films have hexagonal structure in the grains formed after annealing process by electron beam. The threshold energies necessary for the modification of the dye film surface structure after electron beam irradiation were estimated. The obtained results give possibility for the study of dye layer behaviour as an electron beam assisted recording medium.

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