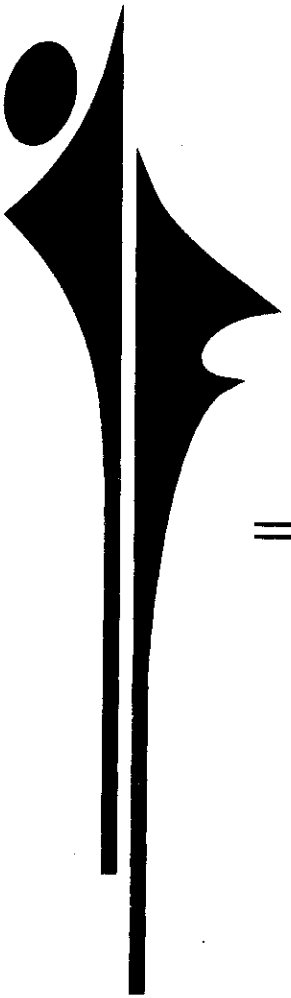

ИНСТИТУТ ЗА ФИЗИКУ
Београд

АКТИВНОСТИ И АПСТРАКТИ РАДОВА

ACTIVITIES AND ABSTRACTS OF PAPERS

INSTITUTE OF PHYSICS
Beograd

1991-1995

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САДРЖАЈ

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ПРЕДГОВОР

Ово је шеста књига радова сарадника Института за физику (ИФ) у Београду. Она обухвата публикације објављене у току петогодишњег периода 1991-1995. године, а у којима име Института за физику фигурише на било који начин. Они радови наших сарадника код којих име ИФ-а није наведено, нису унети у књигу.

Књига је тематски подељена на поглавља која одговарају називима званичних пројеката из основних истраживања код Министарства за науку и технологију Републике Србије чији су носиоци били Институт за физику (ИФ), Физички факултет (ФФ) Универзитета у Београду и сви остали научни н универзитетски центри у Србији. Поред ових пројеката Институт за физику (ИФ) учествује у реализацији стратешко истраживачко-технолошких пројеката код истог министарства. Почетак н завршетак ових пројеката не поклапа се са пројектима из основних истраживања па ће стога резултати са тих пројеката бити објављени у наредној публикацији. Званични пројекти из основних истраживања дати су у књизи следећим редом:

1. Пројекат 0101
"*Основни и методолошки проблеми физике*"
руководилац: Академик Звонко Марић (ИФ)

2. Пројекат 0105
"*Теоријска атомска и молекуларна физика*"
руководилац: др Цевад Белкић (ИФ)
др Петар Грујић (ИФ)

3. Пројекат 0106
"*Бинарни судари атомских честица*"
руководиоци: др Нада Ђурић (ИФ)
др Слободан Цвејановић (ИФ)
др Милан Курепа (ФФ, ИФ)

4. Пројекат 0107
"*Атомски судари у гасним пражњењима и на површинама*"
руководиоци: др Брана Јеленковић (ИФ)
др Милан Поповић (ИФ)
др Зоран Петровић (ИФ)

5. Пројекат 0111
"*Физика плазме и ласера*"
руководилац: др Слободан Вуковић (ИФ)

6. Пројекат 0104
"*Физика оксидних и полупроводних материјала*"
руководилац: др Зоран Поповић (ИФ)

7. Пројекат 0114*
"Истраживање контролисане термонуклеарне фузије помоћу плазме-фокуса"
руководилац: др Јагош Пурић (ФФ)
за ИФ: др Радован Антанасијевић (ИФ)

8. Пројекат 0103
"Физика кондензованог стања и нових материјала"
руководилац: др Саво Милошевић (ФФ)
за ИФ: др Љиљана Грујић-Добросављевић (ИФ)

9. Пројекат 0110*
"Експериментална физика високих енергија"
руководилац: др Драгомир Кршић (ФФ)
за ИФ: др Живојин Тодоровић (ИФ)

10. Пројекат 1805*
"Заштита атмосфере"
руководилац: др Зорка Вукмировић (ИФ)

За пројекте означене звездицом материјале је прикупио мр Драган Маркушев, а за остале пројекте материјале је прикупио мр Михајло Мудринић.

Задржана је концепција (у највећој мери) претходне књиге (*Активности и апстракти радова 1986-1990*). Свако од поглавља састоји се из три секције, које обухватају:

- Апстракте објављених књига, монографија и радова у међународним научним и стручним часописима.
- Апстракте уводних предавања и радове саопштене на конференцијама и у домаћим часописима.
- Одбрањене магистарске и докторске тезе.

У свакој од ове три секције прилози су дати хронолошким редом. На крају књиге је дат списак аутора свих радова који су ушли у састав књиге. Материјали за ову књигу прикупљени су на основу одговарајућих годишњих извештаја, а затим су дати руководиоцима пројеката на евентуалне дораде. Уколико је притом ипак дошло до пропуста, уредништво се извињава оштећеним ауторима.

Организација научно-истраживачког дела института на крају 1995. године била је следећа:

- Центар за теоријску физику (Центар I)

директор: др Ђорђе Шијачки
Укупно 36 запослених, а од тога 27 доктора наука и 5 магистара наука.

- Центар за експерименталну физику (Центар II)

директор: др Зоран Петровић
Укупно 41 запослен, а од тога 13 доктора наука и 16 магистара наука.

• Центар за атомску и субатомску физику (Центар III)
директор: др Братислав Маринковић
Укупно 45 запослених, а од тога 14 доктора наука и 10 магистара наука.

• Центар за примењену и техничку физику (Центар IV)
директор: др Радован Антанасијевић
Укупно 11 запослених, а од тога 3 доктора наука и 1 магистар наука.

• Центар за физику чврстог стања (Центар V)
директор: др Зоран Поповић
Укупно 31 запослен, а од тога 6 доктора наука и 8 магистара наука.

Директор Института за физику до 10.05.1994 био је др Марко М. Поповић, а од тада је директор ИФ-а др Драган С. Поповић

Београд, април 1996.

Уредници

FOREWORD

This is the sixth volume in the series "*Activities and Abstracts of Papers*" containing the scientific results related to the Institute of Physics (IP) employees covering the five years period, 1991-1995. Only the publications with a clear statement that at least one of the authors is affiliated to the IP were included.

The text of the book is divided into chapters according to the titles of the scientific projects from the basic researches financed by the Ministry of Science and Technology of the Republic of Serbia. In these projects the main participants are Institute of Physics, Faculty of Physics and other scientific and university centers in Serbia. Apart from these projects the Institute of Physics takes part in the realization of strategic research - technology projects of the same Ministry. The beginning and the end of these projects are not in accordance with the basic research project so their results will be published in the next issue.

The basic research projects are titled below:

1. Project 0101
"*Fundamental and methodological problems in physics*"
Head of project: Academician Zvonko Marić (IP)

2. Project 0105
"*Theoretical atom and moleculor physics*"
Head of project: Dr. Dževad Belkić (IP)
Dr. Petar Grujić (IP)

3. Project 0106
"*Binary collisions of atomic particles*"
Head of project: Dr. Nada Djurić (IP)
Dr. Slobodan Cvejanović (IP)
Dr. Milan Kurepa (FP, IP)

4. Project 0107
"*Atomic collisions in gas discharges and on surfaces*"
Head of project: Dr. Brana Jelenković (IP)
Dr. Milan Popović (IP)
Dr. Zoran Petrović (IP)

5. Project 0111
"*Plasma and laser physics*"
Head of project: Dr. Slobodan Vuković (IP)

6. Project 0104
"*Physics of oxide and semiconductor materials*"
Head of project: Dr. Zoran Popović (IP)

7. Project 0114
"*Controlled thermonuclear fusion investigation with plasma focus*"
Head of project: Dr. Jagoš Purić (FP)
in IP: Dr. Radovan Antanasijević (IP)

8. Project 0103
"*Condensed matter physics and new materials*"
Head of project: Dr. Savo Milošević (FP)
in IP: Dr. Ljiljana Dobrosavljević-Grujić (IP)

9. Project 0110
"*High energy experimental physics*"
Head of project: Dr. Dragomir Krpić (FP)
in IP: Dr. Živojin Todorović (IP)

10. Project 1805
"*Protection of the atmosphere*"
Head of project: Dr. Zorka Vukmirović (IP)

The conception of this book is the same as in the previous book ("*Activities and Abstracts of Papers 1986-1990*", *ed. V. Čadež et al.*) and each chapter of this book is further split into three sections:

-PUBLICATIONS: Books, monographs and articles
-CONFERENCES: Invited talks (with abstracts), progress reports (with abstracts), contributions and articles in national journals
-THESES: Ph.D. and M.S. (provided they were defined within the considered period)

All contributions within this sections are given chronologically. Author index is given at the end of the book. Materials for this book were first completed by use of annual reports for the given period and then the principal investigators of the projects made the final checkings of the corresponding chapters. The editors apologize if, in spite of this, eventual errors, regarding the presented materials, should occur.

The IP organization at the end of 1995. is given as follows:

Center for Theoretical Physics
Director: Dr. Đorđe Šijački
Out of 36 employees there were 27 with the Ph.D. degree and 5 with the M.S. degree

Center for Experimental Physics
Director: Dr. Zoran Petrović
Out of 41 employees there were 13 with the Ph.D. degree and 16 with the M.S. degree

Center for Atomic and Subatomic Physics
Director: Dr. Bratislav Marinković
Out of 45 employees there were 14 with the Ph.D. degree and 10 with the M.S. degree

Center for Applied and Technical Physics
Director: Dr. Radovan Antanasijević
Out of 11 employees there were 3 with the Ph.D. degree and 1 with the M.S. degree

Center for Solid State Physics
Director: Dr. Zoran Popović

Out of 31 employees there were 6 with the Ph.D. degree and 8 with the M.S. degree

The IP director was Dr. Marko M. Popović until May, 10th, 1994. and from that date Dr. Dragan S. Popović.

Beograd, April 1996.

The Editors

П 0101: ОСНОВНИ И МЕТОДОЛОШКИ ПРОБЛЕМИ ФИЗИКЕ

P0101: FUNDAMENTAL AND METHODOLOGICAL PROBLEMS IN PHYSICS

PUBLICATIONS: Books, Monographs and Articles

"Remarks on the formulations of the adiabatic theorem"
M. Božić, R. Lombard and Z. Marić
Z. Phys. D **18** (1991) 311.

By comparing the adiabatic limit of the exact solutions of the time-dependent Schrödinger equation for spin in rotating magnetic field and for harmonic oscillator with time-dependent frequency with the solutions obtained using the quantum adiabatic theorem we have demonstrated the complete agreement of the two sets of solutions and the importance of phase fixing condition for this agreement. We argue that the notions like "familiar dynamical phase" of the "usual quantum adiabatic theorem" and "an additional phase" of "geometrical origin" have been based on the unjustified neglection of the mentioned condition by applying the quantum adiabatic theorem. There is nothing to add to the quantum adiabatic theorem in which time-dependent eigenbasis satisfies phase fixing condition.

"Probabilities of de Broglie's trajectories in Mach-Zehnder and in neutron interferometers"
M. Božić and Z. Marić
Phys. Lett. A **158** (1991) 33.

The usual assumptinns of probability theory and the ideas of de Bmglic (about real particle trajectories guided by real associated "pilot"/"control" fields) yield a new probability scheme for the motions of neutron through neutron interferometers as well as for the motions of photons through Mach-Zehnder interferometers. All possible trajectories are taken iato account and the probabilities of particle motinns are determined. This scheme agrees with Einstein's view according to which quantum mechanics is not complete since it describes single events only statistically.

"The wave function of the universe and p-adic gravity"
I. Ya. Arefeva, B. Dragović, P. H. Frampton and I. V. Volovich
Int. J. of Modern Phys. A **6** (1991) 4341.

A new approach to the wave function of the universe is suggested. The key idea is to take into account fluctuating number fields and present the wave function in the form of a Euler product. For this purpose we define a p-adic generalization of both classical and quantum gravitational theory. Elements of p-adic differential geometry are described. The action and gravitatioo field equations over the p-adic number field arc investigated. p-adic analogs of some known solutions to the Einstein equations are presented. It follows that io quantum cosmology one should consider summation only over algebraic manifolds. The correspondence priociple with the standard approach is considered.

"On signature change in p-adic space-time"
B. G. Dragović
Modern Phys. Lett. A **6** (1991) 2301.

Change of signature by linear coordinant transformations in p-adic space-time is considered. It is shown that there exists arbitrary change of trivial signature in Q_p^n for all $n \geq 1$ if $p \equiv 1 \pmod 4$. In other cases it is possible to change only even number of the signs of the signature. We suggest new concept of signature with respect to distinct quadratic extensions of Q_p. If space-time dimension is restricted to four there is no signature change.

"P-adic perturbation series and adelic summability"
B. G. Dragović
Phys. Lett. B **256** (1991) 392.

The convergence of p-adic analogues of perturbation series is considered. Summation of some series, with terms containing n! is performed. Adelic summability is introduced and the connection between real and common p-adic properties at integer points is established. The possible relevance of the ultrametricity to study the Planck scale models is indicated.

"Off-shell BRST quantization of the massive superparticle"
Ž. Antunović and M. Blagojević
Nucle. Phys. B **363** (1991) 622.

The massive superparticle in D = 9 is covariantly quantized by using a generalized lagrangian BRST formalism. The method is based on the structure of the classical gauge algebra, and ensures the off-shell nilpotency of the BRST symmetry of the gauge-fixed action by introducing a set of auxiliary fields with non-vanishing ghost numbers.

"Origins of nuclear and hadron symmetries"
Y. Ne'eman and Đ. Šijački
Symmetries in Science (1991) 475.

One component of the strongly-coupled IR region in QCD consists of exchange of a phenomenological field $G_{\mu\nu}(x)$ formed by a color-neutral pair of gluons. The $G_{\mu\nu}$ acts formally as a Riemennian metric with $J^P = 0^+, 2^+$ quanta coupled symmetrically to nuclear matter. This is the origin of the IBM paradigm and several features of hadrons.

"Improved covariant quantization of the heterotic superstring"
M. Blagojević, B. Sazdović and M. Vasilić
Nucle. Phys. B **365** (1991) 467.

A generalized lagrangian BRST formalism is developed and used to study the covariant quantization of the heterotic superstring. The quantum action is by construction invariant under the off-shell nilpotent BRST transformation, which is achieved by introducing a minimal set of auxiliary variables with nonzero ghost number. The method relies on the classical gauge structure, and represents a natural lagrangian extension of the ideas existing in the hamiltonian BRST approach.

"The Magnetic top as a model of quantum spin"
A. O. Barut, M. Božić and Z. Marić
Annals of Phys. **214** (1992) 53.

The magnetic top is defined by the property that the external magnetic field B couples to the angular velocity ω, as distinct from the top whose magnetic moment is a body-fixed vector. This allows one to construct a "gauge" theory of the top where the canonical angular momentum, s, is analogous to the canonical momentum of the point particle and the B field plays the role of the gauge potential. The magnetic top has four constants of motion so that Lagrange equations for Euler angles θ,φ,χ (which define the orientation of the top) are integrable and are solved here. Although the Euler angles perform complicated motions, the canonical angular momentum s, interpreted as spin, obeys precisely a simple precession equation. The Poisson brackets of s, allow us further to make an unambiguous quantization of spin, leading to the Pauli spin Hamiltonian. The use of canonical angular momentum alleviates the ambiguity in the ordering of the variables $\theta,\varphi,\chi,p_\theta,p_\varphi,p_\chi$ in the Hamiltonian. A detailed gauge theory of the asymmetric magnetic top is also given.

"Quantization of Gauge invariant theories - BRST approach"
D. Popović
SFIN **2** (1992) 15. (in Serbian)

The basic elements of BRST canonical quantization and the general principles of the quantization in QED are given. The emphases was given on the relation of gauge and BRST invariance. Differences of non-Abelian and Abelian cases were analyzed, and quantization of non-Abelian theories was performed.

"Probabilistic ergument for *and* in the discussion inbetween *or* and *and* "
M. Popović-Božić
SFIN **2** (1992) 95. (in Serbian)

During this year Zvonko Marić and me have published the article "Probabilities of de Broglie's trajectories in Mach-Zehnder and in neutron interferometers". Immediately afrewards we wrote with Vigier the article entitled "De Broglian probabilities in double-slit experiment". Those two papers have resulted from our joint scientific research which started in 1973. in scientific atmosphere created in the Institute of Physics in Belgrade by Zvonko Marić . Today, looking into the past, all our scientific activities: seminars, discussions, international collaboration look to me as a preparation for the moment in which a formula for probability was written. When this formula appeared on our blackboard Marić said "nice formula". It seems to me that for this occasion it is appropriate to present those two papers together with the research process through which they were written.

"De Broglian probabilities in the double-slit experiment"
M. Božić, Z. Marić and J. P. Vigier
Found. of Phys. **22** (1992) 1325.

A new probability interpretation of interference phenomena in the double-slit experiment is proposed. It differs from the standard interpretation (based on elementary events happening in complementary, mutually exclusive setups - arrivals of waves to the screen when one of the slits is closed) which encounters the "paradox" that the law of total probability is violated. This new interpretation is free of such difficulties and paradoxes since it is based on compatible elementary events (events happening in the same setup in which happen all events considered - arrivals of quantons to the screen when both slits are open). Quantum objects-quantons possess simultaneously particle and wave properties. Compatible statistical interpretation synthesizes in a consistent way the superposition principle for waves and the law of total probability applied to compatible events. Such synthesis is a theoretical expression of de Broglie's observation, now fully confirmed by experiments, that the interference fringes obtained on a photographic plate result from an infinite number of tiny local spots which display arrival of quantons, while the set of fringes is a statistical effect of the wave aspect.

"A note on smoothed quasidistributions"
D. M. Davidović and Z. Marić
Phys. Lett. A **162** (1992) 437.

It is shown that in the Cohen class of quasidistributions for pure states the non-negativity is achieved always when a kernel belongs to the same class of functions by which a quasidistribution is built as a bilinear functional.

"On p-adic aspects of some perturbation series"
B. G. Dragović
Teoret. i Matem. Fizika **93** (1992) 211.

Series with factorial terms, which are of potential interest in quantum field theory and string theory, are considered. Divergent series in the real case are usually p-adic convergent. Using simple and number field invariant methods of summation, rational sums are obtained. Sums of the convergent and divergent counterparts of the same series are connected by adelic summability.

"Proof of pseudo-gravity as QCD approximation for the hadron IR region and J~M^2 Regge trajectories"
Y. Ne'eman and Đ. Šijački
Phys. Lett. B **276** (1992) 173.

We prove the approximation in which the IR region of QCD is dominated by the exchange of a two-gluon effective metric-like field $G_{\mu\nu}(x) = B^a{}_\mu B_\nu{}^b \eta_{ab}$ (η_{ab} a colour-SU(3) metric), "gauging" pseudo-diffeomorphisms. We derive the equations of motion for the effective pseudo-gravity. Aside from yielding p^{-4} propagators, indicating confinement, we obtain linear J~M^2 Regge trajectories.

"Constraint algebra from local Poincaré symmetry"
I. A. Nikolić
General Relat. and Gravitat. **24** (1992) 159.

A rigorous derivation of the constraint algebra between lapse, shift and Lorentz Hamiltonians is presented assuming that only local Poincaré symmetry constraints are present in the theory. It is also shown that the Dirac-Arnowitt-Deser-Misner form of the Hamiltonian is merely a consequence of the local Poncaré symmetry identities.

"Improved covariant quantization of the superparticle"
M. Blagojević, B. Sazdović and M. Vasilić
Nuovo Cim. A **105** (1992) 1395.

A generalized BRST formalism is developed and used to study the quantization of the Siegel superparticle. The method provides and off-shell nilpotent BRST symmetry of the gauge-fixed, quantum action. The construction relies on the structure of the classical gauge algebra, and is realized by introducing a set of auxiliary, nonphysical variables. The elimination of these variables reduces the theory to the Batalin-Vilikovisky form.

"Power series everywhere convergent on R and all Q_p"
B. G. Dragović
J. Math. Phys. **34** (1993) 1143.

Power series are introduced that are simultaneously convergent for all real and all p-adic numbers. Our expansions are in some aspects similar to those of exponential, trigonometric, and hyperbolic functions. Starting from these series and using their factorial structure new and summable series with rational sums are obtained. Fnr arguments x∈Q adeles nf series are constructed. Possible applicatinns at the Planck scale are also considered.

"Measurement of time-dependent quantum phase"
A. O. Barut, M. Božić, S. Klarsfeld and Z. Marić
Phys. Rev.A **47** (1993) 2581.

We evaluate the exact (Pancharatnam) phase differences between the final state $|\psi(t)\rangle$ and varinus initial states for n spin -1/2 particle in n rotating magnetic field B (t). Fnr initial states $|n; B_{ef}(0)\rangle$, which are eigenstates of the spin component alnng the direction of the initial effective field $B_{ef}(0)$, the exact phase has an energy-dependent part and an energy-independent part. It is shown that these states $|n; B_{ef}(0)\rangle$ are cyclic and their corresponding Aharonov-Anandan phases are evaluated. In thc adiabatic limit we discuss different choices of time-dependent bases and the relatinnship between the exact phase, the Born-Fock-Schiff phase, and Berry's phase. We propose neutron interference experiments to test separately the exact and the adiabatic evolution laws, as well as tn measure exact and adiabatic time-dependent phases.

"A search for the classical model of spin"
M. Božić and Z. Marić
Found. of Phys. **23** (1993) 819.

The study of the mntion of the magnetic top - a classical spherical top which carries magnetic moment proportional to its angular momentum, is motivated and inspired by the quantum mechanical relntion between spin angular momentum and spin magnetic moment. Inversely, the magnetic top, taken to be the classical model of quantum spin, implies the description of spin states by probability amplitudes of the top orientation angles, instead of by Pauli spinors. This opens new possibilities fnr the interpretation of many interesting spin experiments which serve as tests of basic principles of quantum mechanic and of the postulates of the quantum theory of measurement.

"Tumačenje kvantne teorije"
Z. Marić
GLAS CCCLXXI SANU, Odelenje prirodnomatematičkih nauka, knj. 57 (1993) 5.
(in Serbian)

"Preliminary observations on possible implications of new Bohr orbits (resulting from electromagnetic spin-spin and spin-orbit coupling) in "cold" quantum mechanical fusion processes appearing in strong "plasma fokus" and "capillary fusion" experiments"
R. Antanasijević, I. Lakićević, Z. Marić, D. Zečević and J. P. Vigier
Phys. Lett. A **180** (1993) 25.

The theoretical interpretation of recently observed "excess heat" (i.e. break-even) in low intensity electrolytic and discharge experiments (which both deuterium and hydrogen) as resulting from a new type of non-nuclear quantum phenomena (i.e. spin-spin and spin-orbit couplings added to the usual Coulomb potential in specially structured dense media) leads to the prediction that "fusion ashes" of deuterium (or deuterium compounds now in vanishingly small quantities) will grow with the current intensity input, thus increasing the excess energy output. To test this prediction one can study the dynamic of fusion reactions in simple capacitor bank discharges into deuterated media, both in plasma focus (PF) and capillary fusion (CF) type experiments.

"Hadrons in an $(\overline{SL})(4, R)$ classification. II. mesons and C, P assignments"
Đ. Šijački and Y. Ne'eman
Phys. Rev. D **47** (1993) 4133.

The $(\overline{SL})(4,R)$ classification scheme for hadrons [Phys. Rev. **D 37** (1988) 3267.] is reviewed, including the recent rederivation of the model from QCD as an approximation for the IR region, with applications in headron and nuclear physics. The classification is extended to include P and C parities. The representations of the $\overline{SL}(4,R)\wedge[Z_2(P)\otimes Z_2(C)]$ group are described. Mesons are assigned to four predicted J^{PC} bandors. From the Regge trajectory mass formula, derived from a dynamical theory for the QCD IR region, a new mass spectrum formula for the $SO(4)\subset\overline{SL}(4,R)$ recurrences of meson states is obtained in agreement with experiment. Various missing states are predicted. The system is more restrictive than the conventional systematic based on the nonrelativistic quark model.

"Susy auxiliary fields from BRST analysis"
M. Blagojević, B. Sazdović and T. Vukašinac
Modern Phys. Lett. A **8** (1993) 349.

A generalized Lagrangian BRST formalism is used to study globally supersymmetric systems with open classical gauge algebra. It is shown that in this approach one can naturally introduce a set of auxiliary fields, so that new form of the original theory has closed classical algebra.

"BRST structure and auxiliary fields of simple supergravity"
Ž. Antunović, M. Blagojević and T. Vukašinac
Modern Phys. Lett. A **8** (1993) 1983.

A generalized Lagrangian BRST formalism is used to study quantum structure of the simple supergravity, whose classical gauge algebra is not closed. It is shown that in this approach one can naturally introduce a set of auxiliary fields as certain combinations of ghosts and antifields, so that the resulting theory has the closed classical gauge algebra.

"Rational summation of p-adic series"
B. G. Dragović
Teoret. i Matem. Fizika **100** (1994) 342.

Problem of the rational summation for a wide class of p-adic convergent series is considered. Here, rational summation means a method to obtain a rational sum of power series for a rational value of its variable. Formula suitable for this summation is derived. Conditions for rational summability are obtained. Rational summation is possible only for special forms of the series. It is shown that the inverse problem of rational summation is always solvable. This is illustrated by some characteristic examples. Possible rational (adelic) summation of divergent perturbative expansions in string theory, and quantum field theory, is discussed.

"On p-adic series in mathematical physics"
B. G. Dragović
Tryč. Matemat. Instit. PAH **203** (1994) 255.

Some aspects of p-adic perturbation series, which are of reliance in mathematical physics, are considered. This is review of the subject and it also contains some new results.

"Adelic model of harmonic oscillator"
B. G. Dragović
Teoret. i Matem. Fizika **101** (1994) 349.

Adelic quantum mechanics is formulated. The corresponding model of the harmonic oscillator is considered. The adelic harmonic oscillator exhibits many interesting features. One of them is a softening of the uncertainty relation.

"Probability and interference"
M. Božić and Z. Marić
Courants, amers, ecueils en microphysique, G. Lochak, P Lochak, eds. (Foundation Louis de Groglie, Paris) (1994) 89.

Present, predicted, and hidden probabilities (Broglian probabilities) are determined and mutually compared for various one particle and two-particle interference experiments.

"Hamiltonian analysis of SL (2, R) symmetry in Liouville theory"
M. Blagojević, M. Vasilić and T. Vukašinac
Class. Quant. Grav. **11** (1994) 1155.

The Hamiltonian structure and the residual symmetries of the Liouville theory in the lightcone gauge is studied. The generators of the re-parametrization symmetry are constructed and used to analyze the symmetry of the theory in the lightcone gauge, whilst the symmetry of the gauge-fixed theory and that of the gauge-fixed action is clarified, and the relation to the Nöther current method is established.

"Conformal Gauge generators in Liouville theory"
M. Blagojević, M. Vasilić and T. Vukašinac
Class. Quant. Grav. **11** (1994) 2143.

The conformal symmetry in the Liouville theory is analyzed by using the Hamiltonian light-front formalism. The boundary conditions of dynamical variables are seen to involve an arbitrary function of time, so that the standard methods for studying gauge symmetries do not work. We develop a general method for constructiog the gauge generators, which enables a consistent treatment of the boundary conditions present io the case of the conformal symmetry.

"Theory of electroweak interactions"
D. S. Popović
SFIN **2** (1995).

The basic principles of the unified theory of electroweak interactions are exposed. The concept of gauge invariance as the most essential ingredients of the theory and physical assumptions lying behind gauge symmetry are presented. Spontaneous symmetry breaking and the Higgs mechanism as the most important elements nf the unified theory are explained in relatively simple manner. The Weinberg-Salam model is presented as a synthesis nf all previous research in the field. Connection to experimental facts is discussed providing direct confirmations of the approach we are describing. Finally open questions are considered and possible extension of the theory was discussed.

"Semi-classical quantization of the magnetic top"
D. Arsenović, A. O. Barut, Z. Marić and M. Božić
Nuov. Cimm. **110** (1995) 163.

The magnetic top (A. O. Barut, M. Božić and Z. Marić: *Ann. Phys. (N.Y.)*, **214** (1992) 53) is quantized using the Bohr-Sommerfeld-Einstein (BSE) and the Einstein-Brillouin-Keller (EBK) quantization methods. It has been previously quantized by canonical, Schrödinger (A. O. Barut, M. Božić and Z. Marić: *Ann. Phys. (N.Y.)*, **214** (1992) 53) and path -integral methods (A. O. Barut and I. Duru: *Phys. Lett.* **A 158** (1991) 441). By comparing the exact wave functions with the semi-classical ones, it is concluded that the usual conditions of quantization should be modified in order to allow for half-integer values of canonical angular momentum (spin). This modification requires to abandon the condition of single-valuedness of wave functions. We justify this using Pauli's and the Reiss argumentation that single-valuedness of wave functions does not follow from basic quantum-mechanical postulates and that a certain kind of multi-valued (i.e. path-dependent) wave functinns cannot be excluded a priori.

"The critical turning point in the solutions of the magnetic-top equations of motion"
D. Arsenović, A. O. Barut and M. Božić
Nuov. Cim. B **110** (1995) 177.

The solutions of the equations of motion of the magnetic top, whose orientation is described by the Euler angles ϑ, φ, χ are expressed through the integrals of motion and the dependence of their properties on these integrals of motion are studied. We find that when the initial canonical momenta p_χ and p_φ have equal absolute values, the angular velocity $\dot{\vartheta}$ undergoes a discontinuous change of sign when the turning point of the orbit in ϑ are at the poles ($\cos \vartheta_1 = 1$ or $\cos \vartheta_2 = -1$). These discontinuities in $\dot{\vartheta}$ can be compensated by discontinuities in φ and χ (by π or $-\pi$) so that the linear velocity components of the frame axes are continuous.

"Adelic harmonic oscillator"
B. Dragović
Inter. J. of Mod. Phys. A **10** (1995) 2349.

Using the Weyl quantization we formulate one-dimensional adelic quantum mechanics, which unifies and treats ordinary and p-adic quantum mechanics on an equal footing. As an illustration the corresponding harmonic oscillator is considered. It is simple, exact and instructive adelic model. Eigenstates are Schwartz-Bruhat functions. The Mellin transform of the simplest vacuum state leads to the well-known functional relation for the Riemann zeta function. Some expectation values are calculated. The existence of adelic matter at very high energies is suggested.

"An analysis of use of the cluster separability in scattering theory"
M. Damnjanović and Z. Marić
Few-Body Systems Suppl. **99** (1995) 1.

In the framework of the Time Dependent Scattering Theory we discuss three forms of Ctuster Separability as well as the conditions for the representation of the scattering system dynamics implied by their respective use.

"Compatible statistical interpretation of a wave packet"
M. Božić and Z. Marić
Found. of Phys. **25** (1995) 159.

Compatible statistical interpretation of a wave packet is proposed. De Broglian probabilities which unite wave and particle features of quantons are evaluated for free wave packets and for a superposition of wave packets. The obtained expressions provide a very ptausible and physically appealing explanation of coherence in apparently incoherent beams and of the characteristic modulation of the momentum distobution, found recently in neutron interferometry combined with spectral filtering. Certain conclusions about dualism and objectivity in quantum domain are also derived.

"Classical and quantum magnetic top"
D. Arsenović, M. Božić and A. O. Barut
Tr. J. of Phys. **19** (1995) 465.

The essential feature of the dynamics of the magnetic top that a motion of its magnetic moment and a motion of the top itself are entirely different, makes obsolete the requirement that wave functions should be unchanged after a rotation for 2π (which would eliminate half integer valucs of the canonical angular momentum-spin). This means that the whole spectrum of the quantum magnetic top, which is allowed mathematically, is acceptable also from the physical point of view. Because of that property magnetic top seems to be a candidate for the classical model of spin.

"Chiral symmetries of the WZNW model by Hamiltonian methods"
B. Sazdović
Phys. Lett. B **352** (1995) 64.

The connection between the Kac-Moody algebras of currents and the chiral symmetries of the two dimensional WZNW model is clarified. It is shown that oaly the zero modes of the Kac-Moody currents are the first class constraints, and that, consequently, the corresponding gauge symmetries are chiral.

"W-strings on group manifolds"
A. Miković and B. Sazdović
Modern Phys. Lett. A **10** (1995) 1041.

We present a procedure for constructing actions describing propagation of W-strings on group manifolds by using the Hamiltonian canonical formalism and representations of W-algebras in terms of Kac-Moody currents. An explicit construction is given for the case of the W_3 string.

"Hawking radiation and back-reaction in a unitary theory of 2D quantum gravity"
A. Miković
Phys. Lett. B **355** (1995) 85.

We construct a manifestly unitary quantum theory of the CGHS model of 2D dilation gravity by performing a reduced phase space quantization. It is shown that physical states exist such that in the semiclassical limit the Hawking radiation is present. A new method for calculating the back-reaction corrections to the classical metric is introduced, based on the expansion of the metric operator in a power series of the matter energy-momentum tensor operator. The first order correction to a local black hole mass function is evaluated, and it agrees with the expected semiclassical behavior. We briefly discuss the calculation of higher-order corrections and implications for the quantum fate of a 2D black hole.

"Dirac Hamiltonian formulation and algebra of the constraints in the Einstein-Cartan theory"
I. A. Nikolić
Class. Quant. Grav. **12** (1995) 3103.

We present here a detailed but rather transparent Dirac Hamiltonian formulation of the first-order Einstein-Cartan theory of gravitation, including a rigorous derivation of the off-shell constraint algebra between lapse, shift and Lorentz Hamiltonians. Taking the simplest solution for determined multipliers, it is shown that squares of the second-class constraints appear on the right-hand side of the Poisson brackets algebra.

"Spacetime geometry of three-dimensional Yang-Mills theory"
V. Radovanović and Đ. Šijački
Class. Quant. Grav. **12** (1995) 1791.

It is shown that the SU(2) Yang-Mills theory in 3-dimensional Riemann-Cartan spacetime can be completely reformulated as a gravity-like theory in terms of gauge invariant variables. The resulting Yang-Mills induced equations are found, and it is demonstrated that they can be derived from a torsion-square type of action.

"Chromogravity: QCD-induced diffeomorphisms"
Y. Ne'eman and Đ. Šijački
Inter. J. of Modern Phys. A **10** (1995) 4399.

We expand the QCD gluon field B^a_μ around a constant "pure gauge" solution N^a_μ in the IR sector, i. e. $B^a_\mu(x) = N^a_\mu + A^a_\mu(x)$ and provide a mathematical definition for an "IR limit" in which the frequencies of the fluctuation field $A^a_\mu(x)$ vanish. We prove that in this limit, $SU(3)_{color}$ gauge transformations become equivalent to space-time diffeomorphisms. A gravitylike contribution is then shown to emerge from the overall "n gluon exchange" component in the expansion of the generating functional of QCD Green functions, with the two-gluon term acting like the metric field in gravity. This QCD-induced "chromogravity" provides and effective long range action, i. e. longer-ranged than the contribution of quark-antiquark (meson) exchanges. We conjecture chromogravity to be responsible for many of the features of the hadron spectrum and of color confinement, issues for which there is as yet no proof in QCD (including lattice calculations), beyond general qualitative arguments. The method exhibits a smooth transition to the perturbative and semiperturbative treatment of high energy hadron scattering, including the emergence of the Pomeranchyk trajectory.

CONFERENCES: Invited lectures, progress reports and contributions

"Magnetic top: On the origin of quantum spin and magnetic moment"
A. O. Barut and M. Božić
II Int. Wigner Symposium (Glosar, Germany, 1991) Edited by: H. D. Doebner, W. Scherez and F. Schroeck Jr. (World Scientific, Singapore, 1992) 257.

The quantum spin can be modeled by a top in which the magnetic field couples to the angular velocity $\vec{\omega}$. A complete symplectic theory can be given and the system is integrable. Although the top performs a complicated motion the magnetic moment has the exact Pauli precession. The system is quantized, and a point charge model is developed to calculate the gyromagnetic ratio g.

"SU(2/1), superconnections and geometric higgs field"
Y. Ne'eman, C. Y. Lee and Đ. Šijački
II Int. Wigner Symposium (Glosar, Germany, 1991) Edited by: H. D. Doebner, W. Scherez and F. Schroeck Jr. (World Scientific, Singapore, 1992).

It has been suggested that the Standard Model SU(2) × U(1) be embedded in the supergroup SU(2/1). The successful features relate mostly to the composition of the spectrum of leptons and quarks and to the Higgs field assignment. The result $\sin^2\theta = .25$ involves normalization of the algebra by traces rather than by supertraces. We derive this result from the "superconnection" geometry and discuss the present state of the theory.

"On the structure, function and development of scientific theories"
Z. Marić
Naučni skupovi Srpske akademije nauka i umetnosti, knj. LXIII, *Predsedništvo*, knj. 7 (1991) (in Serbian)

Four aspects of the nature of scientific enquiry: the structure of a theory, the unity of science, the growth of the knowledge and the sociological conditions for the manifestation of the so-called instrumental reason are presented as they are comprehended by the philosophy of the logical empiricism. It is argued that in all aspects, this philosophical position is too narrow and consequently in many instances it cannot be applied to all open horizons to be studied in order to understand the structure of science and its social role and future.

"Geometrical interpretation of time-dependent spin phases"
M. Božić
XIth Workshop on Geometric Methods in Physics, (Bialowieza, Poljska, 1992) Edited by:
T. Ali, I. M. Mladenov and A. Odzijewicz (World Scientific, Singapore, 1993) 211.

The Pancharatnam and Aharonov-Anandan phases for spin in a rotating magnetic field are interpreted and represented geometrically using spherical triangle.

"The theory of light - quantum electodynamics"
D. Popović
Konferencija Luj de Broj, Beograd, (1992), Zbornik radova, *SFIN* 1 (1993) 23.
(in Serbian)

This exposition represents an attempt to explain rather difficult subject - the theory of quantum electrodynamics - for a nontechnical audience. Due to the fact that the time was limitted we could not complete all necessary aspects of the theory which could cause some confusion. This approach was inspired by four extraordinary lectures of Richard Feynman on the same subject.

"Louis de Broglie"
Ž. Marić
Konferencija Luj de Broj, Beograd, (1992), Zbornik radova, *SFIN* 1 (1993) 1.
(in Serbian)

De Broglie's contributions to the development of theoretical physics are reviewed. It concerns the formal derivation of the relation $p = h/\lambda$, origins of the quantum dualism, intoduction of double solution in quantum dynamics and the theory of light. Finally, the de Broglie's critics of the Copenhagen interpretation of quantum mechanics is outlined.

"Probabilities and phases in quantum mechanics"
M. Popović-Božić
Konferencija Luj de Broj, Beograd, (1992), Zbornik radova, *SFIN* 1 (1993) 149.
(in Serbian)

De Broglie's classification of probabilities in quantum mechanics is presented. De Broglie's ideas about probabilities are elaborated and hidden probabilities are determined for various one and two particle interference experiments.

"QCD foundations for hadron Regge trajectories and for the Arima-Iachello symmetries of nuclei"
Y. Ne'eman and Đ. Šijački
Symposium on Symmetries in Science VII: *Spectrum Generating Algebras and Dynamic Symmetries in Physics*, Nakajo, Japan, August (1992).
Symmetries in Science VII: Spectrum Generating Algebras and Dynamic Symmetries in Physics, Edited by: A. Arima, L. C. Biedengarn and B. Gruber (Plenum Press, 1993).

We review our Pseudo-Gravity hypothesis which points to the two (or more) gluon exchange in WCD as the origin of Regge excitations and a variety of other hadronic features resembling gravity. We present a detailed dynamical study. One effect ia nuclei is the emergence of the Arima-Iachello model, with its 2^+, O^+ ground state. We explain the relevant dynamics.

"Quantum magnetic top"
M. Božić and D. Arsenović
XIIth Workshop on Geometric Methods in Physics, Edited by: J. P. Antoine and T. Ali (Plenum Press, New York, 1994) 223.

The classical magnetic top is quantized by applying Schrödinger's method of quantization in non-Euclidean coordinate system. As differeat from a free top (for which one usually imposes the condition of single-valuedness of wave functions) in the case of a magnetic top this condition is not justified. Thanks to this fact a magnetic top could possess integer as well as halfinteger values of canonical angular momentum. This property makes a magnetic top a candidate for the classical model of spin.

"Compatible statistical interpretation of interference in double-slit interferometer"
M. Božić
Int. Conf. *Waves and Particles in Light and Matter*, Edited by: A. van der Merwe and A. Garuccio (Plenum Press, New York, 1994) 171.

De Broglian probabilities, associated with two characteristic sets of trajectories in the double-slit interferometer, are evaluated and graphically presented. The change of de Broglian probabilities with attenuation coefficient a shows a remarkable consistency with the underlying physical picture.

"The "chromo"-gravity algorithm in QCD"
Y. Ne'eman and Đ. Šijački
Int. Conf. Como (1994).

We identify an IR limit, in which the sum of all possible sero-colour gluon combinations exchanged between two hadrons is equivalent to a spin 2 sero-mass pole in the exchange channel, similar to a graviton. This component may explain many of the features relating to the soft hadron-hadron interactions and to confinement, for which Salam and others had suggested the action of a "strong gravity", extraneous to QCD. This also fits smoothly with the QCD treatment nf high-energy scattering and the Harari-Freund conjecture in dual models, in which no quark lines passed in the exchange channel for the Pomeron, and thus overlaps with the studies of elastic scattering based oo gluon "ladders" in QCD. Mixing with J = 2 quark-antiquark and massive gluonium poles could produce the observed pattern of intercepts.

"QCD and the nuclear physics IBM"
Y. Ne'eman and Đ. Šijački
Int. Conf. *Perspectives for the Interacting Boson Model.* Padova, Edited by: A. Vitturi (1994).

QCD has been applied perturbatively to the UV region of strong interactions. However, it has not been useful in the description of hadron physics and the IR limit. We introduce "Chromogravity", reviewing the proof that the non-quark (gluonic) component of interhadron interactions produces a "strong" gravity-like interaction in the IR limit. This reproduces Regge trajectories, the Pomeron etc. Using a Bethe-Salpeter approach, we show that the j = 2,0 basic boson of the Nuclear Physics IBM could arise as a bound state of two nucleons in a spinless, I-spin symmetric combination, with the J = 2,0 chromogravitons.

"Adelic wave function of the universe"
B. Dragović
IIIrd Alexander Friedmenn Inetrnational Seminar on Gravitation and Cosmology, St. Petersburg (1995) 4.

At distances less than or equal to the Planck length, p-adic properties of spacetime should emerge. Adelic generalization of the wave function of the Universe takes into account usual and p-adic geometries. For the de Sitter minisuperspace model a necessary p-adic ground-state wave functinn, which is the characteristic function of Z_p, is calculated. It is shown that there exists adelic wave function for this model of the Universe.

"Adelic wave function of the de Sitter universe"
B. Dragović
7th Lomonosov Conference Problems of Fundamental Physics, Moscow (1995).

Adelic generalization of the wave function of the Universe, which takes into account usual and p-adic geometries, is considered. It is shown that there exists adelic wave function for the de Sitter minisuperspace model.

"P-adic quantum cosmology"
B. G. Dragović
VI Marcel Grossmann Meeting on General Relativity, Kyoto (1991).

"Distributive adiabatic hypothesis in the time-dependent theory"
M. Damnjanović and Z. Marić
V Workshop on Perspectives in Nuclear Physics at Intermediate Energies, Trieste, Italy (1991).

"Different approaches to the quantization of unstable theories"
A. Bogojević
Danube Workshop, Beograd (1991).

"Hamiltonian BRST quantization of antisymmetric tensor field"
D. Popović
Danube Workshop, Beograd (1991).

"SL(4,R) theory for the IR region of quantum chromodynamics"
Đ. Šijački
Danube Workshop, Beograd (1991).

"BRST quantization of reducible gauge theories"
M. Blagojević
Danube Workshop, Beograd (1991).

"BRST approach to anomalies"
B. Sazdović
Danube Workshop, Beograd (1991).

"Generalisani kalibracioni uslovi"
P. Stojkov
Danube Workshop, Beograd (1991). (in Serbian)

"QCD, gravity, hadron spectroscopy and all that"
Đ. Šijački
Danube Workshop, Beograd (1992).

"BRST symmetry"
M. Blagojević
Danube Workshop, Beograd (1992).

"Conformal field theory"
A. Bogojević
Danube Workshop, Beograd (1992).

"Topological quantum field theory"
A. Bogojević
Danube Workshop, Beograd (1992).

"Cosmological stochastic motion"
R. Popić
Danube Workshop, Beograd (1992).

"Supereonformal field theories"
B. Sazdović
Danube Workshop, Beograd (1992).

"Non-linear realizations of symmetry"
P. Stojkov
Danube Workshop, Beograd (1992).

"P-adic analysis"
B. G. Dragović
Danube Workshop, Beograd (1992).

"On Liouville field theory"
M. Blagojević
Danube Workshop, Beograd (1992).

"P-adic evaluation of perturbative sums"
B. G. Dragović
Danube Workshop, Beograd (1992).

"P-adic gravity"
B. G. Dragović
Danube Workshop, Beograd (1992).

"3d gravity and solid state systems"
I. Nikolić
Danube Workshop, Beograd (1992).

"The method of modular smoothing"
N. Burić
Int. Conf. on Hamiltonina Mechanics: *Integrability and Chaotic Behavior*, Tarun, Poland (1993).

"Compatible statistical interpretation of interference in double-slit interferometer"
M. Božić
Int. Conf. Waves and Particles in Light and Matter, Edited by: Alwyn van der Merwe and
A Garuccio (Plenum, New York, 1994) 171.

"Rabi oscillations and wave packets described by de Broglian probabilities"
M. Božić and D. Arsenović
Int. Conf. Frontiers of Fundamental Physics (Olympia, Greece, 1993) Edited by: M. Barone and F. Selleri (Plenum, New York, 1994) 503.

"Compatible statistical interpretation of two-particle interference"
M. Božić
Workshop on Quantum Interferometry (Trieste, Italy, 1993) Edited by: A. Zeilinger and F. de Martini (Word Scientific, Singapure, 1994) 254.

"Chromogravity explains "strong gravity""
Y. Ne'eman and Đ. Šijački
Salam Festschrift (1993).

"QCD originated dynamical symmetry for hadrons"
Đ. Šijački
Danube Warkshop, Beograd (1993).

"The WZNW term in the quantization of theories with anomalies"
B. Sazdović
Danube Workshop, Beograd (1993).

"Non-perturbative two-dimensional dilaton gravity"
A. Miković
Danube Workshop, Beograd (1993).

"Three lectures on Liouville field theory"
A. Bogojević
Danube Workshop, Beograd (1993).

"The Liouville theory and SL(2,R) symmetry"
M. Blagojević
Danube Workshop, Beograd (1993).

"Black holes in 2d"
D. Popović
Danube Workshop, Beograd (1993).

"Cosmological stochastic motion in the Friedmann model"
R. Popić
Danube Workshop, Beograd (1993).

"Probability and interference"
M. Božić and Z. Marić
Courants, amers, ecueils en microphysique, G. Lochak, P. Lochak, eds. (Foundation Louis de Broglie, Paris, 1994) 89.

"Black holes and quantization of 2d dilation gravity"
A. Miković
Ringberg Workshop, Germany (1994).

"Hawking radiation and back reaction in a unitary theory of 2d quantum gravity"
A. Miković
Trieste Workshop (1994).

"Anštajnova traganja za ciljem i metodom teorijske fizike"
Z. Marić
Doprinos Mileve Anštajn-Marić nauci (Novi Sad, 1994)
Zbornik sa savetovanja (1995) 57.

"2d gravity with dynamical torsion"
M. Blagojević
Danube Workshop, Beograd (1994).

"Adelično prostor-vreme"
B. Dragović
Danube Workshop, Beograd (1994). (in Serbian)

"Schwinger-Dyson equation and the measure"
A. Bogojević
Danube Workshop, Beograd (1994).

"2d black holes and Liouville theory"
A. Bogojević
Danube Workshop, Beograd (1994).

"2d dilatation gravity"
A. Miković
Danube Workshop, Beograd (1994).

"Ashtekar variables"
I. Nikolić
Danube Workshop, Beograd (1994).

"Hamiltonian analysis of the WZNW model"
B. Sazdović
Danube Workshop, Beograd (1994).

"Van der QCD"
Đ. Šijački
Danube Workshop, Beograd (1994).

"Cold fusion in terms of new quantum chemistry: The role of magnetic interactions in dense phisica media"
R. Antanasijević, Đ. Konjević, Z. Marić, D. Šević and A. Zarić
International Conference on Cold Fusion, Monaco (1995).

"Adelic generalization of wave function of the universe"
B. Dragović
Jugoslovensko-mađarski simpozijum iz astronomije i astrofizike, Baja (1995).

"Adelic wave function of the universe"
B. Dragović
Thierd A. Friedmann International seminar on gravitation and cosmology, St. Petersburg (1995).

"Towards adelic quantum cosmology"
B. Dragović
XIV International conference on general relativity and gravitation, Florende, Italy (1995).

"Relativistic dynamics and space-time structure of few-body processes"
M. Damnjanović and Z. Marić
Advances in Fundamental Physics, (Palm Harbor, FL U.S.A., 1995) Edited by: M. Barone and F. Selleri (Hadronic Press, 1995) 349.

"Nelinearne lokalne simetrije"
M. Blagojević
Danube Workshop, Beograd (1995). (in Serbian)

"WZNW za 2d YM i 2d gravitaciju"
B. Sazdović
Danube Workshop, Beograd (1995). (in Serbian)

"Kanonska analiza WZ za 2d gravitaciju"
B. Sazdović
Danube Workshop, Beograd (1995). (in Serbian)

"O unitarnosti i renormalizabilnosti gravitacije"
Đ. Šijački
Danube Workshop, Beograd (1995). (in Serbian)

"Haotična kvantizacija"
A. Bogojević
Danube Workshop, Beograd (1995). (in Serbian)

"Četvrt veka kvantne hromodinamike"
Đ. Šijački
Plenarna predavanja, *IX Kongres fizičara Jugoslavije*, Petrovac na Moru, Zbornik radova (1995) 95. (in Serbian)

"Magnetna čigra u spinorskoj reprezentaciji"
D. Arsenović, M. Popović-Božić i Z. Marić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 1.
(in Serbian)

"Zakoni očuvanja u 2d gravitaciji sa torzijom"
D. Popović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 553.
(in Serbian)

"Nekoliko primera primene kompatibilne statističke interpretacije kvantne mehanike"
M. Božić i Z. Marić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 10.
(in Serbian)

"Kritična analiza adijabatske hipoteze i njeno uopstavanje"
M. Damnjanović i Z Marić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 501.
(in Serbian)

"Detekcija nuklearnih reakcija u deuterijumskom plazma fokusu"
R. Antanasijević, A. Zarić, D. Šević, Ž. Todorović, Dj. Konjević, Z. Marić i J. P. Vigier
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 469.
(in Serbian)

"Analiza X-zračenja emitovanog iz deuterijumskog plazma fokusa"
R. Antanasijević, A. Zarić, D. Šević, Dj. Konjević, Z. Marić i J. P. Vigier
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 469.
(in Serbian)

"Kanonska analiza Wess-Zumino modela u zakrivljenom prostoru"
B. Sazdović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 565.
(in Serbian)

"Kvantizacija nelinearnih gradijentnih teorija"
M. Blagojević i T. Vukašinac
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 485.
(in Serbian)

"Adelična kvantna mehanika"
B. Dragović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 13.
(in Serbian)

"Adelično sumiranje divergentnih redova"
B. Dragović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 17.
(in Serbian)

"Adelizacija harmonijskog oscilatora"
B. Dragović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 21.
(in Serbian)

"Spinski efekti i teorija spina"
M. Popović-Božić
Zbornik predavanja na Republičkom seminaru o nastavi fizike, (DFS, Beograd, 1995).
(in Serbian)

"Optička rezonantna fluorescencija i Mezbauerov efekat"
M. Popović-Božić
Zbornik predavanja na Republičkom seminaru o nastavi fizike, (DFS, Beograd, 1995).
(in Serbian)

"Linijski spektri od Fraunhofera do jonske zamke"
M. Popović-Božić
Zbornik predavanja na Republičkom seminaru o nastavi fizike, (DFS, Beograd, 1995).
(in Serbian)

"Slaba interakcija-moderna teorija"
D. Popović
Zbornik predavanja na Republičkom seminaru o nastavi fizike, (DFS, Beograd, 1995).
(in Serbian)

THESES: Ph. D. and M. S.

"BRST kvantizacija superčestice"
P. Stojkov
Fizički fakultet, Univerzitet u Beogradu, (1991) (M. S. thesis in Serbian).

"Klasična i kvantna magnetna čigra"
D. Arsenović
Fizički fakultet, Univerzitet u Beogradu, (1993) (M. S. thesis in Serbian).

П 0105: ТЕОРИЈСКА АТОМСКА И МОЛЕКУЛАРНА ФИЗИКА

P0105: THEORETICAL ATOM AND MOLECULAR PHYSICS

PUBLICATIONS: Books, Monographs and Articles

"Electron transfer from hydrogenlike atoms to partially and completely stripped projectiles: CDW approximation"
Dž. Belkić
Physica Scripta **43** (1991) 561.

Electron transfer from hydrogenlike target systems to multiply charged projectiles is examined within the Continuum Distorted Wave (CDW) approximation. Using vector spherical harmonics, the most concise analytical expressions are derived for the transition amplitude in the case of arbitrary initial and final hydrogenic bound states. The resulting algorithm is superior to any of the computational devices previously proposed in connection with the CDW method. The present code is used to provide comprehensive tables of the state-selective and total cross sections for charge exchange in collisions between atomic hydrogen and completely stripped projectiles at incident energies ranging from 25 keV to 10 MeV. These data also yield results for partially stripped projectiles by applying the appropriate mass and charge scaling. Thorough comparisons between the CDW theory and experiments on electron capture from atomic hydrogen by completely and partially stripped projectiles reveal systematically good agreement.

"Exact second-order Born approximation with correct boundary conditions for symmetric charge exchange"
Dž. Belkić
Phys. Rev. A **43** (1991) 4751.

Symmetric (homonuclear) charge transfer between completely stripped projectiles and hydrogenlike atoms is studied by means of the second-order Born approximation (CB2) with the correct boundary conditions. Along the integration path, the transition amplitude T^{CB2}_{if} exhibits so-called *movable singularities*, such as branch points and poles. A powerful method is presented which demonstrates that these singularities are integrable, not only for the resulting cross sections, but also for every individual matrix element. The resulting algorithm is very efficient, since the exact differential cross sections of the CB2 method are readily obtained through only two-dimensional numerical quadratures. The present theory is applied to symmetric resonant charge exchange in $H^+ + H(1s) \rightarrow H(1s) + H^+$ collisions at several impact energies, and the results are found to be in satisfactory agreement with the experimental data of Martin *et al.*

"Periodic orbit theory of broad resonances in the hydrogenic Stark effect and the two-Coulomb-center problem"
T. P. Grozdanov, M. J. Raković and E. A. Solov'ev
Phys. Lett. A **157** (1991) 376.

The periodic orbit theory is used to calculate the poles of the S-matrix which are related to broad resonances in two important realistic systems: the hydrogen atom in a uniform electric field and the two-Coulomb-center problem. It is shown that the contributions of certain complex periodic orbits in the periodic orbit sum give results that coincide with the comparison equation method calculations.

"Separated and united atom limits for dynamical adiabatic states"
T. P. Grozdanov, and E. A. Solov'ev
Phys. Rev. A **44** (1991) 5605.

For the case of one-electron collisional systems and the straight-line nuclear trajectories, we study the limits of separated and united atoms of dynamical adiabatic states compatible with physical boundary conditions. The limit of separated atoms is similar to the problem of hydrogen atom in crossed, orthogonal electric and magnetic fields, and analytic results are obtained by utilizing the O(4) symmetry of bound states in a Coulomb field. In the united-atom limit the overlapping manifolds of dynamical potential-energy curves are predicted and analyzed

"Periodic orbit theory of broad resonances in two-dimensional hydrogenic Stark effect"
T. P. Grozdanov and M. J. Raković
J. Phys. A **24** (1991) 5517.

The modified version of periodic orbit theory, developed by Robbins for systems which possess discrete symmetries, is used to calculate parameters of broad resonances in the case of twn-dimensinnal hydrogenic Stark effect at energies above the zero field ionization threshold. It is shown thai the contribution of single periodic orbits of the system give results that coincide with those of the comparison equation method, also presented in the paper.

"A rotating-frame of reference paradox"
P. Grujić
Spec. Sci. Techn. **14** (1991) 154.

The relativistic shift of emitted light is analyzed in a quasi-inertial reference system and an apparent observational paradox is discussed. A possible relevance to the cosmological red shift is investigated and a negative result is obtained.

"Light polarization effects in laser-assisted (e,2e) collision a Sturmian approach"
R. Taieb, V. V'eniard, A. Maquet, S. Vučić and R. M. Potvliege
J. Phys. B **24** (1991) 3229.

We discuss the influence of the laser polarization on the angular distribution of the ejected electron in electron impact ionization of atomic hydrogen, in the presence of a strong laser field. To this end, we have used a lnwest-order time-dependent perturbation approach and introduced a new computational scheme to evaluate the relevant second-order transitinn amplitudes. The calculation is performed by expanding the atomic wavefunctions (perturbed or not) on to a Sturmian basis, which allows us to exactly take into account the contributinn of the continuum spectrum to the dressing of the atomic states. Our numerical results indicate that light polarization effects can lead to important modifications of the triply differential cross section for laser-assisted (e, 2e) processes.

"Semiclassical study of He^- doubly excited Rydberg states"
Z. Dohčević, P. Grujić and J. Jovanović-Kurepa
Physica A **170** (1991) 447.

The rovibronic spectra of highly excited Wannier-ridge states of negative helium ions have been calculated within the semiclassical theory, beyood the first-order perturbation theory. A thorough numerical analysis of the stability of classical configuration has been carried out and an estimate of the core electron impact on the lifetime of the resonance states is made. The calculations resolve degeneracies, both with respect to angular momentum and vibrational quantum numbers, which are different from previous analyses. The overall effect of the 1s electron motion on the correlated outer electron motions is found to be negligible.

"Termodinamika i Kosmološko vreme"
P. Grujić
Theoria **3** (1991) 59. (in Serbian)

"Paradigma nauke"
P. Grujić
Polja **386** (1991) 158. (in Serbian)

"The classical Helium atom - an asynchronous-mode model"
P. Grujić and N. Simonović
J. Phys. B **24** (1991) 5055.

We present a new classical helium model for L=0 (plane case), with electrons moving out of phase. Stability of the periodic orbits is examined numerically and other state parameters have been calculated. Comparison with the standard Bohr-Sommerfeldlike synchronous-mode has been made.

"Trajectory capture rate coefficients for ion-quadrupolar molecule reactions"
I. Mendaš and P. Milutinović
Chem. Phys. **153** (1991) 73.

The calculated classical trajectory capture rate coefficients K_c for ion (He^+, C^+, N^+) -quadrupolar molecule (c-C_6H_{12}, C_6F_6) reactions at three different temperatures (297 K, 67 K and 27 K) are compared with the semiclassical adiabatic theory results of Bates and Mendaš and with the CRESU/SIFT experimental values of Rebrion et al. Taking into account the statistical error of the classical trajectory results it is found that there is a fair agreement between the two theoretical methods at all three temperatures. The SIFT measured values of K_c are reproduced satisfactorily at room temperature while the theoretically predicted increase of the reaction efficiency at the two lower temperatures (67 k and 27 K) is not corroborated by the CRESU experiment. It is found that the dimensionless similarity parameter I which characterizes the inertial properties of the system is not an important factor in determining the value of the dimensionless capture rate coefficient.

"Zero-range potential model for the description of atomic and molecular systems in a laser field"
P. S. Krstić, D. B. Milošević and R. K. Janev
Phys. Rev. A **44** (1991) 3089.

The method of zero-range potential is used to model negative atomic and quasimolecular ions in a circularly polarized laser field. The range of the laser-field parameters is extended in comparison with the previous calculations of the complex quasienergies of an atomic particle. A closed-form expression that defines the adiabatic electronic complex quasienergies of a two-state quasimolecular system is derived and solved numerically. Both laser-induced widths and shifts of the terms are discussed for a wide region of the laser-field parameters and internuclear distances, using H^-_2 and OH^- ions as examples. The effect of suppression of the ionization rate of the excited state of a negative quasimolecular ion at small internuclear distances due to the presence of a laser field, as well as deepening of the ground-term potential well, was found.

"Additional superpromotion ionization channels in low-energy heavy-particle collisions"
R. K. Janev and P. S. Krstić
Phys. Rev. A **44** (1991) R1435.

Additional superpromotion S series successively connecting an infinite number of $|N, l, m\rangle$-$|N+1, l, m\rangle$ adiabatic states of a one-electron-two-Coulomb-center system (Z_1, e, Z_2) have been discovered in the complex plane of internuclear distance. The structure of the $5g\sigma$ series for the $Z_1 = Z_2$ system has been investigated in more detail. The additional superpromotion S series provide additional ionization channels in the (Z_1, e, Z_2) collision system, with a significant contribution to the total cross section for energies above ~5 keV/amu.

"Laser-induced resonant transitions with Gaussian switching conditions"
P. S. Krstić, R. K. Janev and D. Fussen
J. Phys. B **24** (1991) 1273.

A simple closed-form formula is obtained for the transition probability of a two-state atom in a Gaussian laser pulse. The validity of the formula is tested by comparison with numerical results. The analytic formula is applicable over a wide range of the laser intensities, detunings and pulse durations. Particularly, it can be used for calculation of excitation probability when the Rabi frequency is of the order of or larger than a frequency associated with the pulse duration.

"Cross sections for electron capture from atomic hydrogen by fully stripped ions"
Dž. Belkić, R. Gayet and A. Salin
Atom. Data and Nucl. Data Tables **51** (1992) 59.

We have calculated electron-capture cross sections from atomic hydrogen with the Continuum Distorted Wave method for impact energies between 40 and 10,000 keV/amu. The projectile ions are H^+, He^{2+}, Li^{3+}, Be^{4+}, B^{5+}, C^{6+}, N^{7+}, and O^{8+}. The cross sections are given for each value of the final quantum numbers n, l, m, summed over m for given n and l and over l and m for given n. The maximum n runs from n=5 for H^+ to n=10 for O^{8+}.

"Prineiples of quantum scattering theory"
Dž. Belkić
SFIN **1** (1992). (in Serbian)

The key problem in quantum scattering theory is the probability conservation, i. e., the unitarity of the S-matrix, which connects the initial with the final state of evolution of the considered physical system. This problem is not possible to solve if the scattering states neglect the boundary conditions, which require that the bound and free dynamics coincide with each other at infinite distances between the colliding particles. The usual approach to scattering theory is overwhelmed by heuristic formulas, with a stereotypic explanation that a rigorous mathematical formalism would merely obscure the physical arguments. That is not the case, as is thoroughly documented in the present work, relying upon the basic theorems of the strong topology of vector spaces and spectral operator analysis, from which directly follow all the standard synonyms of collision theory such as, the Lippmann-Schwinger integral equations, correct boundary asymptotic behaviors of the scattering states. probability transition from the initial to the final state, differential as well as total cross sections, etc. Furthermore, rigor in mathematical treatment is not only in absolute compatibility with physical argumentation and intuition, but also is established in this monograph in a simple and plausible manner. These fundamental aspects are not only relevant to the foundation of a complete scattering theory, whose principles are given in this work for short range potentials and the non-relativistic case, but they are also of primary importance in applications to real situations of general importance.

"Vector spherieal harmonics and scattering integrals"
Dž. Belkić
Physica Scripta **45** (1992) 9.

We consider scalar and vectorial non-relativistic bound-free transition from-factors. These integrals are spatial three-dimensional Fourier transforms of the product of the bound and continuum hydrogenlike wavefunctions $\phi_{nlm}(r)\,\phi^{-}_{k}(r)$, weighted with operators 1, r^{-1}, r or ∇_r. Hamilton gradient operator ∇_r may be applied to either $\phi_{nlm}(r)$ or $\phi^{-}_{k}(r)$. The same type of matrix elements is also calculated by using Slater-type orbitals for $\phi_{nlm}(r)$. Concise general results are obtained for all the form-factors under study in terms of finite quadruple summatinns. Quantization axis for $\phi_{nlm}(r)$ is held arbitrary and the exact analytical calculations are carried out for any triple nlm of quantum numbers. Vectorial integrals are most elegantly treated by employing circular Cartesian coordinates and the vector spherical harmonics $Y_{jlm}(r)$.

"Formation of H- by double charge exchange in fast proton-Helium collisions"
Dž. Belkić and I. Mančev
Physica Scripta **45** (1992) 35.

The problem of double electron capture by fast bare nuclei from heliumlike atoms is considered. The quantum version of the Continuum distorted wave approximation is formulated without recourse to the usual independent particle model. The results for double charge exchange in collisions between protons and helium are in good agreement with the existing experimental data.

"Hydrogen atoms in circularly polarized microwave fields: photoexcitation of Rydberg states"
T. P. Grozdanov, M. J. Raković and E. A. Solov'ev
J. Phys. B **25** (1992) 4455.

The hydrogen atom in a circularly polarized microwave electric field is treated as a periodically time-dependent quantum system. Quasienergy states of Rydberg manifolds are determined by applying second-order perturbation theory, while the n=2 manifold is treated with inclusion of relativistic effects. The photoabsorption spectrum for transitions from the n=2 manifold to Rydberg manifolds is calculated.

"Conditions for the existence of oscillations in the distribution of the vibrational quanta of squeezed states"
Z. Mendaš and D. B. Popović
J. Phys. A **25** (1992) L1049.

The conditions for the existence of oscillations in the distribution of the vibrational quanta fnr the general case of the time-evolving squeezed state (which does not remain a minimum-uncertainry state) of the one-dimensional harmonic oscillator are investigated. To aid this, new parametrization of squeezed states is introduced. It is found that in addition to the usual conditions which produce oscillations, the value of the phase ζ of the complex parameter z (which is the argument of the Hermite polynomial H_n appearing in the expression for the expansion coefficient a_n of the squeezed state in the number state basis) must have a value in the vicinity of $\zeta = 0$ or $\zeta = \pi$ ($|\mathrm{Im}(z)| << |z|$). It is shown how this necessary condition results from the explicit expression for $|H_n(x)|^2$.

"Charge exchange, excitation and ionization in slow Be^{4+}+H and B^{5+}+H collisions"
P. S. Krstić, M. Radmilović and R. K. Janev
At. Plasma-Mater. Int. Data Fusion **3** (1992) 113.

Using the adiabatic superprnmotion model for the dynamics of low energy atomic processes, the cross-sections for electron capture, excitation and innization in Be^{4+}+H (n≤2) and B^{5+}+H (n≤2) collisions have been calculated in the energy range from 0.2 to 100 keV/amu. Similar processes for the H^++Be^{3+}(n) and H^++Be^{4+}(n) collisions have also been considered.

"Status and critical assessment of the database for collisions of Be^{q+} and B^{q+} ions with H, H_2 and H_e"
R. A. Phaneuf, R. K. Janev, H. Tawara, M. Kimura, P. S. Krstić, G. Peach and M. A. Mazing
At. Plasma-Mater. Int. Data Fusion **3** (1992) 105.

The available cross-section database for charge exchange, excitation and ionizatioo in collision of Be^{q+} and B^{q+} ions with H, H_2 and H_e is critically reviewed. Reference to data sources containing cross-sections of high accuracy is given. The gaps in the database for these collisional systems have been identified, as well as the reaction for the existing data information is of inadequate accuracy.

"Symmetric double charge exchange in fast collisions of bare nuclei with Heliumlike atomic systems"
Dž. Belkić
Phys. Rev. A **47** (1993) 189.

Double charge exchange in fast collisions between completely stripped projectiles and heliumlike atomic systems is investigated by means of the correct first Born approximation. The theory is devised beyond the usual independent-particle model. For the reason of consistency, the usual proper boundary conditions must be reformulated when dealing with atoms or ions containing more than one electron. Consequently an appropriate correction ought to be introduced in the perturbation potential, which conveniently deals with the difficulty related to the unavailability of exact two-electron bound-state wave functions. For the purpose of illustration, numerical computations are performed for electron capture by α particles from helium. Total cross sections are found to be in satisfactory agreement with the available experimental data from 100 to 2000 keV.

"Two electron capture from Helium-like systems by completely stripped projectiles"
Dž. Belkić
J. Phys. B **26** (1993) 497.

Asymmetric and/or symmetric double-charge exchange in fast collisions of bare nuclei with helium-like atomic systems is considered. We emphasize the need for going beyond the standard independent particle model and consequently employ the four-body version of the boundary corrected first Born (CB1) approximation with a full account of the long-range Coulomb effects arising from the relative motion of the scattering aggregates. A method is devised which is capable of reducing the transition amplitudes $T_{if}^{(CB1)\pm}$ to two-dimensional real integrals. As a test of the proposed theory, we currently investigate the double-electron capture from helium by completely stripped lithium. The *prior* and *post* total cross sections obtained are found to be in satisfactory agreement with the available experimental data at impact energies ranging from 250 to 2000 keV.

"Four-body CDW approximation: Dependence of prior and post total cross sections for double charge exchange upon bound-state wave-functions"
Dž. Belkić and I. Mančev
Physica Scripta **47** (1993) 18.

Double electron capture by fast protons from helium ($p+He \rightarrow H^-+\alpha$) is examined by means of the strict *four-body* generalization of the Continuum distorted wave (CDW) approximation, without any reference to the commonly employed independent particle model. We investigate the sensitivity of the 'prior' Q_{if}^- and 'post Q_{if}^- forms of the total cross sections to the choice of the ground state wave functions for He and H^-. Three different orbitals due to Hylleraas, Green *et al* and Löwdin yield the results which are in mutual agreement to within 40% at impact energies greater then or equal to 100 keV. The so-called 'post-prior' discrepancy is also dependent upon the choice of the bound state wave functions. At incident energies 100 keV, the values of the ratio of the 'post' to the 'prior' cross sections belong to the intervals [1.0, 1.3], [0.6, 0.9] and [0.8, 1.0] for the orbitals of Hylleraas, Green *et al* and Löwdin, respectively.

"Resonances in electron scattering on zero-range potential in a magnetic field"
T. P. Grozdanov and M. J. Raković
Phys. Rev. A **47** (1993) 3105.

Exact amplitudes for the scattering of an electron on the zero-range potential in a magnetic field are analyzed as functions of a complex energy variable. Trajectories of the poles in various sheets of the Riemann surface are studied. Physically important resonances are identified and analytic estimates predicting their characteristics are presented. Transmission and reflection probabilities are calculated and related to the study of the resonances.

"Photodetachment of an electron bound by a zero-range potential in magnetic fields of arbitrary strength"
T. Grozdanov
Phys. Rev. A **51** (1993) 607.

The model problem of photodetachment of an electron initially bound by a zero-range potential in a homogeneous static magnetic field of arbitrary strength is solved exactly. Expressions for the cross sections are derived within the nonrelativistic theory for various photon polarizations. In particular, photodetachment from states that exist only in the presence of a magnetic field is studied. In the limit of small fields the results obtained agree with findings of other authors.

"Hidden crossings and the separation constant of a Hydrogenlike atom in spheroidal coordinates"
T. Grozdanov
Phys. Rev. A **51** (1993) 2630.

Considered as a limiting case of a highly asymmetric two-Coulomb-center problem, the analytic properties of the eigenvalues of the constant of motion allowing separation of variables for a hydrogenlike atom in spheroidal coordinates are studied. Calculations of the positions of the branch points of the eigenvalues in the complex plane of internuclear separations are performed. It is found that they form characteristic series whose limiting points can well be predicted by semiclassical quantization conditions.

"Newtonian and Coulombic Systems"
P. Grujić
Bull. Astron. Belgrade **147** (1993) 15.

A comparative study of few-body systems with gravitational and electromagnetic interactinn is given, with emphasis on similarities and distinctions of a number of relevant features. Recent advances in investigations of multiply excited atomic and planetary celestial systems are presented and a number of some interesting analogies are discussed.

"Generating function for the product of the associated Laguerre and Hermite plynomials"
I. Mendaš
J. Phys. A **26** (1993) L93.

The generating function for the product of the associated Laguerre and Hermite polynomials is formulated and used to determine the coordinate-space wavefunction of the displaced number states of the harmonic oscillator for the general case of a complex displacemeot parameter. The benefits, in this context, of an extended form of the associated Laguerre polynomials are advertised.

"Determination of line intensity and pressure broadening of the 619,68 nm Methane overtone absorption line at low temperatures using intracavity laser spectroscopy"
P. Vujković Cvijin, W. K. Wells, I. Mendaš, J. K. Delaney, J. I. Lunine, D. M. Hynten and G. H. Atkonson
J. Quant. Spectrosc. Radiat. Transfer **49** (1993) 639.

The temperature dependence of the line intensity and of the pressure broadened width of the 619,68 nm absorption line in the $\Delta_{vCH} = 6$ overtone rotational-vibrational band of methane is studied experimentally. Measurements are performed in the temperature range between 77 and 296 K and with H_2, N_2 and Hc as foreign-gas collisions partners. Absorption spectra of methane at low temperatures and with a variety of pressure conditions are recorded by intracavity laser spectroscopy (ILS) to obtain large (0.7-60 km) equivalent absorption pathlengths. The line intensities and pressure broadening coefficients determined here demonstrate that quantitative spectroscopic data can be derived from a lineshape analysis of ILS data. The significance of these results with respect to observational spectroscopy of planetary atmospheres is discussed.

"Pancharatnam phase for displaced number states"
I. Mendaš and D. B. Popović
J. Phys. A **26** (1993) 3313.

The Pancharatnam phase for displaced number states of the harmonic oscillator is discussed. In particular, it is examined how a single quantum oscillator, driven by a suitable transient external force, evolves from the initial eigenstate $u_m(x)$ to the final, displaced number state modified with a suitable phase factor. The significance of this, usually neglected, phase factor for the solution of the relevant time-dependent Schrödinger equation and for the geometric phase accumulated in the wavefunction during the time evolution of the system is examined. The general expression for the geometric phase for a non-cyclic evolution from and initial displaced number state at time t_1 to the final state time t_2 is derived and two applications, that of δ and harmonic forcing, are worked out. The special case of cyclic evolution is subsequently discussed and, in particular, the conditions leading to such an evolution are derived. The relationship to the classical notion of cyclic evolution is also examined in some detail and it is demonstrated that the general expression for the Pancharatnam phase reduces tn the corresponding Berry phase. It is found that, in the case of cyclic evolution, the geometric phase for displaced number states becomes independent of the quantum number m of the initial eigenstsate, and becomes equal to the geometric phase for the coherent states. The general considerations are illustrated with the special case of the harmonic forcing function. Finally, the possibility of experimental verification, in the realm of quantum optics, is briefly considered.

"Two-electron capture from Helium by fast α particles"
Dž. Belkić, I. Mančev and M. Mudrinić
Phys. Rev. A **49** (1994) 3646.

Two-electron capture from helium by fast alpha particles is investigated. Working within the four-body framework of scattering theory, we perform detailed computations for differential as well as total cross sections, by means of the second-order Born Distorted Wave (BDW) approximation, and find good agreement with the available experimental data. We also report the results obtained by means of the Continuum Distorted Wave (CDW) method in both the four-body formalism and Independent Particle Model. The former fails to reproduce the measurement, whereas the latter emerges as a satisfactory method for α-He double charge exchange. The reported study of the electronic continuum intermediate states clearly indicates that double charge exchange is remarkably sensitive to inclusion of these long-range Coulomb effects, even at incident energies at which Thomas double scattering is completely unimportant. This is in sharp contrast to the familiar situation at comparable energies encountered in treating single-electron transfer in ion-atom collisions.

"Orientation propensity for states populated by electron capture in B^{3+}/He collisions"
M. Gargaud, M. C. Bacchus-Montabonel, R. McCarroll and T. Grozdanov
J. Phys. B **27** (1994) 4675.

The orientation of the $(1s^2\ 2p)^2p$ excited state of the doubly charged B^{2+} ions, resulting from electron capture in collisions of triply charged B^{3+} ions with He, is investigated theoretically. The collision dynamics are carried out in the range of ion energies from 0.3 to 1.5 keV. Our results, which are in excellent agreement with experiment, confirm the strong propensity for orientation of the ^2p state at small scattering angles. The main contributing factors responsible for the orientation are carefully analyzed.

"Born-Floquet theory of electron-atom collision in the presence of a laser field"
M. Dorr and C. J. Joachain, R. M. Potvliege, S. Vučić
Z. Phys. D **29** (1994) 245.

We present a theory of fast electron-atom collisions in the presence of a strong laser field, which treats the interaction of the laser field with both the projectile electron and the target atom in a fully non-perturbative way. The theory is illustrated by considering the laser-assisted "elastic" scattering of fast electrons by atomic hydrogen, for non-resonant as well resonant cases.

"Born-Floquet theory of laser assisted electron-atom collisions"
M. Dorr and C. J. Joachain, R. M. Potvliege, S. Vučić
Phys Rev. A **49** (1994) 4852.

The non-Hermitian Born-Floquet theory of scattering of fast electrons by atoms in the presence nf a strong monochromatic laser field is presented. The interaction of the laser field with both the incident electron and the target atom is treated nonperturbatively, while the interaction of the incident electron with the target atom is treated in first Born approximation. Fluorescence is neglected. Detailed calculation are performed for the "elastic" scattering of 500 eV electrons by atomic hydrogen accompanied by the transfer of photons. The contribution of the entire spectrum of unperturbed atomic states to the dressing of the target is exactly taken into account by performing the calculations on a complex Sturmian basis set. In the nonresonant case, and for electric field strengths that are small with respect to the atomic unit, our Born-Floquet results are in agreement with those obtained using semiperturbative approach of Byron and Joachain (in which target dressing is treated in first-order perturbation theory) even at intensities where multiphotnn ionization is nonperturbative. The Born-Floquet approach is particularly useful to study resonant cases, where the laser frequency matches a transition frequency in the atom. Two such situation are analyzed.

"Complexity of critical functions for Hamiltonian systems"
N. Burić, M. Mudrinić, A. Piper and D. Timotijević
J. Phys. A **27** (1994) 5201.

Transition to predominantly chaotic motion in Hamiltonian systems with two degrees of freedom is described by a complicated function of a frequency, which is called the critical function. A graph nf this function is a fractal set with the local structure which is believed to depend only on the arithmetic nature of the frequency. We calculated numerically fractal dimensinns of these function fnr few typical systems using the method of modular smoothing and an efficient algorithm for computatinn nf the fractal dimensions. The dimensions which measure a complexity of the fractal are indeed the same within the accuracy, and are equal to the dimensions of the exponent of the Brjuno function, which is a purely arithmetic functinn.

"Two-electron systems: Stability analysis of the Wannier Ridge"
N. Simonović
Phys. Rev. A **50** (1994) 4390.

We examine the stahility of classical two-electron systems with an electron moving along elliptic orbits on the Wannier ridge. Lyapunov exponents are evaluated analytically for circular nrbits within the first-order perturbation theory. In the case of the helium atom, these results compare favorably with numerical values obtained by means of the monodromy matrix method.

"Asymmetrical configurations in Coulombic rigid rotators"
P. Grujić and N. Simonović
Phys. Rev. A **50** (1994) 4386.

We investigate possible asymmetrical configurations of Coulombic three-body systems (A^{n+} +B^{m+} +B^{m+}), within Langmuir's rigid-rotator model. The recently found effect by Poirier [Phys. Rev. A 40, 3498 (1989)] that in the two-electron atoms asymmetrical configurations appear possible for certain charge ratios n/m (in additinn to symmetrical ones) has been generalized to constituents of arbitrary masses. Results fnr realistic cases of the charge ratios 1/2 and 2/3 are presented. It is found that these systems possess the same type of degrees of instabilities as those investigated by Poirier.

"Atomic processes near threshold"
P. Grujić
SFIN **1** (1994). (in Serbian)

Collisions of atomic (molecular) systems, among themselves as well as with their constitueats and other subatomic particles, constitute elementary processes in a wide class of macroscopic physical systems, like laboratory and astrophysical plasma, gas phase of matter in general, scattering on a cristal lattice, chemical reactions and other systems with discrete structure. Final outcomes of binary, ternary and other collisions, so-called (final) reaction channels, depend on physical parameters which define the initial reaction channel. At those parameters values where a possibility of new channels opens, i. e. at the threshold of a new reaction, measurable physical quantities undergo specific changes. These latter are the subject nf distinct studies, both theoretical and experimental. Here we shall provide an overview of theoretical methods and results of calculations for a class of collision processes in which atoms, molecules, electrons, protons, photons and other (sub)atomic particles take place, in the vicinity of reaction thresholds. The emphasis will be on the processes with Coulombic and from that derived interactions, as well as on the methodologies studied and applied at the Institute of Physics.

"Small-energy three-body systems: V. Threshold laws when Wannier theory fails"
M. Dimitrijcvić, P. Grujić and N. Simonović
J. Phys. B **27** (1994) 5717.

We investigate cases of Coulombic systems near the break up threshold for which the Wannier model holds , but not Wannier theory. Making use of the classical trajectory method, we derive threshold laws fnr a model system of fractional charge (Z = 1/4 au) nucleus and electrons, and a real (though perhaps impractical) system of two beryllium nuclei and an antiproton. For the first system we find the threshold law of the form exp (-λ/koren iz E), where E is the total energy, and for the second one a number of characteristic features above the classical threshold have been obtained. Finally we investigate numerically a realistic case of an electron and two beryllium nuclei and discuss some general features of the ionization probability above the classical threshold.

"Number-phase uncertainty product for displaced number states"
I. Mendaš and D. B. Popović
Phys. Rev. A **50** (1994) 947.

The number-phase uncertainty product for displaced number states of the harmonic oscillator is examined within the framework of three different approaches: (i) the Carruthers-Nieto number-phase uncertainty relation in terms of the Susskind-Glogower sine and cosine phase operators, (ii) a similar relation to this calculated with the Pegg-Barnett unitary phase operator, and (iii) the number-phase uncertainty relation arising from the Pegg-Barnett Hermitian phase operator. The corresponding number-phase uncertainty product is calculated extending from average photon numbers 30 down to m for the first few classes of displaced number states (m = 0, 1,.....,5). It is found that, for a displaced number state with a reasonable average number of excited quanta, all three rival phase formalisms yield similar number-phase uncertainty products, tending, for increasingly large magnitude of the displacement parameter, to the constant value m+1/2. On the other hand, for a small number of excited quanta it is found that according to the first two formalisms, the number-phase uncertainty product for a given class of displaced number states tends to the maximum value $\sqrt{2m+1}\,/\,(\sqrt{m+1}-\sqrt{m})$, while the third phase formalism predicts an entirely different behavior; with decreasing magnitude of displacement parameter, after passing through a maximum, the number-phase uncertainty product falls off eventually to zero making, in particular, the search for minimum number-phase uncertainty states futile. It is argued in favor of this last result, and the possibility of experimental verification, in the realm of quantum optics, is briefly considered.

"Effects of relaxation and interchannel coupling in inner-shell photoionization of atomic Ytterbium"
M. Kutzner and V. Radojević
Phys. Rev. A **49** (1994) 2574.

Photoionization cross sections, branching ratios, and photoelectron angular-distribution asymmetry parameters have been calculated for the Yb (Z = 70) 4f, 4d, and 6s subshells using the relativistic random-phase approximation, the truncated relativistic random-phase approximation, and the relativistic random-phase approximation, modified to include relaxation effects. Comparisons are made between the various approximations and experimental data. Important relaxation effects for the 4f and 4d channels are noted and strong effects of interchannel coupling are noted for 6s photoionization in the region near the 4f and 5p thresholds.

"Introduction into the theory of scatteringof electrons on atoms and molecules"
P. Grujuć
Naucna Knjiga, Beograd (1995). (Book in Serbian)

Principal elements of the scattering theory are expounded, together with elements of atomic and molecular structures. Physical background for atomic collisional processes is exposed and discussed. The electron-atom collision theory has been presented, within classical, semiclassical and quantum mechanical approaches, with an emphasis on the main conceptual models used today. A concise theory of electron-molecule collision is given, for several most important processes.

"Inelastic fast-electron-Hydrogen-atom collision in a laser field"
S. Vučić
Phys. Rev. A **51** (1995) 4754.

The laser assisted electron impact excitation of 2s and 2p dressed states of hydrogen is studied. The interaction of a linearly polarized laser field with the colliding system is treated by non-perturbative Floquet theory, while the interaction of the fast incident electron with the target atom is treated in the first Born approximation. The non-resonant collision in low-intensity, low-frequency laser field is dominated by the process with no exchanged photon with the field, while at larger intensities the collision accompanied by the exchange of real or virtual photons is much more important. For the stimulated bremsstrahlung the 1s $\rightarrow$ 2s transition is strongly influenced by the resonant coupling between the final 2s and the intermediate 3p state. In the resonant cases, where laser frequency matches a transition frequency between the initial or final and an intermediate state, the collisions with the largest cross section are those in which the projectile induces dipole transition in the atom.

"Semiclassical calculations of intra-shell S resonances of doubly excited Helium"
P. V. Grujić and N. Simonović
J. Phys. B **28** (1995) 1159.

We calculate the energy spectrum of doubly excited ^{1,3} S^e equivalent-electron states, within a semiclassical planar model. The latter is based on the so-called asynchronous-mode configuration, proposed previously by Grujić and Simonović. Making use of the propagation method with regularization classical configuratioos with very complex structure and surprisingly rich kinematics have been computed. Semiclassical energies of singlet and triplet intra-shell S states are evaluated. Numerical results show that the model improves values for the ^{1} S^e states, obtained by other authors within the asymmetric-stretch collinear kinematics, but overestimates triplet-state energies. The general features of the model are discussed and compared with other proposed classical configurations.

"Doubly-excited atoms and the line broadening"
P. Grujić
Bull. Astron. Belgrade **152** (1995) 79.

Atomic systems with doubly-excited electrons have been the objects of extensive studies in the last fifteen years. These autoionizing states may be long-lived metastable atoms, with a number of properties peculiar to those systems where interelectron correlations play crucial role, and the independent-particle picture fails even as a zero-order approximation. We shall expound principal mechanisms for forming such states, quote essential features of the two-electron excited states and the most common ways for their decays. Particular attention will be paid to the methods for evaluating energy spectra, especially quantum mechanical and semiclassical approaches for calculating line positions and widths. Possible modes of radiative transitions will be enumerated and a number of mechanisms of line broadening shall be discussed. Some prospective developments in the line broadening theory will be outlined.

"Number-phase uncertainty product for generalized squeezed states arising from the Pegg-Barnett Hermitian phase operator formalism"
I. Mendaš and D. B. Popović
Phys. Rev. A **52** (1995) 1.

The number-phase uncertainty relation based on the Pegg-Barnett Hermitian phase operator formalism is discussed for generalized squeezed states of the harmonic oscillator. The corresponding number-phase uncertainty product is calculated for the magnitudes of the squeeze and displacement parameters ranging from 0 to 3/2 ia the former case and from 0 to 4 in the latter case for the first few classes of generalized squeezed states (m = 0, 1, and 2) and for different values of their combined phases. It is found that for a given magnitude of the squeeze parameter, the number-phase uncertainty product tends to thc fixed limiting value m+I/2 when the magnitude of thc displacement parameter tends to infinity. On the other hand, for a fixed magnitude of the displacement parameter, thc uncertainty product grows indefinitely as the magnitude of the squeeze parameter increases. It is also observed the number-phase uncertainty product tends for zero for few-photon generalized squeezed states (when the magnitudes of both squeeze and displacement parameters tend to zero) so that, according to the Pegg-Barnett Hermitian phase formalism, it is possible to have generalized squeezed states with a number-phase uncertainty product smaller than 1/2.

"Recursion polynomial expansion of the Green's function with absorbing boundary conditions: Calculations of resonances of HCO by filter diagonalization"
T. Grozdanov, V. Mandelshtam and H. S. Taylor
J. Chem. Phys. **103** (1995) 7990.

An interative method for calculating resonance positions and widths is developed. The system Hamiltonian with an asymptotic complex absorbing potential is represented by a large and sparse matrix. A small set of "good" basis functions suitable for diagonalizing the Hamiltonian matrix in a given energy window is generated by acting with a polynomical expansion of the imaginary part of the system Green's function onto a generic initial wave packet. As an application to a realistic three-dimensional system, the calculation of 65 resonances of the nonrotating HCD molecule up to the energy 9000 cm^{-1} is presented. The method is shown to be rapidly cnnvergent and accurate, especially for narrow resonances.

"Single and double charge exchange in fast ion-atom collisions"
Dž. Belkić
Nucl. Inst. and Meth. in Phys. Researc. B **99** (1995) 218.

A novel theoretical framework, which includes multiple scattering effects, is devised for consistently treating charge exchange at intermediate and high impact energies. From this versatile and general formalism, which obeys the asymptotic coavergence of total scattering states, as the most essential criterium for the validity of collision theory, a number of particular methods can be derived in a systematic manner. In such a way, several proper versions of the impulse approximation are introduced, fulfilling the correct boundary conditions in both channels and using only mathematically justified solutions of the basic dynamic equations, associated with a twofold Coulomb wave of intermediate states. It is precisely the lack of these two basic features. which invalidates the standard impulse approximation and all its previous extensions in the field of atomic collisions.

"Photodetachment of an electron bound by a zero-range potential in magnetic fields of arbitrary strength"
T. Grozdanov
Phys. Rev. A **51** (1995) 607.

The model problem of photodetachment of an electron initially bound by zero-range potential in a homogeneous static magnetic field of arbitrary strength is solved exactly. Expressions for the cross sections are derived within the nonrelativistic theory for various photon polarizations. In particular, photodetachment from states that exist only in the presence of a magnetic field is studied. In the limit of small fields the results obtained agree with findings of other authors.

"Hidden crossings and the separation constant of a hydrogenlike atom in spheroidal coordinates"
T. Grozdanov and E. A. Solov'ev
Phys. Rev. A **51** (1995) 2630.

Considered as a limiting case of a highly asymmetric two-Coulomb-center problem, the analytic properties of the eigenvalues of the constant nf motion allowing separation of variables for a hydrogenlike atom in spheroidal coordinates are studied. Calculations of the positions of the branch points of the eigenvalues in the complex plane of internuclear separations are performed. It is found that they form charecteristic series whose limiting points can well be predicted by semiclassical quantization conditions.

CONFERENCES: Invited lectures, progress reports and contributions

"Atomic "stabilization" in a high intensity laser field beyond the one mode and dipole approximation"
P. S. Krstić
Big Sky Workshop on Super-Intense Laser-Atom Physics, Big Sky Lodge, Big Sky, Montana (1991).

It has been shown recently that, within the framework of the nonrelativistic dipole approximation, a one mode high frequency, high intensity laser produces metastable states of atomic hydrogen. The binding energy and state width decreases with the increase of the laser intensity and therefore the high frequency approximation becomes unnecessary. Inclusion of the relativistic and multipole corrections into the problem shows the bounds of validity of the previous results. If the laser becomes very intense bound states still exist, but they completely change their character. Particularly, previously found scaling laws and atomic dichotomy are lost. Binding energy and wave functions depend not only on one parameter α_0, but also on the laser frequency. The spin behavior in the metastable atom is also changed and shows strong dependency on the laser field polarization. Circular polarization produces a new spin interaction term which is significant for strong, though realizable laser fields. Multimode effects on the binding energy of hydrogen are also investigated, A multimode laser with fixed mode amplitudes and random uncorrelated phases yield an additional reduction of the binding energy and in some cases eliminates it entirely.

"Calculations of excitation and ionization cross sections for He^{2+}-H slow collisions"
P. S. Krstić
IAEA met. *Atom. Mol. Data for Fusion Plasma Impurities*, Vienna, Austria (1991).

The excitation and ionization of hydrogen atoms (initially in ground and excited state) by slow fully stripped ions are considered within the concept of promotion of the system to the continuum and to the excited states through series of hidden adiabatic energy crossing. The topolngy of the energy branches of the systems H^+ +H and He^{2+} +H is presented in the plane of complex R. The cross sections for ionization and excitation in slow collisions of He^{2+} +H (n=1,2) is obtained. More than 120 molecular states were included in these calculations.

"Excitation, ionization and electron capture cross sections in low energy collisions of Be^{4+} and B^{5+} with H (n=1, 2)"
P. S. Krstić
Meeting on Be and B Collisional Database, IAFA, Vienna (1991).

Slow collisions of fully stripped ions of Be and B with hydrogen are considered. The theory of transitions within the framework of hidden crossing of the adiabatic molecular terms in the plane of complex R is rewieved. The newest results for cross sections for ionization, excitation and charge exchange in collisions of fully stripped Be and B with H in ground and the first excited state are presented.

"Semiclassical quantization"
T. P. Grozdanov
Konferencija Luj de Broj, Beograd, (1992), Zbornik radova, *SFIN* 1 (1993) 37.
(in Serbian)

Methods of semiclassical quantization applicable to classically integrable and nonintegrable systems are reviewed. The first half of the article is devoted to rather detailed exposition of some topics of the classical mechanics such as action-angle variables, invariant phase-space tori and Poincare surfaces of section. Onset of chaos in classical systems is discussed. the second part of the article contains the description of the various implementations of the EBK quantization as well as the periodic orbit theory of Gutzwiller. Finally, quantum mechanical properties of the systems whose classical analogs are chaotic are discussed and illustrated in a number of examples.

"Semiclassical theory of two-electron systems"
N. Simonović
XVI SPIG, Beograd, Book of Contributed papers (1993) 9.

In the light of the recent discovery that the classical helium atom is not globally ergodic in spite of high correlated nature of two-electron motion, but is of mixed structure (i.e. regular and chaotic motion exists in different parts of phase space), a few characteristic types of this motion are studied. The types where angular component of motion is dominant are mostly stable, whereas those with dominant radial component are mostly unstable. The radial instability (classicaly) leads to autoionization of the system. Here we compare Wannier collinear (symmetric stretch) and a planar (eliptic) orbits, hyperbolic orbits (collinear antisymmetric stretch and a planar so-called asynchronous model), Langmuir oscillatory model, planetary model and recently discovered so-called frozen planet configurations. For Wannier orbits it is found that their Lyapunov (stability) exponents diverge as ellipses degenerate to straight lines. This implies that this kind of two-electron configurations cannot be associated with resonant structures in (quantum) spectra. All the hyperbolic orbits are found to be unstable, but their Lyapunov exponents remain finite (motion is fully but weakly chaotic). This type of motion can be associated with intra-shell resonances for which it has been widely believed until recently that they should be associated with Wannier orbits. For other mentioned models it is discovered that in phase space there exist stability islands around periodic orbits, what implies possibility of rigorous torus quantization. The classical analysis is performed using technique of Poincaré surfaces of section and Lyapunov exponents. Regularization procedure appears necessary for numerical solving equations of motion, because of singular character of the Coulomb interaction.

"Relative recombination at low energies"
Dž. Belkić
XVI SPIG, Beograd, Book of Contributed papers (1994) 5.

We are concerned with the radiative recombination (RR) between free electron and ions at very low relative energies (0.0t meV - 30 eV). Here an ion A of total charge q caprures a free electron e forming another system in excited state $A^{(q-1)+*}$ with the reduced charge (q-1) foltowed by emission of light $(h\nu)$: $A^{q+} + e^- \rightarrow A^{(q-1)+*} + h\nu$.

"Laser assisted fast electron collisions with Hydrogen in n=1 and n=2 states"
S. Vučić
EC Network Meeting *Electron Atom Collisions in Intense Laser Fields and Multiphoton ionization* Paris (1995).

We study the elastic and inelastic scattering of fast electrons by hydrogen atoms in a state with the principal quantum number n=1 or n=2, in the presence of a linearly polarized laser field. The non-perturbative Born-Floquet theory is applied.

"The atomic three-body problem from the classical and semi-classical points of view"
N. Simonović and P. Grujić
The School on Advances and Methods in the Study of Atomic Doubly-Excited States, Medeilim, Columbia (1995) 47.

Here we give an overview of the double-excited two-electron atomic system models, based on the notion of a classical orbit. The emphasis will be on the possible classical structures of these simple atoms (ions) and on their stability as dynamical systems. We present a brief overview of the underlying classical dynamics, then expound basic mathematical methods for treating classical configurations of two-electron atoms. A number of the recently calculated classical configurations will be presented and semiclassical energy spectra evaluated.

"Komunikacija i informacija u nauci"
P. Grujić
Filosofski problemi komunikacije, Beograd (1991). (in Serbian)

"Hydrogen atoms in circularly polarized microwave fields: Photoexcitation of Rydberg quasienergy states"
T. P. Grozdanov, M. J. Raković and E. A. Solov'ev
ICAP XII, Munich (1992) A26.

"The small-energy behavior on non-Wannierian systems"
N. Simonović and P. Grujić
XVI SPIG, Beograd, Book of Contributed papers (1993) 22.

"Photodetachment in strong magnetic fields"
T. P. Grozdanov
XVI SPIG, Beograd, Book of Contributed papers (1993) 56.

"Inelastic processes in Slow Li^{3+} + H collisions"
M. D. Radmilović, P. S. Krstić and R. K. Janev
XVI SPIG, Beograd, Book of Contributed papers (1993) 58.

"Born-Floquet theory of laser assisted electron-atom collision"
M. Dorr, C. J. Joachain, R. M. Potvliege and S. Vučić
NATO Workshop *Super-Intense Laser-Atom Physics* , Belgium (1993).

"Inelastic electron-Hydrogen atom collision in a laser field"
S. Vučić
VI Inter. Conf. on Multi-Photon Processes, Quebec City, Canada (1993).

"The first Born-Floquet theory for the electron-Hydrogen atom collision in a laser field"
S. Vučić
XVI SPIG, Beograd, Book of Contributed papers (1993) 20.

"Analytical properties of the separation constant of the Hydrogenlike atom in spheroidal coordinates"
T. Grozdanov and E. Solov'ev
XVII SPIG, Belgrade, Book of Contributed Papers (1994) 49.

"Semiclasical calculations of 1Se intra-shell resonances of double-excited Helium"
P. Grujić and N. Simonović
XVII SPIG, Beograd, Book of Contributed Papers (1994) 20.

"Formation of H^- in fast H-H collisions"
I. Mančev and M. Mudrinić
XVII SPIG, Belgrade, Book of Contributed Papers (1994) 55.

"Photoionization calculations for the 6s subshell in atomic Ytterbium"
M. Radmilović and V. Radojević
XVII SPIG, Belgrade, Book of Contributed Papers (1994) 35.

"Calculation of 4d → 4f oscillator strengths for $La3^+$"
D. Lukić, V. Radojević and Lj. Stevanović
XVII SPIG, Belgrade, Book of Contributed Papers (1994) 32.

"Fast e^-H (2s) collision in a laser field"
S. Vučić
XVII SPIG, Belgrade, Book of Contributed Papers (1994) 37.

"Kako misliti budućnost"
P. Grujić
Kako misliti budućnost Evrope, Sr. Karlovci, (1994). (in Serbian)

"Fast e-H(2s) collision in a laser field "
S. Vučić
ECAMP5, Edinburgh (1995).

"Dvostruko pobudjeni atomi i širenje spektralnih linija"
P. Grujić
1st Yug. Conf. Spectr. Line Shapes, Krivaja (1995). (in Serbian)

"Kant i problem kosmogonije"
P. Grujić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 29.
(in Serbian)

"Proizvod neodređenosti broj kvanata-faza za generalizovana stisnuta stanja kvantnog oscilatora"
D. B. Popović i I. Mendaš
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 33.
(in Serbian)

"Torus-kvantizacija klasičnog atoma helijumna na Wannierovom grebenu"
N. Simonović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 113.
(in Serbian)

"5s→np rezonance u fotojonizaciji La^{3+}"
Lj. Stevanović, D. Lukić i V. Radojević
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 121.
(in Serbian)

"Metod egzaktnog izračunavanja druge Bornove amplitude za e-H sudare srednjih energija razvojem po bazisu Sturmianskih funkcija"
S. Vučić i R. M. Potvliege
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 137.
(in Serbian)

"Hamiltonovi sistemi na granici haosa: globalno skaliranje i univerzalnost"
N. Burić, M. Mudrinić, D. Timotijević i A. Piper
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 153.
(in Serbian)

"Teorijska istraživanja fotojonizacije atoma sa spoljnom ns^2 podljuskom"
M. Radmilović i V. Radojević
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 109.

THESES: Ph. D. and M. S.

"Asinhroni model helijuma-semiklasična teorija"
N. Simonović
Fizički fakultet, Univerzitet u Beogradu, (1993) (Ph. D. thesis in Serbian).

"Procesi ekscitacije, jonizacije i razmene naelektrisanja pri sporim sudarima visestruko naelekrisanih jona i atoma vodonika"
M. Radmilović
Fizički fakultet, Univerzitet u Beogradu, (1994) (M. S. thesis in Serbian).

"Istovremena ekscitacija i izmena naelektrisanja u brzim sudarima izmedju jezgara i dvoelektronskih atomskih sistema"
M. Mudrinić
Fizički fakultet, Univerzitet u Beogradu, (1994) (M. S. thesis in Serbian).

П 0106: БИНАРНИ СУДАРИ АТОМСКИХ ЧЕСТИЦА

P0106: BINARY COLLISIONS OF ATOMIC PARTICLES

PUBLICATIONS: Books, Monographs and Articles

"Elastic and inelastic electron scattering by cadmium"
B. Marinković, V. Pejčev, D. Filipović and L. Vušković
J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 1817.

Relative elastic scattering and excitation cross sections of cadmium, up to the first ionization potential, are obtained from spectroscopic measurements on electrons with initial energies ranging from 3.4 to 85 eV. Relative differential cross sections in the angular range of 0^0 to 150^0 are reported for excitation of the 5^1S_0 (elastic), 5^3P_1, 5^3P_2, 5^1P_1, 6^3S_1, 6^1S_0, 5^1D_2, 6^1P_1, 7^1S_0, $(6^1D_2+7^1P_1)$, 8^1S_0 and $(7^1D_2+8^1P_1)$ levels. Relative integrated scattering cross sections as well as momentum transfer and viscosity cross sections are also given.

"Electron impact total ionization cross-sections for methane, ethane and propane"
N. Djurić, I. Čadež and M. Kurepa
Int. J. Mass Spectrom. Ion Proc. **108** (1991) R1.

The present measurements of total positive charge production cross-sections for the three simplest saturated hydrocarbon molecules: methane (CH_4); ethane (C_2H_6); and propane (C_3H_8) represent a continuation of our efforts in the absolute determination of these collision parameters for simple molecules of interest in various fields of physics and other related sciences. Preliminary results have already been reported.

"Resonance C.A.R.S. detection of SiC_2 as reaction intermediate in IR laser synthesis of SiC_2 from SiH_4 hydrocarbon mixtures"
F. Fantoni, F. Bijnen, N. Djurić and S. Piccirillo
Appl. Phys. B **52** (1991) 176.

Coherent anti-Stokes Raman Scattering has been employed to investigate gas-phase reactions between SiH_4 and small hydrocarbons leading to formation of SiC powder. SiC_2 has beeo identified as reaction intermediate, due to the occurrence of resonance enhanced CARS coupling vibrational levels in the ground ($X\sim^1 A_1$) and first electronically excited ($A^1 B_2$) state. The rich structure observed in the range 4480 Å$< _{AS} <$ 4650 Å is assigned to SiC_2 taking into account the cyclic geometry of this species and revising former data on $A\sim X\sim$ electronic transitions.

"Interferométrie atomique par effet Stern-Gerlach longitudinal"
J. Baudon, J. Robert, Ch. Miniatura, F. Perales, Y. Yuan, V. Bočvarski, V. Lorent, S. le Boiteux, G. Vassilev et J. Reinhardt
Annales de Physique, Coll.2, Supp.2, **16** (1991) 91.

The principle of an atomic interferometer using the longitudinal Stern-Gerlach effect is explained. The study of the external motion shows that a permanent spatial separation among the $2j+1$ Zeman components is achieved. Multiply localized atoms in a unique internal state $|j,m_j>$ ("beaded" atoms) can also be prepared. These atoms exhibit special properties as concerned with their interaction with radiation.

"Atomic interferometry with metastable hydrogen atoms"
J. Robert, Ch. Miniatura, S. le Boiteux, J. Reinhardt, V. Bočvarski and J. Baudon
Europhys. Lett. **16** (1) (1991) 29.

An atomic interferometer using the longitudinal Stern-Gerlach effect has been constructed. A thermal beam of metastable hydrogen atoms has been used to test the apparatus. Interference patterns have been obtained. The visibility of the fringes is limited by the velocity spread of the beam. The observed patterns are in good agreement with that predicted from the actual velocity distribution.

"Absolute cross section measurements for electron impact ionization of Ar^{7+}"
S. Rachafi, D. S. Belić, M. Duponchelle, J. Jureta, M. Zambra, Z. Hui and P. Defrance
J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 1037.

The first absolute cross sections measurements for single and double electron impact ionization of sodium-like Ar^{7+} are reported. The animated crossed beams method has been employed in the energy range from threshold to 3000 eV. The measured cross sections for single ionization are higher than the theoretical and semi-empirical predictions by about 20-50%. This discrepancy has been associated with the contribution of the indirect ionization processes. The double ionization cross sections is only 1% of the single one.

"Pulsed laser photoacoustic spectroscopy of gases"
P. Vujković Cvijin, M. Terzić, D. D. Markušev, A. Dj. Petrović,
J. Jovanović-Kurepa and G. Atkinson
J. de Phys. IV 1 (C7) (1991) 477.

Pulsed laser photoacoustic spectrometer based on CO_2 laser excitation is reported. Advantage has been taken of the temporal resolution of the gas absorption signal relative to that of the background. Detection sensitivity of 1.5 ppbv ethylene ($4.9 \times 10^{-8} cm^{-1}$) is achived.

"Triplet states of ammonia excited by low-energy electrons"
S. Cvejanović, J. Jureta, M. Mimić and D. Cvejanović
J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 4337.

A low-energy crossed-beam electron spectrometer is used to investigate excitation of ammonia. Spectra obtained at low residual energies and large scattering angles in both constant residual energy mode and energy loss mode show excitation of two triplet states of ammonia, labelled a and b. A triplet b state is observed for the first time in the present work, while for the a state several lower, previously unobserved vibrational levels are detected. The threshold electron spectrum obtained by detecting zero residual energy electrons reveals a strong influence of threshold resonance in the excitation of the lowest Rydberg a state. Also a very large threshold peak in the excitation of the v=1 level of the symmetric stretch mode (ν_1) of the ground electronic state suggests a resonant process at very low energies.

"Elastic and inelastic electron scattering by sodium at 10, 20 and 54.4 eV"
B. Marinković, V. Pejčev, D. Filipović, I. Čadež and L. Vušković
J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 5179.

Relative differential electron impact cross sections ($\sigma(\theta)$) for elastic and inelastic (3p, 4s, 3d, 4p) scattering at 10 eV, 20 eV (3p and 4s excitation only) and 54.4 eV by sodium atom have been measured. The $\sigma(\theta)$ for the 3s-3p transition are normalized to the optical oscillator strength. The angular range of measurements is from 2^0 for inelastic and from 6^0 for elastic scattering up to 150^0 for both. Results are compared with the available experimental and theoretical data. Present results of $\sigma(\theta)$ are lower at large scattering angles than coupled-channel theory predicts. Comparison with the recent distorted wave calculations by Madison et al is given in the following paper.

"The formation of H^+ from H^- by electron impact"
D. J. Yu, S. Rachafi, J. Jureta and P. Defrance
J. Phys. B: At Mol. Opt. Phys. **25** (1992) 4593.

New absolute cross section measurement for the reaction $H^- + e^- \rightarrow H^+ + 3e^-$ is reported for interaction energies from threshold to 2 keV by using the animated crossed beam method. The present results confirm the disagreement between the previous results of this laboratory and the results of Peart et al.

"Associative ionization in collisions between metastable hydrogen atoms"
X. Urbain, A. Cornet and J. Jureta
J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 189.

Absolute total cross sections have been measured for the reaction $H(2s) + H(2s) \rightarrow H_2^+ + e^-$ in collisinn energy range 0.004-0.65 eV. Single beam measurements yield a cross section of 2.1×10^{-15} cm^2 at an average collision energy of 4.1 meV. Relative measurements performed with merged beams indicate, together with the absolute measurements, an overall E^{-1} energy dependence.

"Threshold electron excitation of Na"
B. Marinković, P. Wang, A. Gallagher
Phys. Rev. A **46** (1992) 2553.

Electron collisional excitation of the 4D, 5D, 4P, and 6S states of Na has been measured with about 30 meV energy resolution. Very rapid, unresolved threshold onsets are seen for all but the 4P state, and a near-threshold resonance is suggested by the 5D data. However, only weak undulations in the cross sections are observed above threshold.

"Absolute cross sections for low-energy scattering of electrons by excited sodium"
T. Y. Jiang, M. Zuo, L. Vušković and B. Bederson
Phys. Rev. Lett. **68** (1992) 915.

Electrons scattered by $3^2P_{3/2}$, $M_L = \pm 1$ sodium has been measured in the collision energy range up to 5 eV and in the angular range 0^0 to 30^0. Absolute differential cross sections are reported for deexcitation to $3^2S_{1/2}$ and excitation to $4^2S_{1/2}$, obtained without normalization. The 3P→4S cross sections are over a factor of 2 times larger than those for the corresponding 3S→3P reaction for the same final electron energy. Comparison with available theory is presented.

"Absolute cross-section measurements for electron-impact ionization of Cl^+"
N. Djurić, E. W. Bell, E. Daniel and G. H. Dunn
Phys. Rev. A **46** (1992) 270.

Absolute cross sections for electron-impact ionization of Cl^+ have been measured from threshold to 200 eV with the use of the crossed-beams technique. The cross section shows a peak value of 11.34×10^{-21} m^2 at about 70 eV. Results are compared to the semiempirical prediction formula of Lotz. Expansion coefficients and formulas for generating ionization rate coefficients in temperature range $10^4 \leq T \leq 10^7$ are presented.

"Conditions for the existence of oscillations in the distributions of the vibrational quanta of squeezed states"
I. Mendaš and D. B. Popović
J. Phys. A: Math. Gen. **25** (1992) 1049.

The conditions for the existence of oscillations in the distribution of the vibrational quanta for the general case of the time evolving squeezed state (which does not remain a minimum-uncertainty state) of the one-dimensional harmonic oscillator are investigated. To aid this, new parametrization of squeezed states is introduced. It is found that in addition to the usual conditions which produce oscillations, the value of the phase of the complex parameter z (which is the argument of the Hermite polynomial H_n appearing in the expression for the expansion coefficient a_n of the squeezed state in the number state basis) must have a value in the vicinity of $\zeta = 0$ or $\zeta = \pi\{|\mathrm{Im}(z)| << |z|\}$. It is showed how this necessary condition results from the explicit expression fnr $|H_n(z)|^2$.

"Elastic and inelastic electron scattering by mercury"
R. Panajotović, V. Pejčev, M. Konstantinović, D. Filipović, V. Bočvarski and B. Marinković
J. Phys. B: At Mol. Opt. Phys. **26** (1993) 1005.

Relative differential electron impact cross sections $\sigma(\theta)$ for elastic and inelastic scattering in mercury have been measured. The $\sigma(\theta)$ are normalized to the optical oscillator strength for the 6^1S_0-6^1P_1 transition and put on an absolute scale. Results are presented at 15, 25, 35, 40, 50, 60 and 100 eV for elastic scattering and the 6^1P_1 excitation. In additinn the 6^3P_1, 7^1P_1 excitation $\sigma(\theta)$ are presented at 60 eV. The angular ranges are frnm 2^0 for inelastic and from 10^0 for elastic scattering, up to 150^0. Results are compared with the other experimental and theoretical data. Comparison with the recent relativistic calculations is given by Srivastava et al in the following paper.

"Electron impact on free C_{60}: Excited states below 10 eV"
R. Abouaf, J. Pommier and S. Cvejanović
Chem. Phys. Letters **213** (1993) 503.

Electron energy loss spectra have been performed on C_{60} vapour, both at very low (E_r=0), and at intermediate residual energies (up tn E_r=70 eV), along with an angular analysis of the scattered electrons. Besides the two strong bands at 3.78 and 4.84 eV, due to dipole-allowed transitions to $^1T_{1u}$ states, and the $\pi - \pi^*$ collective excitation at 6.1 eV, we have observed a band peaking at 2.26 eV, dominant at low residual energies, corresponding to superimposed transitions to triplet states, and dipole orbitally forbidden states. A new peak, likely to be of triplet character is observed at 2.96 eV. In contrast with similar studies on C_{60} films, we have not found any evidence of the lowest triplet state $^3T_{2g}$ at 1.55 eV.

"Hydrogen recombination on metals: Vibrational excitation of desorbed molecules"
I. Čadež, C. Schermann, M. Landau, F. Pichou, D. B. Popović and R. I. Hall
Z. Phys. D **26** (1993) 328.

The vibrational excitation of hydrogen molecules fnrmed by recombination of hydrogen atoms on different metal surfaces has been studied. A recently developed experimental technique was used to determine vibratinnal state populations of the molecules up to v=7. Excitation of high vibrational levels is observed for molecules formed on metal surfaces which strongly chemisorb hydrogen. Metals with weaker chemisorption lead to vibrational excitation of lower levels, predominantly up to v=3. Knowledge of the vibrational state of desorbed molecules gives information on the energy of adsorbed hydrogen atoms and on the dynamics nf surface reactions. This information is complementary to that obtained from studies of hydrogen reactions with metal clusters.

"Absolute cross sections for electron-impact single ionization of Si^+ and Si^{2+}"
N. Djurić, E. W. Bell, X. Q. Guo, G. H. Dunn, R. A. Phaneuf, M. E. Bannister, M. S. Pindzola and D. C. Griffin
Phys. Rev. A **47** (1993) 4786.

Absolute cross sections for electron-impact single ionization of Si^+ and Si^{2+} have been measured using crossed beams of inns and electrons and calculated using a configuration-average distorted-wave method. Cnrrectinns have been made for mstastable components and small fractions of nitrogen impurities in the incident ion beams. Excitation-autoionization measurably enhances the cross sections of both Si^+ and Si^{2+}. Ionization rate coefficients and fitting parameters are presented for the experimental data.

"Electron-impact ionization of In^+ and Xe^+"
E. W. Bell, N. Djurić, and G. H. Dunn
Phys. Rev. A **48** (1993) 4286.

Absolute ionization cross sections for In^+ and Xe^+ by electron impact have been measured from below threshold to 200 eV using the crossed-beams technique. The cross sections for In^+ were possihly enhanced by indirect ionization processes. The excitation of the ion from the $4d^{10}5s^2$ ground state to the $4d^95s^25p$ state followed by autoinnization has been postulated. The In^+ cross sections show a peak value of 15.9×10^{-17} cm^2 at about 80 eV. The cross sections for Xe^+ peak at a value of 25.6×10^{-17} cm^2 at about 35 eV. Experimental measurements are compared to configuration-averaged distorted-wave calculations [M S Pindzola et al., J. Phys. B 16, L355 (1983)], the semiempirical formula of Lotz [Z. Phys. 216 (1968)], and, in the case of Xe^+, previous experimental results [C. Achenbach et al., J. Phys. B 17, 1405 (1984)]. Alsn presented are ionization-rate coefficients and fitting parameters for both ions for temperatures in the range $10^4K\leq T\leq10^7K$.

"Crossed-beams measurements of absolute cross sections for electron impact ionization of S^+"
N. Djurić, E. W. Bell and G. H. Dunn
Int. J. Mass Spectrom. Ion Proc. **123** (1993) 187.

Absolute cross sections for electron impact ionization of S^+ have been measured in the electron energy range from 30-250 eV using the crossed-beams technique. Results are compared with scaled cross sections from other P-like ions, with a semiempirical formula and with other recently reported measurements. Expansion coefficients and formulas for generating ionization rate coefficients in the electron temperature range 10^4 K $\leq$ T $\leq$ 10^6 K are presented.

"Pancharatnam phase for displaced number states"
I. Mendaš and D. B. Popović
J. Phys. A: Math. Gen. **26** (1993) 3313.

The Pancharatnam phase for displaced number states of the harmonic oscillator is discussed. In particular, it is examined how a single quantum oscillator, driven by a suitable transient external force, evolves from the initial eigenstate $u_m(x)$ to the final, displaced number state modified with a suitable phase factor. The significance of this, usually neglected, phase factor for the solution of the relevant time-dependent Schrödinger equation and for the geometric phase accumulated in the wavefunction during the time evolution of the system is examined. The general expression for the geometric phase for a *non-cyclic* evolution from an initial displaced number state at time t_1 to the final state at time t_2 is derived and two applications, that of and harmonic forcing, are worked out. The special case of cyclic evolution is subsequently discussed and, in particular, the conditions leading to such an evolution are derived. The relationship to the classical notion of cyclic evolution is also examined in some detail and it is demonstrated that the general expression for the Pancharatnam phase reduces to the corresponding Berry phase. It is found that, in the case of cyclic evolution, the geometric phase for displaced number states becomes independent of the quantum number m of the initial eigenstsate, and becomes equal to the geometric phase for the coherent states. The general considerations are illustrated with the special case of the harmonic forcing function. Finally, the possibility of experimental verification, in the realm of quantum optics, is briefly considered.

"Feshbach resonances in electron excitation functions of HBr"
D. Čubrić, J. Jureta, S. Cvejanović and D. Cvejanović
J. Phys. B: At. Mol. Opt. Phys. **27 (1994)** 3231.

Electron impact excitation functions for b $^3\Pi_1$, h $^3\Pi_0$ and C $^1\Pi$ states of HBr have been measured in a energy range from threshold to 2.5 eV above and for scattering angles from 40^0 to 120^0. Strong threshold excitation and a large number of structures in the investigated energy range are interpreted in terms of resonances, reported previously by Spence and Noguchi in a transmission experiment. A new resonance has been found at 10.15 eV appearing strongly at large angles in the states involving the ($^2\Pi_{1/2}$) core. The almost constant value of the energy separation between the members of the resonance pairs, selectivity of resonance decay with respect to the excited state ionic core and observed angular dependences have been used in discussing the resonance state assignments.

"Low energy electron collisions on OCS: differential vibrational cross sections and S^- production around 1 eV"
R. Abouaf, J. Pommier, S. Cvejanović and B. Saubaméa
Chem. Phys. **188 (1994)** 339.

The low energy vibrational excitation in OCS has been re-examined. The angular dependences of the vibrational cross sections in the $^2\Pi$ resonance region are shown to be proportional to 2-$\cos^2\theta$ for vibrational modes, and to 1+7$\cos^2\theta$ for modes. The threshold spectrum ($E_{residual}$= 0 eV) reveals that, in the bending series below 0.5 eV, the vibrational modes of symmetry are more excited than the modes. Indeed the vibrational excitation cross sections recorded for a few vibrational modes, show a peak at threshold for the modes but not for the ones. We have also observed a new structure in the S^-/OCS dissociative attachment cross sections.

"Satellite and resonance states in the near-threshold photoionization of argon"
S. Cvejanović, G. W. Bagley and T. J. Reddish
J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 5661.

High resolution threshold photoelectron spectroscopy, in conjunction with synchrotron radiation has been employed to investigate single and double photoionization of argon in the 32-51 eV photon energy range. We have been able to distinguish between satellite and resonance states observed in our spectrum and thereby correct previous misassignments. Furthermore, we have developed a method to extract partial cross sections for satellite states from threshold to 150 meV. The excitation functions of these electron-correlated processes generally show a strong threshold peak, which we attribute to dynamic effects within the excitation complex, as well as other peaks due to the nearby neutral resonances. In addition, the apparent asymmetry of the Ar^{2+} ^1D threshold cups is discussed in terms of a possible effect.

"Highly excited hydrogen molecules desorbed from a surface: experimental results"
C. Schermann, F. Pichou, M. Landau, I. Čadež, R. I. Hall
J. Chem. Phys. **101** (9) (1994) 8152.

The rovibrational excitation of hydrogen molecules resulting from recombination of atoms nn a metallic surface has been observed by means of an electronic collision method. We present the obtained H experimental spectra reflecting the vibrational populations of the desorbed hydrogen molecules. This study brings to light the fundamental role of the nature of the metallic surface in the recombination process: excitation of higher vibrational levels (from v=5 to v=8) is observed only on those metal surfaces which strongly chemisorb atomic hydrogen. To explain these observations we propose the formation, on these surfaces, of a physisorbed H layer on the chemisorbed one.

"Absolute cross-section measurements for electron-impact single ionization of Se^+ and Te^+"
N. Djurić, E. W. Bell, G. H. Dunn
Int. J. Mass Spectrom. Ion Proc. **135** (1994) 207.

The crossed-beams technique has been used to measure absolute cross-section for the single ionization of Se^+ and Te^+ at electron energies from threshold to 200 eV. The peak cross-sections obtained are 16.6×10^{-17} cm^2 at about 53 eV for Se^+ and 24.3×10^{-17} cm^2 at about 43 eV for Te^+. The measured Se^+ cross-sections are bracketed from above by direct-ionization cross-sections from configuration-averaged distorted-wave calculations of Pindzola [unpublished work] and from below by results using the single parameter semi-empirical formula of Lotz [Z. Phys., 216 (1968) 241], with both calculations giving results in moderate agreement with the measurements. In contrast, comparisons of measured Te^+ cross-sections with similar calculations are generally poor. Ionization-rate coefficients for a Maxwellian electron-temperature distribution calculated from the experimental data are presented.

"Study of the Ar LMM spectra by He^+ projectile at 1250 keV, 1500 keV AND 2000 keV bombardment energies"
L. Toth, Gy. Vikor, S. Ricz, P. Pelicon and R. Miller
NIM Phys. Res. B **86** (1994) 151.

The influence of He^+ ion impact on the Ar LMM spectra was investigated at the ESA-21 electron spectrometer using three different ion energies. Observed line relative energies to the $L_3M_{2,3}(^1D_2)$ line agree well with other results, but the relative intensities of five angular-isotropic lines deviate significantly from other measurements and theory. The angular dependence of energy shifts agrees with the quantum PCI theory of Barrachina and Macek, except for directions close to 180^0, where a slight enhancement of energy shift was observed. Finalty, the angular distributions of the $L_2M_{2,3}(^1S_0)$, $(^1D_2)$ and $(^3P_{0,1,2})$ line intensities were compared to the alignment theory of Sizov and Kabachnik.

"Observation of collisionally induced $(1_s2_p2_p)^{4pe}$ shape resonance of He^-"
P. A. Zavodszky, L. Sarkadi, L. Vikor, and J. Palinkas
Phys. Rev. A **50** (1994) 50.

Autodetachment via the collisionally populated $(1_s2_p2_p)^{4pe}$ shape resonance of He^- has been observed by means of 0^0 electron spectroscopy in a measurement of the double-differential cross section for single and double electron loss to the continuum in He^- on Ar collisions at 75-keV/u projectile energy. An altrnative parametrization has been developed for the autodetachment lines emitted with low energy in the projectile reference frame. The determined position and width of the shape resonance are in agreement with the results of theoretical calculations and photodetachment measurements.

"Number-phase uncertainty product for displaced number states"
I. Mendaš and D. B. Popović
Phys. Rev. A **50** (1994) 947.

The number-phase uncertainty product for displaced number states of the harmonic oscillator is examined within the framework of three different approaches: (i) the Carruthers-Nieto number-phase uncertainty relation in terms of the Susskind-Glogower sine and cosine phase operators, (ii) a similar relation tn this calculated with the Pegg-Barnett unitary phase operator, and (iii) the number-phase uncertainty relation arising from the Pegg-Barnett Hermitian phase operator. The corresponding number-phase uncertainty product is calculated extending from average photon numbers 30 down to m for the first few classes of displaced number states (m=0,1,...,5). It is found that, for a displaced number state with a reasonable average number of excited quanta, all three rival phase formalisms yield similar number-phase uncertainty products, tending, for increasingly large magnitude of the displacement parameter, to the constant value m+1/2. On the other hand, for a small number of excited quanta it is found that, according to the first two formalisms, the number-phase uncertainty product for a given class of displaced number states tends to the maximum value $\sqrt{(2m+1)}/(\sqrt{(m+1)}-\sqrt{m})$, while that third phase formalism predicts an entirely different behavior, with decreasing magnitude of displacement parameter, after passing through a maximum, the number-phase uncertainty product falls off eventually to zern making, in particular, the search for minimum number-phase uncertainty states futile. It is argued in favor of this last result, and the possibility of experimental verification, in the realm of quantum optics, is briefly considered.

"Pulsed photoacoustic study of collisional effects in IR multiphoton absorption measurements"
J. Jovanović-Kurepa, D. D. Markušev, M. Terzić
J. de Phys. IV **4** (C4) (1994) 751.

The pulsed laser photoacoustic technique, simultaneously used with transmission spectroscopy, was applied for detail study of IR multiphoton absorption processes in polyatomic molecules. Collisional effects were specially investigated in SF_6 diluted with Ar as nonabsorbing species. The results regarding the enhanced absorption cross sections (σ^*) for SF_6-Ar mixtures are obtained with precision of ±18-±29%. The differential absorption cross sections (σ^*_d), as well as the average number of absorbed photons <n> per SF_6 molecule in (0.1-0.7)J/cm^2 fluence range and (1-140) mbar Ar pressure range are also presented.

"Photoacoustic study of collisional effects on rotational relaxation processes induced by infrared multiphoton absorption"
M. Terzić, D. D. Markušev, J. Jovanović-Kurepa
J. de Phys. IV **4** (C4) (1994) 739.

The novel experimental approach was applied to investigate the cross sections for rotational relaxation $s_{rot.-rel.}$ in the SF_6-Ar mixtures irradiated by pulsed CO_2 laser line. The applied method is the pulsed photoacoustic technique, and it is based on proposal for $\sigma_{rot.-rel.}$ determination by transmission spectroscopy technique. The collisionall effects have been investigated for the (0.1-0.8)J/cm^2 laser fluence range. Also, the collisional effects on rotational and translational temperature (T_R) for SF_6-Ar mixtures have been calculated.

"Pulsed photoacoustic detection technique applied to the study of multiphoton absorption in molecules"
J. Jovanović-Kurepa, M. Terzić, D. D. Markušev and P. Vujković Cvijin
Meas. Sci. Technol. **5** (1994) 847.

A pulsed laser photoacoustic technique is described. It is optimized for the simultaneous investigations of multiphoton absorption processes as well as rotation relaxation and vibration relaxation studies. The experimental procedure is presented, concerning the calibration of the photoacoustic detector/cell set-up, which can be alternatively used for the sensitive curve S(p,γ,T) of the apparatus. A priveously proposed model is confirmed.

"Water molecule fragmentation by electron impact"
Gy. Vikor and M.V. Kurepa
J. Serb. Chem. Soc. **60** (1995) 199.

Electron impact partial ionization cross sections of the water molecule for the formation of H^+, OH^+, O^+ and H_2O^+ ions were measured for electron energies from thresholds to 200 [eV]. Relative ion intensity curves obtained experimentally were normalized to the recent total ionization cross sections of Duric et al. via the partial ionization cross sections of Schutten et al, at 100 [eV] incident energy. The present partial ionization cross section curves agree with those of Schutten et al, while they differ from corresponding ones by Mark and Egger and Orient and Srivastava, both in shape and absolute values.

"A method for extracting near-threshold partial cross Sections from threshold photoelectron spectra"
S. Cvejanović and T. J. Reddish
J. Phys. B: At. Mol. Opt. Phys. **28** (1995) L1.

A method used to obtain the first state-selected cross sections for the near-threshold photoionization of argon from an analysis of threshold electron spectra is described. The yield of photoelectrons in the wings of threshold peaks is normalized by division with the efficiency function of the penetrating field threshold electrnn analyser, convoluted with a Gaussian photon beam profile. Although very non-uniform within the first 150 meV, the analyser efficiency function was found to have a particularly simple analytic form suitable for further numerical treatment. We have discussed the measured ratios of the two components of the lowest Ar^+ $3p^5\ ^2P$ state in relation to the spectral repulsion theory of Fann and Cooper. The potential of the technique is illustrated on the $3p^4\ (^3P)3d^4F_{3/2}$ ion state cross section, showing enormous resonant peaks. The limitation in the general applicability of the method is also discussed.

"The double ionization cusp in the threshold photoelectron spectrum of helium"
S. Cvejanović, R. C. Shiell and T. J. Reddish
J. Phys. B: At. Mol. Opt. Phys. **28** (1995) L707-17.

New measurements of the zero-energy electron yield in the region of the photodouble ionization threshold in helium are presented, showing for the first time a Wannier-type cusp with a small asymmetry of the excitation/ionization wing amplitudes, similar to the electron impact results in the region of the first ionization threshold. The observed pressure dependence of the cusp amplitude asymmetry and other second-order effect are discussed in an explain the discrepancy with the earlier photoionizatinn results of Hall *et al.*

"Collisions of electrons with highly-charged ions"
G. H. Dunn, N. Djurić, Y. S. Chung, M. Bannister, A. C. H. Smith
NIM Phys. Res. B **98** (1995) 107.

This progress report in addition to describing recent work in the authors' laboratory, highlights the general character and importance of electron collisions with highly-charged ions (HCI) and describes major advances in the field since the previous conference on the subject. Thus, while the authors' principle efforts are currently directed toward investigation of excitation of HCI, there have been very notable advances by others in the areas of ionization and recombination and an attempt is made to put these into context of the field in general. Also, for the first time , significant progress is now being made by others in investigation of elastic scattering of electrons from HCI.

"Absolute cross sections for the electron-impact single ionization of Mo^{4+} and Mo^{5+} ions"
M. E. Bannister, F. W. Meyer, Y. S. Chung, N. Djurić, G. H. Dunn, M. S. Pindzola, D. C. Griffin
Phys. Rev. A **52** (1995) 413.

Absolute total cross sections for the electron-impact single ionization of Mo^{4+} and Mo^{5+} ions have been measured using a crossed-beams technique from below the ground-state ionization threshold to 500 eV with typical total uncertainties of 9% near the peak of the cross sections. Molybdenum ion production in the source was facilitated by a mini-oven sublimating MoO_3. The measured cross sections are in good agreement with distorted-wave calculations and are dominated by contributions from excitation autoionization. Nonzero cross sections below the threshold for ionization of $Mo^{5+}(4p^64d)$ ground-state ions indicate that metastable ions were present in the beam extracted from an electron-cyclotron-resonance ion source. No evidence of metastable ions was found in the case of the Mo^{4+} measurements. Ionization rate coefficients and fitting parameters are presented for the experimental data.

"Contribution of transfer ionization to cusp electron production in proton on argon collisions"
L. Vikor, P. A. Zavodszky, L. Sarkadi, J. A. Tanis, M. Kuzel, A. Bader, J. Palinkas, E. Y. Kamber, D. Berenyi and K. O. Groeneveld
J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 3915.

Cusp-electron emission in proton on argon collisions has been investigated at impact energies 33, 50 and 75 keV. By detecting the electrons in coincidence with the charge-state analysed outgoing $H^{+,0}$ projectiles, the process of electron capture to the continuum (ECC), as well as the process of simultaneous ECC and bound-state capture (transfer ionization, TI) were identified. The ratios of the yields for cusp-electron production by TI and ECC are found to decrease with increasing projectile energies. At the lowest proton energy (33 keV) the measured TI/ECC ratio is about four times smaller than the corresponding ratio for incident He^+ measured in earlier work. Significant is the finding that there exists a cusp associated with TI events, and moreover that this cusp is present for neutral outgoing projectiles.

"A particle detector for energetic ions"
A. Bader, L. Sarkadi, Gy. Hegyesi, Lj. Vikor and J. Palinkas
Meas. Sci. Technol. **6** (1995) 959.

A fast ion detector based on secondary electron emission from an aluminum surface is presented. The secondary electrons are accelerated by 1.2 kV and detected by two microchannel-plates in cascade configuration. Applying channel-plates for the secondary electrons one can achieve the same detector efficiency as in case of channeltron but at much higher counting rate. The measured effieiency of the detector for 150 keV protons was found to be 0.8 at I MHz counting rate.

"Number-phase uncertainty product for generalized squeezed states arising from the Pegg-Barnett Hermitian phase operator formalism"
I. Mendaš and D. B. Popović
Phys. Rev. A **52** (1995) 4356.

The number-phase uncertainty relation based on the Pegg-Barnett Hermitian phase operator formalism is discussed for generalized squeezed states of the harmonic oscillator. The corresponding number-phase uncertainty product is calculated for the magnitudes of the squeeze and displacement parameters ranging from 0 to 3/2 in the former case and from 0 to 4 in the latter case for the first few classes of generalized squeezed states (m=0, 1, and 2) and for different values of their combined phases. It is found that for a given magnitude of the squeeze parameter, the number-phase uncertainty product tends to the fixed limiting value m+1/2 when the magnitude of the displacement parameter tends to infinity. On the other hand, for a fixed magnitude of the displacement parameter, the uncertainty product grows indefinitely as the magnitude of the squeeze parameter increases. It is also observed that the number-phase uncertainty product tends to zero for few-photon generalized squeezed states (when the magnitudes of both squeeze and displacement parameters tend tn zero) so that, according to the Pegg-Barnett Hermitian phase formalism it is possible to have generalized squeezed states with a number-phase uncertainty product smaller than 1/2.

CONFERENCES: Invited lectures, progress reports and contributions

"Collisional dynamics of vibrationally excited hydrogen molecules"
I. Čadež, D. B. Popović and R. I. Hall
Proc. Pentagonale Workshop on Elementary Processes in Clusters, Lasers and Plasmas (EPCLP) (1991) 22.

Molecular hydrogen is the most abundant molecule in the interstellar media. It is commonly accepted that the mechanism for its formation is recombinative desorption of hydrogen atoms on the interstellar grains. For understanding the characteristics of these grains as well as for the purpose of determining the interstellar environmental conditions it is of primary importance to know in which vibrational states the molecules are formed.

"Partial and total ionization cross sections of some small molecules"
M. V. Kurepa, N. Djurić, Dj. Vikor and I. Čadež
Proc. *Pentagonale Workshop on Elementary Processes in Clusters, Lasers and Plasmas (EPCLP)* (1991) 49.

We report here new experimental results for partial and total ionization cross sections of small molecules of importance for fusion and MHD plasmas and/or discovered in the interstellar space: H_2O, CH_4, C_2H_6, C_3H_8, C_2H_2, CH_3OH, C_2H_5OH and n-C_3H_7OH. We have undertaken these measurements following a number of reviews (Bell et al., 1983; Ehrhardt and Langer, 1987; Lennon et al. 1987; Tawara and Kato 1987; Shinamura 1989; Janev et al. 1989; Märk 1985; de Heer and Inokuti 1985) were it was repeatedly states that for many small molecules, especially hydrocarbons, there are no reliable or even any cross section data for electron impact ionization.

"Gustine verovatnoće nalaženja elektrona u atomskim i molekulskim orbitalama"
M.V. Kurepa
I savetovanje društva fizikohemičara Srbije, "Fizička hemija 92"
Beograd, Uvodno predavanje, Izvodi radova (1992) 7. (in Serbian)

"Transporni procesi i efektivni dijametar molekula"
Dj. Vikor
Republički seminar o nastavi fizike, Predavanje po pozivu, Beograd, *Zbornik*, (1992) 87. (in Serbian)

"Detection of wave packets in Rydberg atomic states"
M.V. Kurepa
Naučni skup "L. de Broglie", Invited lecture, Beograd (1992)
SFIN, 6 (1993) 72. (in Serbian)

In this lecture results of highly excited atomic energy states behaviour, created by single or multiple photon absorption as investigated by experimental methods, are reviewd. During the absorption coherent excitation of a number of stationary statesoccures, and as a result a localized wave packet is created. The radial and angular motion of this wave packet, it's decay and reconstruction was the objective of recent experiments. The coherently excited states represent a kind of transition between those describabte by quantum-mechanical methods and states close in their characteristics to the clasical electron motion around the atomic nucleus.

"Slikovit prikaz procesa u atomima"
B. Marinković
Republički seminar o nastavi fizike, Predavanje po pozivu, Beograd, *Zbornik*, (1993) 42. (in Serbian)

"Threshold and resonant features in the vibrational excitation fimctions on hydrogen halides"
S. Cvejanović
XVIII ICPEAC, Aarhus, Denmark, Invited Lecture, AIP Conf. Proc. 295 *The Physics of Electronic and Atomic Collisions*, (1993) 390.

The present situation in the understanding of the scattering mechanisms responsible for the unique features of the vibrational excitation cross sections in hydrogen halides is reviewed. A particular attention is applied to the critical evaluation of the available experimental data concerning the location and shape of the threshold peaks. New structure found in the region of higher vibrational thresholds in all hydrogen halides is discussed in terms of resonances and channel interference.

"Electron excitation of C_{60} vapour by electron energy loss spectroscopy"
R. Abouaf, J. Pommier and S. Cvejanović
In *"Electron Collisions with Molecules, Clusters, and Surfaces"* (1994) 211.

A lot of work has already been devoted to the determination of the electronic states of the highly symmetric Buckminsterfullerene molecule. Only a few references are given here both on theoretical, and experimental viewpoints. Most of the experiments have been performed on the C_{60} solid phase, or in C_{60} solutions. The recent opportunity to produce gram quantities of relatively pure C_{60} have allowed the extension of experiments to energy loss studies in the gas phase. The present contribution is dealing with electron energy loss spectra, with angular analysis, recorded in C_{60} vapour, in the low and intermediate incident energy range, i.e. 0 to 70 eV above the excitation thresholds of the low lying electronic states (1 - 10 eV).

"Procesi jonizacije molekula vode udarom elektrona"
M. Kurepa
Glas Odeljenja prirodnih nauka SANU, Pristupna beseda, Beograd (1994). (in Serbian)

"Experimental studies of electron impact dissociation of molecular ions"
N. Djurić, Y-Soo Chung, B. Wallbank and G. H. Dunn
XIX ICPEAC, Whistler, Canada (1995).

Recent progress on experimental studies of electron impact dissociation of molecular ions is presented. A technique especially configured to detect and measure 'light particles' is described. Preliminary results of absolute cross sections for dissociation of CD_2^+ and Cl_2^+ are presented.

"Partial ionization cross sections of the water molecule by electron impact"
Dj. Vikor and M. Kurepa
Proc. *Gen. Conf. of the Balkan Phys. Union*, Thessaloniki (1991).

"3P 3P and 3P 4S cross sections for 2 eV electrons scattered by laser-excited sodium"
T.Y. Jiang, M. Zuo, L. Vušković and B. Bederson
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"Neke nove osobine pomaknutih i stisnutih stanja kvantnog oscilatora"
D. B. Popović
Fizički fakultet, Univerzitet u Beogradu (1994) (Ph.D. thesis in Serbian).

"Interakcija laserskog zračenja sa plazmom ispred metalne mete"
Lj. Vikor
Fizički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Parcijalni preseci za jonizaciju atoma argona i molekula vode"
Dj. Vikor
Fizički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Sudarni procesi sa vibraciono pobudjenim molekulom vode"
D. B. Popović
Fizički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Visoko pobudjena rezonantna stanja na ekscitacionim funkcijama helijuma"
M. Minić
Fizički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Odredjivanje efektivnih diferencijalnih preseka za elestično i neelastično rasejanje elektrona na atomima žive"
R. Panajotović
Fizički fakultet, Univerzitet u Beogradu (1993) (M.S. thesis in Serbian).

"Multifotonsko pobudjivanje molekula SF_6 u prisustvu metana"
D. D. Markušev
Fizički fakultet, Univerzitet u Beogradu (1994) (M.S. thesis in Serbian).

"Ekscitacione funkcije 3^3S i 3^1S stanja helijuma u optičkom kanalu"
Momir Stepanović
Fizički fakultet, Univerzitet u Beogradu (1995) (M.S. thesis in Serbian).

П 0107: АТОМСКИ СУДАРИ У ГАСНИМ ПРАЖЊЕЊИМА И НА ПОВРШИНАМА

P0107: ATOMIC COLLISIONS IN GAS DISCHARGES AND ON SURFACES

PUBLICATIONS: Books, Monographs and Articles

"Dissociative excitation of hydrogen in rf and dc glow discharges through H_2"
S. B. Vrhovac, S. B. Radovanov, S. A. Bzenić, Z. Lj. Petrović and B. M. Jelenković
Chem. Phys. **153** (1991) 233.

The spectral and spatial profile of H_β from the low pressure rf and dc glow discharges in hydrogen is studied in order to reveal the excitation mechanism of the fast excited H fragments. Measurements were performed both for the normal and abnormal dc glow discharges. Spatial distributions of the Balmer line radiation reflect the local plasma conditions in the discharge, especially the excitation efficiency which is used to determine the excitation kinetics in hydrogen discharges. Spectral H_β profiles were measured and used to determine the kinetic energy of excited H atoms and to check which of the mechanisms describes best the results observed in nur experiment. We have also calculated the number densities of vibrationally excited levels by solving a set of vibrational master equations for the conditions similar to those of our experiments, as excitation from the vibrationally excited ground-state hydrogen molecules may be used to explain the changes in the intermediate wing component of the line profile with the changing current.

"On the mechanism of Doppler broadening of H_α after dissociative excitation in hydrogen glow discharges"
S. A. Bzenić, S. B. Radovanov, S. B.Vrhovac, Z. B.Velikić and B. M. Jelenković
Chem. Phys. Letters **184** (1991) 108.

The analysis of the Doppler profile of the Balmer (H_α) line emitted from the low current, low pressure H_2 dc, and low and high frequency rf discharges was used to get additional data on the fast excited hydrogen atom production in the cathode sheath region. The results show very broad line profile in both dc and low frequency discharges, due to the escited particles of several hundred electrovolt moving towards and away from the cathode. The effect of different heavy particle collisions on dissociative excitation and ionization in the cathode region for different discharge conditions is discussed.

"Plasma beam depositioo of diamond-like films"
J. Kessler, B. Tomčik, J. Waldorf and H. Oechsner
Vacuum **42/4** (1991) 273.

A novel rf plasma beam source operated with CH_4 and CH_4+H_2 mixtures is used for the formation of hydrogenated hard carbon layers. The film composition, particularly the H content, is determined by secondary neutral mass spectrometry (SNMS) and the binding structure by XPS utilizing the characteristic plasmon losses of the C(1s) photoelectrons. As demonstrated by the characteristic XPS structures, diamond-like films are obtained for plasma beam energies around 120 eV with the substrates being held at room temperature. The microhardness and the electrical resistance of the films compare with the best values reported in the literature.

"Investigation of hard a-C:H layers generated by a novel r.f. plasma beam source"
H. Oechsner and B. Tomčik
Surface and Coating Technology **47** (1991) 162.

A novel r.f. plasma beam source being operated with CH_4 as the working gas has been employed for the formation of a-C:H films on (100)Si substrates. The energy E_i of the ion component in the extracted electrically neutral plasma beam was varied between 120 and 600 eV. The mechanical and electrical film properties are determined and discussed in dependence of E_i, which in turn is shown to control the hidrogen content of the films in a deffinite manner.

"Stark broadening of the HeI 4471 Å line and its forbidden component at high electron densities"
N. I. Uzelac, I. Stefanović and N. Konjević
J. Quant. Spectrosc. Radiat. Transfer **46** (1991) 447.

Results are reported of measurements on the neutral helium 4471 Å line and its forbidden component at 4470 Å in the plasma of a high-pressure pulsed discharge at an electron temperature of about 2.5 eV and at electron densities ranging from $0.6x10^{17}$ to $3.4x10^{17}cm^{-3}$. Good agreement is found with other low-electron-temperature experiments at about 1.5 eV. Differences between the results obtained ia these studies and other experimental data show, in some cases, systematic discrepancies with the results derived from available calculations.

"Stark broadening and shift of singly ionized zino and cadmium spectral lines"
S. Đeniže, A. Srećković, J. Labat, R. Konjević, L. Popović
Phys. Rev. A **44** (1991) 410.

The Stark width and shift of six Zn II and six Cd II spectral lines have been measured for the electron-density range of $1.0x10^{23}$-$1.23x10^{23}m^{-3}$ and for an electron-temperature range of 23000-33000 K in a pulsed linear arc plasma discharge in SF_6 and argon-helium mixture. Obtained Stark-width data were compared with the values calculated on the basis of various theoretical approaches.

"Excitation by and surface reflection of fast hydrogen atoms in low-pressure hydrogen discharges"
Z. Lj. Petrović, B. M. Jelenković and A. V. Phelps
Phys. Rev. Lett. **68** (1992) 325.

Fast excited H atoms produced in collisions of fast H atoms with H_2 and observed by Doppler spectroscopy and quantitative radiometry are the dominant H_α source in low-current, low-pressure H_2 dc discharges. For heavy-metal cathodes, backscattered fast H atoms from incident H and H^+ atoms and H_2 and H_2' molecules excite most of the H_α. For graphite cathodes, backscattering is small and H is produced by electrons and by approaching fast H atoms produced by charge transfer in H^+-H_2 collisions and dissociation in H_2'-H_2 and H_2-H_2 collisions. Excitation of H by ion collisinns with H_2 and the cathode is small.

"Electron energy distribution functions in weakly ionized argon"
S. B. Vrhovac, S. B. Radovanov, Z. Lj. Petrović and B. M. Jelenković
J. Phys. D **25** (1992) 217.

In this paper we present measurements of the electron energy distribution functions (EEDF) for electrons in argon discharges at moderate and high E/N values (E being the electric field and N the gas density), for homogeneous electric fields and a low-current diffuse glow regime. Results were obtained for electric field to gas density ratios (E/N) from 500 Td to 50 kTd (1 Td = 10^{-21} Vm^2). A multigridded energy analyser with a retarding grid potential was used to measure distribution functions of electrons sampled through an aperture in the anode. Experimental data are used to make a comparison with the two-term Boltzmann calculations for E/N < 1 kTd, and the single-beam model predictions, normally used to model electron kinetics at high values of E/N.

"Excitation of Balmer lines in low-current discharges of hydrogen and deuterium"
Z. Stokić, M. M. F. R. Fraga, J. Božin, V. Stojanović, Z. Lj. Petrović and B. M. Jelenković
Phys. Rev. A **45** (1992) 7463.

Measurements have been made of electron-impact ionization and excitation of Balmer lines in low-current, steady-state discharges of hydrogen and deuterium. Results were obtained from spatial scans of H lines for E/N ranging from 250 Td to 10 kTd. Here E is the electric field, N is the gas density, and 1 Td = 10^{-21} Vm^2. Ionization and excitation coefficients versus E/N are presented for E/N between 250 and 1800 Td, and Nd (where d denotes the gap length) between 2.3 x 10^{22} and 1.7 x 10^{21} m^{-2}. Excitation coefficients obtained for H_α and D_α are placed on an absolute scale using a standard tungsten lamp calibrated against the blackbody radiation standard. The ionization coefficients are compared with previous experimental and theoretical data, while the excitation coefficients are compared with the calculated values.

"Ion kinetic-energy distribution in argon rf glow discharges"
J. K. Olthoff, R. J. Van Brunt and S. B. Radovanov
J. Appl. Phys. **72** (1992) 4566.

Kinetic-energy distributions have been measured for different mass-selected ions sampled from 13.56 MHz rf glow discharges in argon inside a "GEC rf reference cell". The electrode geometry of this cell produces an asymetric discharge and the cell is operated in a pressure regime where ion-molecule collisions in the sheath region of the discharge are significant. Ions are sampled from the side of the plasma perpendicular to the interelectrode axis using an electrostatic energy analyzer coupled to a quardupole mass spectrometer. Kinetic-energy distributions for Ar^+, Ar_2^+, Ar^{++} and ArH^+ are presented as functions of applied rf voltage, gas pressure, and distance of the mass spectrometer entrance aperture from the edge of the electrodes. The distributions obtained for the sampling orifice placed close enough to the electrodes to allow formation of a sheath in front of the orifice exhibit features similar to those observed previously when sampling ions through the grounded electrode of a parallel-plate reactor. The Ar^+ and Ar^{++} distributions exhibit secondary maxima predicted to result from the formation of low-energy (thermal) ions in the sheath region, such as by charge-exchange and high-energy electron collisions. Kinetic-energy distributions for Ar_2^+ and ArH^+ exhibit no secondary maxima and are peaked at high energies indicative of the sheath potential, and consistent with a formation mechanism involving relatively low-energy collisions in the bulk plasma (glow region).

"Regularities in experimental Stark shifts"
W. L. Wiese and N. Konjević
J. Quant. Spectrosc. Radiat. Transfer **47** (1992) 185.

We have examined regularities in plasma-produced line shifts (Stark shifts) by a comprehensive analysis of literature data. Since the shifts are the result of atomic collision processes, regularities are expected from general atomic structure considerations. Specifically, systematic behaviour shnuld occur for spectral series and for corresponding transitions in homologous atoms and isoelectronic ions. Also, Stark shifts shnuld be similar for lines within multiplies and, to a lesser degree, within supermultiples and transition arrays. Numerous examples show conclusively that the measured data exhibit these predicted regularities. When pronounced irregularities occur, they are readily explainable in terms of special circumstances in the atomic structure.

"Stark widths and shifts of Sn I, Hg II, Hg III and Pb II spectral lines"
S. Đeniže, A. Srećković, J. Labat, R. Konjević, M. Brnović
Z. Phys. D-Atoms, Molecules and Clusters **24** (1992) 1.

Stark widths and shifts of neutral and ionized heavy atom spectral lines have been measured and calculated. The Stark parameters of three SnI (284.0, 286.3 and303.4 nm), five HgII (226.2, 398.4, 222.5, 615.0 and 326.4 nm), two PbII (220.4 and 438.6nm) and one HgIII (235.4 nm) spectral lines were measured for the first time except the Stark widths of one HgII (398.4 nm) and one PbII (438.6 nm) line. Stark width values for a number of corresponding transitions were calculated on the bases of semiclassical and semiempirial formulae.

"On the Stark broadening regularities along a homologous sequence of the IV B subgroup in the periodic system"
S. Đeniže, J. Labat, R. Konjević
Contrib. Plasma Phys. **32** (1992) 69.

On the basis of the exiting experimental results of the Stark widths we have demonstrated the existence nf a Stark-width dependence on the upper-level ionizing potential for the homnlogous sequence nf the fourth B group of the elements in the periodic system for three types of transitions in the case of singly-ionized atoms. On the basis of these regularities we have predicted Stark widths of some Ge II and Pb II spectral lines. Stark widths predicted for Ge II, Sn II i Pb II spectral lines were compared with our calculated values on the basis of the semiempirical and modified semiempirical formula.

"Lasers with variable wavelength"
N. Konjević
Sveske fizičkih nauka (SFIN) VI (1993) 100. (in Serbian).

The principles of the laser wavelength tuning are outlined. Several, most important tunable lasers are described.

"Spatiotemporal optical emission spectroscopy of RF discharges in SF_6"
Z. Lj. Petrović, F. Tochikubo, S. Kakuta and T. Makabe
J. Appl. Phys. **73** (1993) 2163.

Space- and time-resolved emission spectroscopy was applied tn obtain information nn the kinetics of radio-frequency (rf) discharges for 100 kHz, 800 kHz, and 13.56 MHz in SF_6. Emission lines of fluorine and SF_x radical were used, but particularly useful were the second positive (2+) and the first negative (1-) bands of nitrogen. The two nitrogen bands gave an opportunity to separate, respectively, the behavior of middle-energy (11-20 eV) and higher-energy (above 20 eV) electrons. Development of double layers was studied from the excess emission close to the anode due to an increased electric field. Alsn observed were the emission from the bulk and emission due to the electrons accelerated in the instantaneous cathode sheath. The development of these features was followed as a function of the pressure, frequency, and power.

"Oscillations of low current electrical discharges between the parallel plane electrodes I DC discharges"
Z. Lj. Petrović and A.V. Phelps
Phys. Rev. E **47** (1993) 2806.

The oscillatory behavior of dc discharges between parallel-plane electrodes (1 cm spacing) at low pressures (0.5-3 Tnrr) is measured and compared with models. Fnr hydrogen these discharges are unstable for wide ranges of discharge current belnw 0.2 mA/cm^2 and extemal circuit resistances above 4000 . Lateral constructions of the discharge occur over a much more limited range of currents and pressures than do oscillations. Laser-induced photoelectron pulses produce damped oscillations for discharge currents below those at which self-sustained oscillations are observed. The frequency of the oscillations varies approximately as the square root of the discharge current and the damping of the oscillations increases with the discharge current. These results agree with simple models developed in an accompanying paper [this issue, Phelps, Petrovic and Jelenkovic, Phys. Rev. E **47**, 2825 (1993)]. Some data are presented fnr argon and nitrogen.

"Oscillations of low-current electrical discharges between parallel-plane electrodes. II. Pulsed discharges in H_2"
B. M. Jelenković, K. Rosza and A.V. Phelps
Phys. Rev. E **47** (1993) 2816.

Measurements are made of damped oscillatinns in the current and voltage induced by a voltage pulse applied tn the stabilizing resistor of discharges in H_2 at pressure times electrode spacing values of 0.3 to 1 Tnrr cm (40-133 Pa cm) operating at voltages of 300 to 2100 V. The use of pulses 1 ms long and repetition rates of 10 Hz results in low ion bombardment of the cathode. Fnr pulse currents of 0.01 to 5 mA (2×10^{-7}-10^{-4} A/cm^2) and an electrode separation and area of 1 cm and 50 cm^2, the frequencies and damping cnnstants are 10-300 kHz and 2×10^3-10^5 s^{-1}, respectively. The current densities are small ennugh so that space-charge distortion of the electric field is small, but not negligible. At currents below thnse for oscillation growth, the steady-state discharge vnltage decreases as expected for a constant negative differential resistance. Values of 1000 to 4000 are obtained depending on pressure and cathode condition. Transient models, developed in an accompanying paper, relate the frequencies, damping constants, and onset of oscillatinn growth tn ion transit times, electron ionization coefficients, and ion-induced electron yields. The growth of discharge current immediately after the application of the voltage pulse is also used tn determine discharge parameters.

"Oscillations of low current electrical discharges between the parallel plane electrodes III models"
A.V. Phelps, Z. Lj. Petrović and B. M. Jelenković
Phys. Rev. E **47** (1993) 2825.

Simple models are developed to describe the results of measurements of the oscillatory and negative differential resistance properties of low- to moderate-current discharges in parallel-plane geometry. The time-dependent model assumes that the ion transit time is fixed and is short compared to the times of interest, that electrons are produced at the cathode ooly by ions, and that space-charge distortion of the electric field is small but not negligible. Illustrative numerical solutions are given for large voltage and current changes and analytic solutions for the time dependence of current and voltage are obtained io the small-signal limit. The small-signal results include the frequency and dampping constants for decaying oscillations following a voltage change or following the injection of photoelectrons. The conditions for underdamped, overdamped, and self-sustained or growing oscillations are obtained. A previously developed steady-state, nonequilibrium model for low-pressure hydrogen discharges that includes the effects of space-charge distortion of the electric field on the yield of electrons at the cathode is used to obtain the negative differential resistance. Analytic expressions for the differential resistance and capacitance are developed using the steady-state, local-equilibrium model for electron and ion motion and a first-order perturbation treatment of space-charge electric fields. These models generally show good agreement with data from dc and pulsed discharge experiments preseoted in the accompanying papers.

"Electronic excitation of the 750 and 811-nm lines of argoo"
Z. M. Jelenak, Z. B. Velikić, J. Božin, Z. Lj. Petrović and B. M. Jelenković
Phys. Rev. E **47** (1993) 3566.

Measurements have been made on the electron excitation ceofficients of four Ar levels: $2p_1$, $2p_5$, $2p_7$ and $2p_9$. Radiative decay of these levels to 1s levels is responsible for the strongest line features in argon spectra, at 750 nm due to radiation from $2p_1$ and $2p_5$ levels, and at 811 nm due to transitions from $2p_7$ and $2p_9$ levels. We have measured excitation coefficients of these levels in the range of E/N from 50 Td to 9 kTd (1 Td = 10^{-21} V m^2). Here E is the electric field and N is the gas density. The optical emission intensities normalized to the local current density were placed on the absolute scale after normalizing the data for the $2p_1$-$1s_2$ transition (750.4 nm) to the previous experimental and theoretical results at 50 Td. We have also made measurements of the excitation coefficients of several 4d and 6s vs E/N, in order to estimate the effect of cascading from upper levels to 2p levels. We have found that the excitations of $2p_5$ and $2p_7$ are influenced by collisional population transfer between 2p levels at low E/N (E/N < 100 Td, N > 2.7 x 10^{22} m^{-3}), by cascading from 3d and 4s levels above 100 Td, and by cascading from 4d and 6s levels at E/N > 3 kTd.

"Explanation of memory curve for nitrogen by surface-catalysed excitation"
V. Lj. Marković, M. M. Pejović aod Z. Lj. Petrović
J. Phys. D **26** (1993) 1611.

A theory and numerical model are proposed that explain the dependence of time delay on afterglow period, $t_d = f(\tau)$ (the memory curve), for the Cu-N_2 system by surface-catalysed excitation at nitrogen atom recombination on the cathode. The kinetics in the late nitrogeo afterglow are determined by nitrogeo atom recombination. It is shown that the nitrogen atom recombination on the container walls (glass) is of second order in N (the recombination on copper is of first order). The probability of the metastable formation of N_2 $N_2(A^3\Sigma_u^+)$ by recombination at the electrode surface is determine. The electron yield in interelectrode space caused by metastable secondary emission (the Auger de-excitation process) determines the time delay. On the basis of this mechanism, the time-delay method is very efficieot in detecting nitrogen atoms.

"Influence of frequency, pressure and abundance of electronegative gas on electrical characteristics of RF discharges in N_2-SF_6 mixtures"
S. Kakuta, F. Tochikubo, Z. Lj. Petrović and T. Makabe
J. Appl. Phys. **74** (1993) 4923.

Electrical characteristics of rf discharges in SF_6 and in its mixtures with N_2 were experimentally investigated. In addition space- and time-resolved emission spectroscopy was used to gain a better understanding of kinetics of processes leading to various observed characteristics. A complicated dependence of minimum sustaining voltage on frequency was observed with a peak at 3 MHz. It was explained as the result of transition from the conditions where discharge is sustained by ionization in the bulk and the double-layer region to the conditions where secondary electron yield makes a large contribution. Another possible explanation is the one invoking transition from the conditions where at high-frequency double layer is formed by electron modulation to the condition where a double layer is formed by positive and negative ions. In voltage-current dependencies at 13 MHz two distinct regions were observed similar to the to transitions observed for electropositive gases. Ionization by secondary electrons, however, is not supported by spatiotemporal emission measurements, thus explanation may be sought in different processes such as development of double layers and increased field in the bulk. The current-to-voltage phase is much smaller than in electropositive gases, thus the discharge appears more resistive. For a range of operating conditions the phase even becomes inductive due to negative ion inertia.

"Transformation of a time harmonic EM field in a suddenly created two-resonance Lorentz media"
B. M. Stanić, Z. M. Jelenak and A. Jelenak
J. Appl. Phys. **74** (1993) 6477.

A capacitively-coupled reactive ion etcher (RIE) can operate, even under high pressure conditions, for dry etching. Most of the etching gases are known to be strongly electronegative. The spatiotemporal structure of an ideal narrow-gap RIE with parallel plate geometry in an SF_6 discharge is investigated over the pressure range of 0.05-0.5 Torr at 13.56 MHz, using numerical simulations based on the relaxation continuum model. The rf plasma consists of a majority of positive and negative ions and a minority of more mobile electrons. The functionality of the narrow-gap RIE under typical operating conditions is due to the appearance of a double layer in front of the instantaneous anode. The double layer serves as the source of beamlike ions and virgin radicals immediately in front of the electrode surface. A narrower sheath width is realized compared with that found in electropositive gases. The maintenance of the rf discharge is accomplished by ionization at the double layer, while detached electrons from the negative ions have no significant influence on the function or the structure of the SF_6 discharge.

"Plasma broadening of Ne II-Ne VI and F IV-F V spectral lines"
N. I. Uzelac, S. Glenzer, N. Konjević, J. D. Hey and H. J. Kunze
Phys. Rev. E **47** (1993) 3623.

The Stark widths of 3s-3p and 3p-3d transitions of Ne II, Ne III, Ne IV, Ne V, Ne VI, F IV, and F V have been measured in the plasma of a gas-liner pinch discharge. The plasma parameters were determined from 90^0 Thomson scattering. Some of the measured Stark widths for Ne II, Ne III, and Ne IV lines are in good agreement with other experimental data. The results of three independent theoretical calculations are used for comparison with the measured widths. A growing discrepancy between theoretical and experimental results with increasing ionization is detected.

"Simple method for deconvolution of a gaussian and a plasma broadened spectral line profile $j_{A,R}(x)$"
Z. Mijatović, R. Kobilarov, B. T. Vujičić, D. Nikolić and N. Konjević
J. Quant. Spectrosc. Radiat. Transfer **50** (1993) 329.

Computation of the convolution integral of a Gaussian and the Stark-broadened $j_{A,R}(x)$ profile has been carried out and the results are expressed in a form suitable for the analysis of spectral line profiles.

"Simulations of rf glow discharge in SF_6 by the relaxation continuum model: physical structure and function of the narrow-gap reactive-ion etcher"
N. Nakano, N. Shimura, Z. Lj. Petrović and T. Makabe
Phys. Rev. E. **49** (1994) 4455.

A capacitively-coupled reactive ion etcher (RIE) can operate, even under high pressure conditions, for dray etching. Most of the etching gases are known to be strongly electronegative. The spatiotemporal structure of an ideal narrow-gap RIE with parallel plate geometry in an SF_6 discharge is investigated over the pressure range of 0.05-0.5 Torr at 13.56 MHz, using numerical simulations based on the relaxation continuum mogel. The rf plasma donsists of a majority of positive and negative ions and a minority of more mobile electrons. The functionality of the narrow-gap RIE under typical operating conditions is due to the appearance of a double layer in front of the instantaneous anode. The double layer serves as the source of beamlike ions and virgin radicals immediately in front of the electrode surface. A narrower sheath width is realized compared with that found in electropositive gases. The maintenance of the rf discharge is accomplished by ionization at the double layer, while detached electrons from the negative ions have no significant influence on the function or the structure of the SF_6 discharge.

"Surface recombination of atoms in a nitrogen afterglow"
V. Lj. Marković, Z. Lj. Petrović and M. M. Pejović
J. Chem. Phys. **100** (1994) 8514.

The surface recombination of nitrogen atoms in afterglow is studied by the time delay method, accompanied by the macrokinetic diffusive model. The method consists of the measurement of the dependence of the mean value of the breakdown time delay on afterglow period $\bar{t}_d = f(\tau)$ and fitting of the data by the model that was developed. Excited $N_2(A^3\Sigma_u^+)$ nitrogen molecules formed in the surface-catalyzed recombination on cathode produce secondary electrons. The electrons entering the interelectrode space determine the time delay in electrical breakdown. The time delay method is very efficient in nitrogen atom detection down to a natural radioactivity level. By fitting the calculated curve to the experimental data, we have: (1) shown that the nitrogen atom recombination on the glass container walls is second-order in N while the recombination on the copper electrode is the first order; (2) determined the value of the surface recombination coefficient for motybdenum glass; (3) determined the combined probability of $N_2(A^3\Sigma_u^+)$ metastable formation by recombination at electrode surface and of secondary electron emission. Furthermore, we derive the adsorption isotherm of nitrogen atoms on molybdenum glass, the type of recombination mechanism and the dependence of the activation energy for desorption (or the heat of adsorption) on the fractional coverage.

"The radical transport in the narrow- gap- reactive- ion etcher in SF_6 by the relaxation cantinuum model"
N. Nakano, Z. Lj. Petrović and T. Makabe
Jpn. J. Appl. Phys. **33** (1994) 2223.

We have established a selfconsistent modeling of a narrow-gap reactive ion etcher (N-gap-RIE) with parallel-plate geometry in SF_6. Using the discharge structure of the relaxation continuum model, we have numerically predicted the radical transport to the surface of N-gap-RIE in SF_6 under two different surface reactinns. The spatiotemporal profiles of radicals and neutrals are demonstrated for a long time scale (0-1 s) at between 0.05 Torr and 1.0 Torr at 13.56 MHz. The estimated etch rate of Si wafer with F radicals agrees reasonably well with the previous experimental value obtained under a low-power condition. It is stressed from the present result that the ion-molecule reactions for the generation of F radicals as well as the electron impact dissociation of SF_6 are of great importance.

"Kinetic of activated nitrogen states in late afterglow by the time delay method"
V. Lj. Marković, M. M. Pejović and Z. Lj. Petravić
J. Phys. D **27** (1994) 979.

A long-time decay of activated nitrogen is studied by the time-delay method. The kinetics in late nitrogen afterglow is determined by nitrogen atom recombination. Surface-catalysed excitation of nitrogen atom recombination at the cathode gives a metastable induced electron yield in the inter-electrode space (the Auger de-excitation process) that determines the time delay. The probability of $N_2(A^3\Sigma_u^+)$ metastable state formation by recombination at the electrode surface is determined, as are the contribution to electron yield from this mechanism and the contribution from the gas phase metastable species. On the basis of the above-cited mechanism, the time-delay method is found to be very efficient for detection of activated nitrogen.

"Influence of Ar metastable on the discharge structure in Ar and N_2 mixture in RF discharge at 13.56 MHz"
F. Tochikubo, Z. Lj. Petrović, S. Kakuta, N. Nakano and T. Makabe
Jpn. J. Appl. Phys. **33** (1994) 4271.

The influence of Ar metastable atoms on the discharge structure in rf glow discharges is investigated in Ar and N_2 mixed gas experimentally and theoretically. The purpose of adding a small amount of N_2 is to control the metastable density. Time- and space-resolved optical emission spectroscopy is applied to investigate the behavior of high-energy electrons. The density profile of Ar metastables in Ar and N_2 mixture is estimated from the oprical emission intensity of the second positive band of N_2, which results from the energy transfer from Ar metastables to N_2 molecules. The decreases of current and optical emission intensity, as well as the Ar metastable density with increase of N_2 ratio, are observed. It is concluded that ionization through metastables is one of the important processes in increasing the plasma density, especially at higher pressures.

"Drift velocities and characteristic energies of electrons in deuterium at low and moderate E/N"
W. Roznerski, J. Mechlinska-Drewko, K. Leja and Z. Lj. Petrović
J. Phys. D **27** (1994) 2060.

The measurements of the drift velocities and characteristic energies of electrons in deuterium are presented. Drift velocities are obtained between 3 and 125 Td by a standard Bradbury-Nielsen technique with a double set of shutters. The characteristic energy for the transverse diffusion was measured by a standard Townsend-Huxley technique to be between 3 and 1000 Td. The drift velocities and characteristic energies are

in good agreement with the best available data in the range of overlap and extend the availability of the experimental data to higher E/N. The predictions based on the best available cross section sets do not match the experimental results at higher E/N above the limits of the previously available data.

"Kinetic-energy distributions of ions sampled from argon plasmas in a parallel-plate, radio-frequency reference cell"
J. K. Olthoff, R. J. Van Brunt, S. B. Radovanov, J. A. Rees and R. Surowiec
J. Appl. Phys. **75** (1994) 115.

Kinetic-energy distributions are presented for ions sampled from 13.56 MHz discharges in argon in a capacitively-coupled, parallel-plate, Gaseous Electronic Conference (GEC) radio-frequency reference cell. The cell was modified to allow sampling of ions through an orifice in the grounded electrode. Kinetic-energy distributions are presented for Ar^+, Ar^{++}, Ar_2^+, ArH^+, and several trace ions for plasma pressures ranging from 1.3 Pa, where ion-atom collisions in the plasma sheath are not important, to 33.3 Pa, where collisions are important. Applied peak-to-peak radio-frequency (rf) voltages of 50, 100 and 200 V were used, and the current and voltage waveforms at the powered electrode were measured. Dependences of the ion fluxes, mean energies, and kinetic-energy distributions on gas pressure and applied rf voltage are interpreted in terms of possible ion-collision processes. The results agree with previously measured kinetic-energy distributions of ions sampled from the side of the plasma through a grounded probe for similar discharge conditions, verifying that ion kinetics are characteristic of the plasma sheath independent of where it is formed [J.K. Olthoff, R.J. Van Brunt, and S.B. Radovanov, J. Appl. Phys. **72**, 4566 (1992)].

"Stark broadening of triply ionized oxigen lines: The temperature dependence"
B. Blagojević, M. V. Popović, N. Konjević and M. S. Dimitrijević
Phys. Rev. E **50** (1994) 2986.

The Stark widths of the $3s^2S$-$3p^2p^0$ and $3p^2p^0$-$3d^2D$ transitions have been calculated and measured in the plasma of a pulsed arc. Electron densities in the range $(2.1\text{-}6.4)\times10^{17}cm^{-3}$ were determined from the width of the He II P_α line while electron temperatures between 50 800 and 131 800 K are measured from the Boltzmann plot of O IV line intensities. Our experimental O IV Stark width agrees well with another experiment and with our semiclassical theoretical results in the whole temperature range.

"Measured Stark widths and shifts of several Ni I and Ni II spectral lines"
S. Đeniže, Lj. Skuljan, J. Labat, S. Bukvić, R. Konjević
Astron. Astrophys. **105** (1994) 115.

Stark widths and shifts of four NiI and two NiII spectral lines have been measured in a linear low-pressure pulsed arc operated in an argon-helium mixture. The experimental NiI and NiII Stark widths are compared with values calculated from simple approximation formulae.

"Influence of impurities on surface recombination of nitrogen atoms in late afterglow"
V. Lj. Marković, Z. Lj. Petrović and M. M. Pejović
Jpn. J. Appl. Phys. **34** (1995) 2466.

The influence of impurity contents (water vapour and oxygen) on surface recombination of nitrogen atoms on the glass walls and the copper electrode surface is studied. The decay of nitrogen atom number density in late afterglow has been detected by the breakdown time delay method and the memory effect was found for nitrogen with large abundance of impurities (technical purity gas). The dominant reaction on the

glass walls covered with water vapour was found to be of the second order. The surface recombination coefficient has been increased by about two orders of magnitude compared to the pure gas. Also, the increase of the secondary electron yield by about one order of magnitude occurs caused by chemisorbed oxygen on the electrode surface.

"The influence of excited states on the kinetics of excitation and dissociation in gas mixtures containing methane"
A. Jelenak, J. V. Jovanović, S. A. Bzenić, S. B. Vrhovac, S. S. Manola, B. Tomčik and Z. Lj. Petrović
Diamond and related Materials **4** (1995) 1103.

In this paper, we extend the calculations for rare gas discharges, which aim to estabtish the influence of excited states on the kinetics of electron-induced excitation, to rare gas-methane mixtures and pure methane which are often used in diamond-like film deposition. In particular, we address the effect of non-thermal vibrational populations on the rate coefficients in methane-containing gas discharges using the procedure applied previously for pure silane. Furthermore, we investigate the kinetics of electronically excited levels of rare gases and methane in the presence of a significant population of excited states. These states may contribute to the overall ionization, excitation and dissociation rates through stepwise processes, superelastic collisions and energy transfer processes. The influence of superelastic processes on the development of the negative differential conductivity (NDC) is discussed on the basis of the momentum transfer theory, and it is shown that the NDC is reduced when significant populations of excited states are present. This is of importance for calculations of the transport coefficients for a.c. electric field where NDC leads to a complex temporal dependence of the drift velocity and thus directly affects the power deposition in the discharge. Finally, we present the rate and transport coefficients calculated for methane in r.f. fields based on the Monte Carlo simulation for time-dependent fields. A good agreement with the effective field approximation and earlier Boltzmann calculations is found.

"Kinetics of diamond-like film deposition on glass fibers"
B. Tomčik, A. Jelenak, M. Mitrović and Z. Lj. Petrović
Diamond and related Materials **4** (1995) 1126.

In order to determine the mechanism of diamond-like film deposition in r.f. discharge in methane, a tiny glass fiber was spanned along the discharge axis and perpendicular to the parallel-plate electrodes. The discharge was operated in a symmetric and slightly asymmetric regime. The film thickness and its surface topography were analyzed by means of scanning electron microscopy. Across the interelectrode space a non-uniform film thickness distribution on the fiber was observed. The films up to 15 m were deposited with excellent coverage uniformity and time stability on a 40 in diameter glass fiber substrate. The film thickness distribution along the fiber is the result of the space-dependent density profile of methyl CH_3 radicals which contribute mostly tot he film formation. It was concluded that the diffusion of methyl radicals in the discharge is responsible for the observed film thickness profile along the fiber.

"e-Ar scattering length from drift velocities measured in argon- hydrogen mixtures"
Z. Lj. Petrović, T. F. O'Malley and R. W. Crompton
J. Phys. B **28** (1995) 3309.

We present experimental data for drift velocities of very low energy electrons in a 5.45% hydrogen-argon mixture and the analysis of these data to determine the e-Ar scattering length. The addition of a small fraction of hydrogen to argon enables experiments to be made with vely low-energy electron swarms without the use of very high gas densities, thus reducing the uncertainty in the e-Ar cross section derived from the experimental data. A scattering length of -1.459 a_0 is found, laying between the previous swarm

determination and that obtained from time-of-flight (TOF) beam measurements. Pressure effects on the transport coefficients measured in earlier experiments are discussed, and evidence presented for a large departure from the Einstein relation at gas densities of 3×10^{20} cm^{-3}.

"Ion kinetics and symmetric charge-transfer collisions in low-current, diffuse (Townsend) discharges in argon and nitrogen"
S. B. Radovanov, R. J. Van Brunt, J. K. Olthoff and B. M. Jelenković
Phys. Rev. E **51** (6) (1995) 6036.

Translational kinetic-energy distributions of mass-selected ions have been measured in diffuse, low-current Townsend-type discharges at high electric field-to-gas density ratios (E/N) in the range of 1×10^{-18} - 2×10^{-17} Vm^2 (1-20 kTd). The discharges were generated in Ar and N_2 under uniform-field conditions and ion energies were measured using a cylindrical-mirror energy analyzer coupled to a quadrupole mass spectrometer. The mean ion energies determined from measured energy distributions of Ar^+ in Ar and N_2^+ in N_2 are compared with the mean energies predicted from solutions of the Boltzmann transport equation based on the assumption that symmetric resonant charge transfer is the predominant ion-neutral interaction. The results for Ar^+ and N_2^+ are consistent with predictions made using a constant (energy independent) cross section for which an effective ion temperature can be defined. However, for both ions, the measured mean energies tend to fall increasingly below the predicted values as E/N increases. The possible causes and significance of the differences between the measured and calculated mean ion energies are examined by considering collisions other than charge-transfer that can affect ion energies as well as uncertainties in the charge-transfer cross sections used in the calculations. Measurements were also made of the relative contributions from N^+ and Ar^{2+} to the ion flux. Over the E/N range of interest, N^+ accounts for less than 15% of the ion flux in nitrogen and Ar^{2+} accounts for less than 5% of the ion flux in argon.

"On spatial distribution of optical emission in radio frequency discharges"
Z. Lj. Petrović, S. Bzenić, J. Jovanović and S. Đurović
J. Phys. D: Appl. Phys. **28** (1995) 2287.

In this paper we present calculations of the spatial distribution of emission in model argon discharges which correspond to the conditions of argon discharges in the GEC rf reference cell but are relevant for other similar rf discharges. The calculations on the basis of the particle in cell (PIC) code show that transitions with high threshold energy are predominantly excited by secondary electrons originating from the instantaneous cathode while the transitions with lower threshold energy are excited predominantly by electrons accelerated by sheath motion. In addition it is shown that the spatial distribution of 811 nm radiation of argon corresponds best to excitation by very low-energy electrons from the metastable state. The different kinetics of excitation of the three groups of transitions mentioned above, in conjunction with different energy dependences of the cross sections and special conditions when there is a significant if not dominant condtribution of the process in sustaining the discharge, give rise to the different spatial distributions of emission which are opposed to the intuitively expected distributions and raise questions about the applications of spatial distributions of emission in determining the sheath width and in diagnostic techniques such as actinometry.

"Long-range order in laser cooled atomic-ion Wigner crystals observed by Bragg scattering"
J. N. Tan, J. J. Bollinger, B. Jelenković and D. J. Wineland
Phys. Rev. Lett. **75** (1995) 4198.

We report the first observation of Bragg scattering from atomic ions in an electromagnetic trap. The results reveal long-range order and give evidence for bulk behavior in a strongly coupled collection of laser cooled $^9Be^+$ ions in a Penning trap. Long-range order emerges in aproximately spherical clouds with a few as 5

$\times 10^4$ ions (cloud radius $r_0 \approx 37a$ where a = Wigner-Seitz radius). Bulk behavior is evident with 2.7×10^5 trapped ions ($r_0 \approx 65a$), with Bragg scattering patterns characteristic of a body-centered cubic latice.

"Search for ion dynamics effects on the shift and width of plasma-broadened C I and O I spectral lines"
Z. Mijatović, N. Konjević, R. Kobilarov and S. Đurović
Phys. Rev. E **51** (1995) 613.

We report measured Stark shifts and widths of the neutral carbon 5052 - and 4932 - Å lines and the neutral oxygen 4368 - Å line in the plasma of an atmospheric pressure wall stabilized electric arc. Electron densities of $(1.4\text{-}3.1)\times 10^{16}$cm^{-3} are measured from the width of the H_β line while electron and gas temperatures in the range from 9300 to 10300 K are determined from plasma composition data. Experimental Stark widths and shifts are compared to theoretical results obtained from semiclassical calculations of Stark broadening parameters using quasistatic and ion-dynamic treatment of the ions. Some indications are found that the inclusion of ion dynamics in the calculation of the shifts of the C_1 5052 - Å line slightly improves the consistency between theory and experiment.

"Influence of ion dynamics on the width and shift of isolated He I lines in plasmas. II"
Z. Mijatović, N. Konjević, M. Ivković and R. Kobilarov
Phys. Rev. E (1995).

Stark widths and shifts of the He I 7065-, 6678-, 5016-, 4713-, and 3188 - Å lines are measured in hydrogen-helium plasma. A repetivitely pulsed low-pressure arc is used as a plasma source, while the signal averaging technique is employed to record the line profiles. The electron densities in the range of $(2.5\text{-}5.9)\times 10^{17}$cm^{-3} are measured by 10.6-μm laser interferometry. The electron temperatures ranging from 19300 to 23600 K are determined from the ratio of the H_γ line intensity to the underlying continuum, while the gas temperatures from 5000 to 12600 K are measured from the Doppler component of the He I line profiles. The experimental Stark widths and shifts are compared with the theoretical results obtained from the three sets of semiclassical calculations of Stark broadening parameters by using the quasistatic and ion-dynamic treatment of the ions. Inclusion of ion dynamics in the width and shift calculations improves the consistency in the comparison between the theory and the experiment and shows the systematic discrepancy between three semiclassical calculations. Three results suggest the possibility of high precision electron-density diagnostics.

"Experimental study of the influence of ion-dynamics to the shape of HeII P_α and P_β lines"
I. Stefanović, M. Ivković and N. Konjević
Phys. Scripta **52** (1995) 178.

Using a pulsed low pressure discharge in helium-hydrogen mixture, Stark broadened profiles of the first two Pashen lines of He II have been investigated. The electron density in the range $(2.3\text{-}2.8)\times 10^{16}$cm^{-3} was measured with a He-Ne laser interferometer at 3.39 μm. The intensity ratio of the He II 320.31 nm and He I 318.77 nm was employed to determine the electron temperature ranging from 34000-38000 K. At these experimental conditions profiles of investigated He II lines were recorded and compared with corresponding theoretical line shapes. Our experimental half widths for both lines are in agreement with several other experiments and some theoretical calculations. The inclusion of ion dynamics in the evaluation of the central part of P_β line considerably improves the agreement between the experiment and the theory.

"Transitions between glow and arc modes and its influences to the performance of a hollow-cathode discarge CO_2 laser"
M. Ivković and N. Konjević
Jpn. J. Appl. Phys. **34** (1995) 5610.

Hollow cathode discharge is used for excitation of a CO_2 laser. With the aluminium alloy cathode a maximum laser output power of 4.1 W is obtained. This laser output power is related to the formation of aluminium oxide at the cathode surface. These oxide layers induce the transitions between the glow and arc modes of the discharge and formation of microarcs at the cathode surface. This was found beneficial for the laser operation. The results of the time resolved study of the laser parameters are also reported.

"Experimental Stark shifts of several HeI and ArI spectral lines"
S. Dexiže, I.j. Skuljan, R. Konjević
J. Quant. Spectrosc. Radiat. Transfer **54** (1995) 581.

Stark shifts of four HeI and six ArI spectral lines have been measured in a linear pulsed arc plasma, superimposed to the glow discharge positive column plasma in helium and argon-helium mixture, respectively. The measured values were compared to the existing data calculated, according to the various theoretical approaches.

CONFERENCES: Invited lectures, progress reports and contributions

"Heavy particle excitation and ionization in low pressure discharges"
Z. Lj. Petrović and A.V. Phelps
(Invited lecture)
Proceedings of the *International Seminar on Reactive Plasmas,* Nagoya, Japan (1991) 351.

In this paper we survey the evidence for heavy particle excitation in discharges at low pressures and high E/N. The experimental results were obtained in low current discharges with homogeneous electric field. Models were also developed to describe the electron and heavy particle kinetic at high E/N. Proceses occurring in argnn, hydrogen, methane and their mixtures are discussed. We propose that these results be used for modeling higher current discharges.

"Influence of ion-dynamics on the width and shift of non-hydrogenic spectral lines in plasmas"
N. Konjević
(Invited lecture)
Elementary processes in clasters, lasers and plasmas, Proc. of the *Pentagonale Workshop* in Quhtai, Innsbruck, Austria (1991) 344.

"Excitation by fast H atoms near the cathode of hydrogen discharges"
Z. Lj. Petrović
(Progress report)
Joint Symposium on Electron and Ion Swarms and Low Energy Electron Scattering, Gold Coast, Australia (1991) 58.

Fast excited H atoms have been observed in gas discharges in the last 10 years. The energy of these atoms reaches the available energy of the discharge and exceeds by far the maximum energy that can be given to the fragments in electron induced dissociative excitation. This paper reports quantitative tests of mechanisms that have been proposed to explaio the production of these high energy excited atoms. This work was carried out at the Joint Institute for Laboratory Astrophysics in collaboration with B.M. Jelenkovic and A.V. Phelps.

"Preparation and properties of diamond-like films"
B. Tomčik
(Progress report)
XVI SPIG, Belgrade (1993) 176.

Diamond-like films are the new class of materials with a structure of a random network of carbon atoms in a tetrahedral coordination with the nearest neighbor atoms. Short range diamond structure was observed on the film crystallites not larger than 0.6 nm. Deviation of the bond lengths and angles from the diamond lattice is small, even when the distribution of the first and the next neighbor atoms is strongly disordered. Basic diamond structure is modified with a C = C douhle bond and with incorporated hydrogen

atoms. There are numerous methods to deposit diamond-like films. A source of carbon atoms may be either a solid target, which is to be sputtered, or one of the hydrocarbon gases. A decomposition of the gases can be successfully done in the various types of glow discharges leading to the formation of carbon neutral radicals and ions - basic film growth contributing constituents. Main discharge parameters that determine the film quality were found to be: 1) the energy of the depositing particles and 2) a substrate temperature. Almost no difference in the film quality was observed for the films deposited in methane and in the higher molecular weight hydrocarbons, except that the larger film deposition rate was achieved with the latter. The best film adhesion is observed on the substrates that can form a thin carbide phase in the interface e.g. on Si, Fe, Ti, Mn. Nature and a width of the film-substrate interface was revealed by the XPS film depth profiling analysis. Typical diamond like films posses a substantial internal compressive stress that can grow with increasing film thickness. Very often a spontaneous delamination of the film from the substrate takes place at the film thickness over 1 m. Small friction coefficient, relatively high microhardness and transparency in the infra-red region makes diamond-like film good candidate for many protective coatings applications.

"Particles in plasmas: Effects on plasma and plasma processing"
B. M. Jelenković
(Progress report)
XVII SPIG, Belgrade (1994) 159.

Particles ("dust") in plasmas are subject of much current interest due to their occurence in practically all plasma processes, deposition, etching and sputtering. Particle contamination of plasma is believed to be a critical issue for the formation of the small feature size structures as required in semiconductor industry. The particulets in plasmas are typically produced by sputtering from surfaces or from gas phase polymerization. The formation of dust was studied using laser light scattering in order to find the growth mechanism, the particle size and density, their effect on the gas discharge itself and inversely to find how discharge parameters influence the particle formation and stability. Their typical sizes are 10's of m, density can be as high as 10^8 cm^{-3}, they carry high negative charge and the mechanism of their generation being system dependent. Modeling studies of dusty plasmas have been done with attempts to understand the dust formation, plasma-paarticle interaction and particle transport phenomena. The calculations revealed that particle transport and trapping can be affected by a variety of forces acting upon the particles. The particles are trapped in the region of discharge where those forces are balanced. In our presentation the short revue of recent experimental and theoretical results of the effect of particulets on etectron and ion transport, on discharge parameters, on the plasma reactor performance (etching yield or film quality) will be presented. Also, results for a rf discharge in pure silane obtained in a laboratory set-up, similar in shape but smaller than ones used in the industry, on the onset of dust formation as voltage, gas flow and substrate temperature that are changed will be shown and discussed.

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"Ionization and excitation by electrons at moderate and high E/N"
Z. Stokić, V. Stojanović, J. Božin, Z. Petrović and B. M. Jelenković
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"On the importance of ion-dynamics for the Stark broadening electron density diagnostics of helium plasma"
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"Explanation of the memory effect by the surface recombination of nitrogen atoms"
V. Lj. Marković, M. M. Pejović and Z. Lj. Petrović
XVI SPIG, Belgrade (1993) 251.

"Influence of impurities on surface recombination of nitrogen atoms in late afterglow"
V. Lj. Marković, Z. Lj. Petrović and M. M. Pejović
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"Double layer formation in RF discharges in SF_6 at 13.56 MHz"
F. Tochikubo, S. Kakuta, T. Makabe and Z. Lj. Petrović
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J .Jovanović, A. Jelenak, S. Manola, S. Vrhovac, S. Bzenić, B. Tomčik and Z. Lj. Petrović
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"On the Stark broadening of doubly-ionized krypton lines"
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"Investigation of LS coupling in O IV"
B. Blagojević, M. V. Popović and N. Konjević
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"Kinetics of excited states of argon"
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XVII SPIG, Belgrade (1994) 61.

"Monte Carlo simulation of electron swarms in rf field"
S. A. Bzenić and Z. Lj. Petrović
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"Negative differential conductivity in gases in the presence of reactive collisions"
S. B. Vrhovac and Z. Lj. Petrović
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"Neutral and ionic argon spatially resolved emission in the GEC RF reference cell"
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V. Lj. Marković , M. M. Pejović and Z. Lj. Petrović
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V. Lj. Marković, Z. LJ. Petrović and M. M. Pejović
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"Plasma surface modification of polymers"
B. Tomčik and M. M. Mitrović
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J. Božin, Z. Velikić, Z. Lj. Petrović and B. M. Jelenković
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"Particle formation and optical emission in rf discharge of SiH_4"
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T. Kogawa, H. Ohtake, T. Shibagaki, A. Okigawa, Z. Lj. Petrović and T. Makabe
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S. A. Bzenić, K. Maeda, Z. Lj. Petrović and T. Makabe
Proc. *XXII ICPIG* (1995) 2-23.

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"Voltage current caracteristics of low current pulsed discharges in hydrogen and methane"
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"Order of surface recombination of nitrogen atoms on different surfaces"
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S. A. Bzenić, S. S. Manola and Z. Lj. Petrović
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R. J. Van Brunt, J. K. Olthoff, S. B. Radovanov
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J. N. Tan, J. J. Bollinger, B. Jelenković, W. M. Itano and D. J. Wineland
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"Experimental study of the He II P_β line shape"
N. Konjević, I. Stefanović and M. Ivković
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published in *AIP Conference Proceedings*, **328**, AIP Press, New York (1995) 58.

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Z. Mijatović, N. Konjević, R. Kobilarov and M. Ivković
12th International Conference on Spectral Line Shapes, Toronto, Canada,
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Z. Mijatović, N. Konjević, R. Kobilarov and S. Đurović
12th International Conference on Spectral Line Shapes, Toronto, Canada, published in *AIP Conference Proceedings*, **328**, AIP Press, New York (1995) 77.

"Stark broadening of the FV $3s^2S$-$3p^2p^0$ and $3p^2p^0$-$3d^2D$ transitions"
B. Blagojević, M. V. Popović, N. Konjević and M. S. Dimitrijević
Ist Hungarian-Yugoslav Astronomical Conference, Baja, Hungary, 1995, *Publications de L'Observatoire Astronomique de Belgrade* **49** (1995) 89.

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B. Blagojević, M. V. Popović, N. Konjević and M. S. Dimitrijević
Ist Hungarian-Yugoslav Astronomical Conference, Baja, Hungary, 1995, *Publications de L'Observatoire Astronomique de Belgrade* **49** (1995) 93.

"Spektroskopska dijagnostika impulsnog visokostrujnog pražnjenja u mešavini azota i helijuma"
B. Blagojević, M. V. Popović, N. Konjević i Z. Pavlović
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 357. (in Serbian)

"Merenje parametara spektralnih linija emitovanih iz plazme sa poboljšanom tačnošću"
Z. Mijatović, R. Kobilarov, S. Đurović, N. Konjević i I. Savić
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 717. (in Serbian)

"On the LS coupling along the boron sequence"
B. Blagojević, M. V. Popović and N. Konjević
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"On the Stark broadening and shift of triply ionized oxygen lines"
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Ist Yugoslav Conference on Spectral Line Shapes, Krivaja, Yugoslavia, 1995, *Publications de L'Observatoire Astronomique de Belgrade* **50** (1995) 31.

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"Ekscitacioni koeficijenti za $2p_1$ nivo neona"
J. V. Božin, Z. B.Velikić, B. M. Jelenković i Z. Lj. Petrović
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"Monte Carlo simulacija neravnotežnog transporta elektrona u azotu"
V. D. Stojanović i Z. Lj. Petrović
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 125. (in Serbian)

"Gasno-fazni model kinetike procesa u postpražnjenju u azotu - analitičko rešenje"
V. Lj. Marković, M. M. Pejović i Z. Lj. Petrović
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"Temperature behavior of diamond-like films"
N. Romčević and B. Tomčik
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 277. (in Serbian)

THESES: Ph.D. and M.S.

"Ispitivanje uticaja neravnotežnih gasnih pražnjenja u tretiranju površine materijala"
B. Tomčik
Elektrotehnički fakultet, Univerzitet u Beogradu (1991) (Ph.D. thesis in Serbian).

"Elektronski eksitacioni koeficijenti za pobudjena stanja azota na srednjim i visokim vrednostima E/N (E - jačina električnog polja, N - gustina gasa)"
V. D. Stojanović
Elektrotehnički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Energijska analiza elektrona i jona iz pražnjenja u argonu u uslovima srednjih i visokih vrednosti količnika E/N"
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"Proučavanje kinetike sudara u tinjavom pražnjenju u vodoniku analizom Balmerove beta linije"
S. A. Bzenić
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"Istraživanje mogućnosti primena pražnjenja sa šupljom katodom za pobudu molekularnih gasnih lasera"
M. Ivković
Elektrotehnički fakultet, Univerzitet u Beogradu (1993) (M.S. thesis in Serbian).

"Kinetika pobudjenih atoma argona u gasnim pražnjenjima"
J. V. Jovanović
Fizički fakultet, Univerzitet u Beogradu (1995) (M.S. thesis in Serbian).

"Temperaturna zavisnost širine i pomeraja spektralnih linija duž izoelektronske sekvence bora"
B. Blagojević
Fizički fakultet Univerziteta u Beogradu (1995) (M.S. thesis in Serbian).

П 0111 ФИЗИКА ПЛАЗМЕ И ЛАСЕРА

P0111: PLASMA AND LASER PHYSICS

PUBLICATIONS: Books, Monographs and Articles

"Coherent structures in shear flow-driven plasma microturbulence"
D. Jovanović, P. K. Shukla, U. de Angelis and W. Horton
Phys. Fluids B **3** (1991) 45.

Nonlinear electromagnetic perturbations whose characteristic scale length is shorter than the ion Larmor radius are studied using a hydrodynamic description for the electrons, and a kinetic description for the ions, in nonisothermal, nonuniform, magnetized plasma. It is shown that ion drift-Alfvén perturbations may be linearly unstable in the presence of a parallel shear plasma flow. In the fully nonlinear regime a solution in the form of a moving double vortex id found.

"MHD wave reflection in presence of resonant processes"
V. K. Okretič and V. M. Čadež
Phys. Scripta **43** (1991) 306.

An efficient resonant absorption of MHD waves in a double step inhomogeneous plasma is shown to exist provided that a number of parameters is suitably chosen. The absorption mechanism is based on two phenomena: first, the incident and totally reflected MHD wave excites MHD surface modes at the farther boundary by tunneling into the nontransparent section; second, these surface modes are irreversibly transformed into local MHD bulk waves at locations where corresponding frequency matching conditions are satisfied. The calculated absorption coefficient of incident MHD waves may reach unity if the wave parameters are adequately chosen.

"Dinamical regimes of quasistationary magnetic field generation in laser produced plasma"
N. B. Aleksić, N. E. Andreev and V. Yu. Bychenkov
Fiz. Plazmy **17** (1991) 1272.

Generation of quasistationary magnetic fields (QMF) under the influence of an intense electromagnetic field has been investigated in the conditions of inertially confined plasmas. Numerical solutions of nonlinear hydrodynamic and electromagnetic field equations allow for the study of QMF dynamics in subsonic and supersonic regimes of plasma expansion.

"Coulomb conductivity of strongly coupled plasmas"
Z. Đurić, A. A. Mihajlov, V. A. Nastasyuk, M. M. Popović and I. M. Tkachenko
Phys. Lett. A **155** (1991) 415.

The Coulomb conductivity of strongly coupled plasmas is calculated. The transition to the Spitzer formula is analyzed. A comparison with the available experimental data is made.

"IR-laser light coupling to metal surfaces"
S. Jovićević, N. Konjević, I. Ursu, M. Ganciu-Petcu, I. N. Mihailescu, V. Stanicalie, A. Luches, M. Martino and V. Nassisi
Infared Phys. **32** (1991) 177.

Experimental results are reported, concerning the energy coupling of laser light to metal (cooper) surfaces. It is shown that besides the ignition and the evotution of a surface plasma - of either erosion of optical breakdown type- the formation of surface chemical compounds and the condition of the sample surface play key roles in the determination of the interaction process, finally determining the energy coupling efficiency of laser radiation to metal samples.

"Vortices associated with toroidal ion-temperature-gradient-driven fluctuations"
W. Horton, D. Jovanović and J. J. Rasmussen
Phys. Fluids B **4** (1992) 3336.

The three nonlinear hydrodynamic equations for potential, parallel ion velocity and ion pressure used in simulations of the toroidal ion-temperature-gradient-driven fluctuations and transport in a sheared magnetic field are analyzed for coherent vortex structures. Two types of vortex structures are found: one type for weak shear that is a generalization of the usual modon vortex construction and the second type of solution for strong magnetic shear where the convective nonlinearity in the parallel velocity field generates a cubic trapping nonlinearity in the vorticity equation. These vortex structures show the possibility of explaining the saturated states observed in the numerical simulations as self-organized nonlinear states in contrast to wave turbulence.

"Influence of ion-atom collisions on the absorption of radiation in white dwarfs"
A. A. Mihajlov and M. S. Dimitrijević
Astron. Astrophys. **256** (1992) 305.

In order to provide the relevant absorption coefficients for the interpretation of the continuum absorption spectra in a number of white dwarfs with helium dominated atmospheres, the processes $He^+_2 + h\omega \rightarrow He + He^+$ and $He + He^+ + h\omega \rightarrow He + He^+$ have been considered together. We present also the absorptinn coefficients for the conditions of DA white dwarf atmospheres calculated by taking into account together the processes $H^+_2 + h\omega \rightarrow H + H^+$ and $H + H^+ + h\omega \rightarrow H + H^+$.

"Influence of ion-atom collisions on the recombination of electrons"
A. A. Mihajlov, N. N. Ljepojević and M. S. Dimitrijević
J. Phys.B: At. Mol. Opt. Phys **25** (1992) 5121.

We show that for the study of recombinatinn of ions and electrons in weakly ionized low-temperature hysrogen plasmas, the processes $H + H^+ + e \rightarrow H + H^*$ (n) and $H^+_2 + e \rightarrow H + H^*$ (n) must both be considered since their contributions are comparable. A simple method for the calculation of the corresponding rate coefficients is presented.

"Vortices driven by a spatially nonuniform lower hybrid pump"
J. Vranješ and J. Weiland
Phys. Scripta **46** (1992) 72.

An interaction of a spatially nonuniform lower hybrid pump wave with small low frequency plasma density perturbations was investigated. It is shown that such a pump wave, due to its nonuniformity can be an efficient generator of vortices in a plasma.

"Vortices in nonuniform upper hybrid field"
T. A. Davydova and J. Vranjcš
Phys. Scripta **46** (1992) 435.

The possibility of formation of smooth double-vortices due to modulational instability of drift waves produced by a localized pump at the upper-hybrid frequency is investigated. It is shown that the density profile of vortices obtained in this way can be described by analytic functions in all finite part of space. Their characteristic size is much smaller than the size of pump localization region and is completely determined by intensity and spatial length of the upper-hybrid pump.

"Vortices with a nonuniform group velocity"
J. Vranješ and J. Weiland
Phys. Scripta **46** (1992) 463.

An equatinn describing vortices produced by a spatially noauniform upper-hybrid pump wave, in an inhomogeneous plasma, is derived. The vortex group velocity is assumed to be spatially nonuniform and the cnnsequences of this assumption are discussed.

"Waves with nonlinear polarization due to self-generated magnetic field in a plasma"
N. B. Aleksić, Yu. M. Aliev, V. Yu. Bychenkov and S. Vuković
J. Plasma Physics **42** (1992) 325.

We investigate a new mechanism of nonlinear wave interaction in a plasma with an electromagnetic wave, a Langmuir plasma wave and a self-generated quasistationary magnetic field involved in the three-wave process. It is demonstrated that magnetic field generatinn supports a new wave of hybrid polarization, that can be changed during the nnnlinear evnlution. Periodic regimes, as well as regimes of soliton (instant) formation and kink-shaped transitions can be realized.

"Magnetohydrodynamic surface-wave echoes"
Yu. M. Aliev, V. M. Čadež and S. M. Revenchuk
Phys. Rev. A **45** (1992) 1071.

The nonlinear second-order echo effects are investigated for a magnetized ingomogenous plasma by means of ideal magnetohydrodynamic equations. Externally excited perturbations of such a system are damped out due to phase mixing but their initial existence remains "memorized" in terms of oscillations with a continuous Alvén spectrum. It is shown that an appropriate spatial and/or temporal dependence of external disturbances results in a spatial, a temporal, and a spatial-tempolar echo effect. The relevant analytical expressions are obtained for the echo-signal shape and a possible application of the obtained results to plasma diagnostics is considered.

"Stability of drift-wave modons in the presence of temperature gradients"
D. Jovanović and W. Horton
Phys. Fluids B **5** (1993) 9.

In the homogeneous Hasegawa-Mima equation, the dipole vortex or modon is well known to be robustly stable from both analytic and numerical studies. In the inhomogeneous plasma where $\nabla T_e \neq 0$ the corresponding vortex has an external structure extending into the high-temperature region. Lyapunov stability method is used to determine the stability properties of these structures. The overall growth rate of deformation caused by the presence of temperature inhomogeneity is shown to be bounded by $(R/L_T)^2$, where R is the radius of the core of the vortex, and L_T is the scale length of the temperature gradient. The most important source of instability is identified as the excitatinn of monopolar and dipolar perturbation with short spatial scales ≤ R, which are approximately independent on the presence of the density and temperature gradients.

"Quasi-three-dimensional electron holes in magnetized plasmas"
D. Jovanović and W. Horton
Phys. Fluids B **5** (1993) 433.

Using the electron drift-kinetic equation and a hydrodynamic description of the ions new nonlinear vortex equations are derived taking into account the parallel trapping of the electrons in the positive potential regions. It is shown that the usual integration procedure for finding coherent structures for $\vec{E}\times\vec{B}$ flows in the fluid description can be generalized to include the parallel acceleration $eE_{II}\partial f / \partial v_{II}$ producing electron holes in the phase space. An example is considered in some detail.

"Drift wave shear damping annulment due to parametric coupling and magnetic field variation"
T. A. Davydova, D. Jovanović, J. Vranješ and J. Weiland
Phys. Scripta **48** (1993) 603.

Nonlinear suppression of the drift wave shear damping by the simultaneous action of a strong standing pump wave, and of the magnetic field variation along the magnetic field line is studied using a version of the Hasegawa-Mima equation. The threshold for the parametric destabilization is calculated as a function of the plasma parameters. Destabilizatioo occurs due to the elimination of the energy convection towards the dissipative layer, by both the linear toroidal coupling and nonlinear parametric coupling.

"Static electrical conductivity in weak and moderately non-ideal plasmas"
A. A. Mihajlov, A. M. Ermolaev, Z. Đurić and Lj. Ignjatović
J. Phys. D: Appl. Phys. **26** (1993) 1041.

We present a discussion of semiclassical and quantum mechanical RPA treatments of static electrical conductivity in non-ideal plasmas. It is found that the results obtained from both theories agree well with each other in the range of temperatures from 5000 to 50000 K for electron concentrations between 10^{18} and 10^{20} cm^{-3}. The reported results present a significant improvemeot on the predictions of the Spitzer formula. Gook agreement is also found with available experimental data on non-idela plasmas. An analytical formula for static conductivity convenient for applications is introduced.

"Study of the matrix effect of easily and non-easily ionizable elements in an inductively coupled argon plasma" Part I
M. R. Tripković and I. Holclajtner-Antunović
J. Anal. Atom. Spec. **8** (1993) 349.

The influence of easily and non-easily ionizable concomitants on the spectral line profiles of the atomic and ionic components of analytes with different physical properties was investigated depending na the concentration of the concomitant and observation height above the load coil. The results obtained were considered from the point of view of nebulization and plasma discharge processes. For analytical reasons, all the investigations were performed in teh normal analytical zone. The apparent temperatures of excitation, ionization and local thermal equilibrium and electron number density were measured, calculated and compared under plasma conditions with and without the presence of 20 mg ml^{-1} of Li and 50 mg ml^{-1} of Zn. It was found that the presence of Li changed the ionization temperature and non-equilibrium parameter (b_r) particularly in zones higher up in the plasma.

"Spectroscopic investigation of plasma composition of U-shaped argon stabilized d. c. arc"
I. Holclajtner-Antunović, G. Malović and M. Tripković
Spectrosc. Lett. **26** (6) (1993) 1103.

The spectroscopic analysis of emitted radiation from the U-shaped argon stabilized d. c. arc is performed when the arc was burning without and in the presence of water aerosol. The special attention is paid to the emission of molecular components. The radial distribution of rotational temperature is obtained from the OH band spectra. The arc plasma composition is also theoretically calculated supposing the state of local thermodynamic equilibrium and compared with experimental results.

"Study of the matrix effect of easily and non-easily ionizable elements in an inductively coupled argon plasma" Part II
I. Holclajtner-Antunović and M. R. Tripković
J. Anal. Atom. Spec. **8** (1993) 359.

The matrix effect of easily and non-easily ionizable elements in an inductively coupled argnn plasma is discussed in relation to the equilibrium plasma composition. The calculation procedure, based oo the minimization of free energy, was applied io the temperature range 1000-9000 K, assuming the state of chemical equilibrium. The calculations were performed for "pure" argon with water vapour and with the addition of Li, Ba and Zn. The influence of matrix elements on the emissinn intensities of Ca and Cd as analytes was also investigated.

"Continuous emission from a low-temperature helium plasma due to radiative charge exchange and radiative ion-atom recombination"
A. A. Mihajlov, A. M. Ermolaev and M. S. Dimitrijević
J. Quant. Spectrosc. Radiat. Transfer **50** (1993) 227.

Radiative recombination and radiative charge exchange in symmetrical $He^+ + He$ collisions are considered using a semiclassical adiabatic model of collisinns in low-temperature plasmas. The reaction channels are assumed to be uncoupled and the corresponding total and partial spectral coefficients for the spontaneous continuous electromagnetic emission are calculated for helium-plasma temperatures below 3×10^4 K. The results are compared with the similar spectral densities for electron-ion and electron-atom scattering. It is found that in a wide range of physical conditions radiative processes involving ion-atom collisions should be taken into account in the analysis of the continuum radiation from helium plasmas.

"The contribution of ion-atom radiative collisions to the opacity of the solar atmosphere"
A. A. Mihajlov, M. S. Dimitrijević and Lj. M. Ignjatović
Astron. Astrophys. **276** (1993) 187.

We investigate the conrtribution to the opacity of the solar atmosphere of some processes other than formation and photodissociation of the H^- ion. We show that positive-ion-atom radiative collision processes are not negligible at certain layers of the photosphere and of the chromosphere, although they make only a negligible cnotribution to the solar continuous optical emission emergent intensity.

"Gravitational instability problem of nonuniform media"
J. Vranješ
Astrophysics and Space Sci. **213** (1994) 139.

An instability criterion for perturbations of gravitational potential in an inhomogeneous, large gas cloud is derived. We assume that perturbations propagate through the central area of the cloud, along the basic state density gradients. The instability criterion obtained in that way represents generalization of the Jeans's criterion to the case when the system is inhomogeneous in the basic state.

"The RPA conductivity of fully ionized plasmas in a magnetic field"
V. M. Adamyan, Z. Đurić, A. M. Ermolaev, A. A. Mihajlov and I. M. Tkachenko
J. Phys. D: Appl. Phys. **27** (1994) 111.

The random phase approximation method is extended to calculate static electrical conductivity of fully ionized plasmas in the presence of a uniform magnetic field. The components of the corresponding conductivity tensor and other parameters have been obtained for the case of a moderate magnetic field. The results are compared with experimental data available for shock compressed plasmas.

"Stark broadening of AI III and Cu IV lines for diagnostic of the rail gun arc plasma"
M. S. Dimitrijević, Z. Đurić and A. A. Mihajlov
J. Phys. D: Appl. Phys. **27** (1994) 247.

Stark broadening parameters of AI III lines of interest in the diagnostics of an electrodynamic macroparticle accelerator (rail gun) arc plasma created by evaporation of an AI foil have been calculated using the semi-classical perturbation formalism. Stark widths of Cu IV lines of interest for an arc plasma created by Cu foil evaporation have also been calculated by using the modified semi-empirical method.

"The influence of ion-atom radiative collisions on the continuous optical spectra in helium-rich DB whit-dwarf atmospheres"
A. A. Mihajlov, M. S. Dimitrijević and Lj. M. Ignjatović
Astron. Astrophys. **287** (1994) 1026.

We investigate the influence of radiative processes due to He^+ (1s)-$He(1s^2)$ collisions on the continuous optical spectrum of the helium-rich DB white-dwarf atmospheres. We show that these ino-atom collision processes are important in certain layers of the studied white dwarf atmosphere, and that the corresponding contributions to the optical depth and continious opacity are not negligible.

"Spectral coefficients of emission and absorption due to ion-atom radiation collisions in the solar atmosphere"
A. A. Mihajlov, M. S. Dimitrijević, Lj. M. Ignjatović and Z. Đurić
Astron. Astrophys. Suppl. Ser. **103** (1994) 57.

Spectral coefficients of spontaneous emission and absorption (for 365 nm $\leq\lambda\leq$ 820 nm range) due to ion-atom radiation processes $H^- + H(1s) \leftrightarrow H^-_2 (1\Sigma_g)$ and $H^+ + H(1s) \leftrightarrow H(1s) + H^+$ are presented. Calculations have been performed within semiclassical approach for standard solar photosphere and chromosphere models. The presented numerical results enable the inclusion of considered ion-atom radiative processes in the optical depth calculation for the layers mentioned. These results might be of interest as well for other astrophysical plasmas with dominant hydrogen component and temperatures around 6000 K.

"Spectrometric determination of gold, platinum and palladium in geological materials by d.c. arc plasma"
M. Tripković, M. Todorović, I. Holclajtner-Antunović
Analitica Chimica Acta **296** (1994) 315.

A method for the separation and determination of Pt, Au and Pd in various geological materials by coprecipitation with tellurium and applying two spectrometric methods was considered in detail. Particular attentinn was paid to the influence of matrix elements on the determination of these metals. In one instance the metals were determined in solution by applying a U-shaped arc stabilized by an argon vnrtex and in the other in the solid sample by applying a vertical arc burning in a stream of argon-oxygen. The accuracy of the method was verified using the international reference standard SARM-7, and the results achieved were compared with published data.

"Optical emission diagnostics of an U-shaped argon stabilized d. c. arc"
G. Malović, M. Tripković and I. Holclajtner-Antunović
Contrib. Plasma Phys. **34** (6) (1994) 773.

The radial distribution of parameters has been measured by using the optical emission spectroscopy of an U-shaped argon stabilized low current arc at atmospheric pressure. All the measurements reported here were performed from a side-on observation direction by applying the Abel inversion routine. Radial distributions of apparent temperatures ($T_{exc.}$, T_e, T_g) and of electron number density (n_e) for the plasma were measured, with and without presence of KCl (spectrochemical buffer). The measured data of n_e are compared to the theoretically calculated values of the equilibrium plasma composition. On the basis of the measured data, the validity of LTE concept is considered. It was found that deviation from LTE increases to the plasma periphery.

"Parametric excitation of drift waves in a sheared slab geometry"
T. A. Davydova, D. Jovanović, J. Vranješ and J. Weiland
Phys. Plasmas **1** (1994) 809.

The threshold for parametric excitation of drift waves in a sheared slab geometry is calculated for a drift-wave pump which has a standing wave structure along the magnetic field, and the coupling is achieved by the Hasegawa-Mima vector product-type nonlinearity. The usual shear damping is counteracted by the parametric interaction which causes the reversal of the direction of the drift wave group velocity, and the nonlinear eigenvalue problem is solved analytically using Taylor's strong coupling approximation.

"Nonlinear vortex chain associated with tearing mode"
D. Jovanović and J. Vranješ
Phys. Plasmas **1** (1994) 3239.

Nonlinear stage in the development of the tearing mode instability is studied analytically using two fluid plasma description. Coherent nonlinear solution in the form of a moving, single chain of magnetic islands, coupled with a double chain of hydrodynamic vortices, is constructed. Adiabatic theory of the chain evolution in the presence of finite electron viscosity indicates its finite lifetime and the possibility of intermittency, which provides a new mechanism for the magnetic field stochastization within a layer of a collisionless skin depth scale. This process occurs before the magnetic island overlapping and the global stochastization take place.

"On the stability of shear-Alfvén vortices"
D. Jovanović and W. Horton
Phys. Plasmas **1** (1994) 2614.

Linear stability of shear-Alfvén vortices is studied analytically, using the Lyapunov method. Vortices belonging to the drift mode, which is a generalization of the standard Hasegawa-Mima vortex to the case of large parallel phase velocities, are proved to be unstable. In the case of the convective-cell mode, short perpendicular-wavelength perturbations are stable for a broad class of vortices. Eventually, instability of convective-cell vortices may occur on the perpendicular scale comparable with the vortex size, but it is followed by a simultaneous excitation of coherent structures with a better localization than the original vortex.

"Local waves in a magnetic arcade embedded in the solar corona"
V. M. Čadež and J. L. Ballester
Astron. Astrophys. **292** (1994) 669.

We consider a particular type of a magnetic non potential 2D arcade which is in static equilibrium with the ambient, isothermal atmosphere. By applying linear 2D perturbations to it, we obtain the relevant MHD equations that describe the resulting wave velocity field, which can be reduced to a set of two coupled second order differential equations for the velocity components parallel and normal to the magnetic surfaces. Those equations have been solved analytically in local approximation and under the assumption of constant Alfvén speed. The results show the existence of a surface wave, in addition to the propagating waves (the fast and the slow mode), when a single boundary is present. The slow mode cannot escape the arcade while the fast mode can leave it provided the speed of sound is not negligible if compared with the Alfvén speed. In the case of two boundaries, i. e. for a magnetic arch, the obtained wave behaviourresembles that for a horizontal slab.

"The shape of a magnetic arcade embedded in the solar corona"
V. M. Čadež, R. Oliver and J. L. Ballester
Astron. Astrophys. **282** (1994) 934.

We have generated two-dimensional magnetic arcades, with invariance along the longitudinal axis, by solving, together, the Grad-Shafranov equation and the pressure balance equation at the boundary between the arcade and the corona. We have used a particular class of magnetic fields in which the slope of the magnetic field lines only depends on one coordinate and, with this approach, we have been able to obtain general expressions for the magnetic field components, which only depend on the gas pressure profile, without the need to know the analytical expression for the flux function. These expressions for the magnetic field components have allowed us to generate potential and non-potential fields and to obtain some conclusions about the half-width, height and magnetic flux of the different arcades.

"Kinetic coefficients of fully ionized plasmas"
V. M. Adamyan, Z. Đurić, A. M. Ermolaev, A. A. Mihajlov and I. M. Tkachenko
J. Phys. D: Appl. Phys. **27** (1994) 927.

The random phase approximation method is applied to obtain the coefficient of electron thermal conductivity and other kinetic coefficients nf fully ionized plasma, in the absence of a mangetic field. Calculations have been carried out for a wide range of temperature and electron concentrations, which include the domain in which the plasma is strongly coupled. The domain of validity of the Wiedemann-Franz law has been tested.

"Effects of nonlinear coupling and magnetic shear on drift-wave stability"
D. Jovanović, J. Vranješ and J. Weiland,
Univ. Beograd. Publ. Elektrotehn. Fak. Ser. Teh. Fiz. (1994) 33.

"Transport and optical properties of nonideal plasma"
Edited by: G. A. Kobzev, I. T. Iakubov and M. M. Popović
Plenum Press, New York (1995).

The book is devoted to the physical properties of nonideal plasma, in which the effects of interparticle interactions are substantial. Such a plasma is usually compressed so strongly that it is called dense plasma. As a result of a recent sharp increase in the number of experimental and theoretical investigatinns, much interesting and reliable data on the properties of dense pladma hve been obtained. This book is a systematic treatment of the thermodynamics (innization equilibrium, particle composition), charge transport properties (especially electric conductivity), optical properties (peculiarities of continuous and discrete spectra), and collective modes (features and manifestatinns) of nonideal plasma. Theoretical models are considered along with the experimental data. The book is intended fir the wide range of readers, including specialists in plasma physics and various researchers who need knowledge in this field.

"Continuous emission due to radiative ion-atom association and charge exchange in weakly ionized plasmas of H, He, Li and Na"
A. M. Ermolaev, A. A. Mihajlov, Lj. M. Ignjatović and M. S. Dimitrijević
J. Phys. D: Appl. Phys. **28** (1995) 1047.

The contributioa of radiative charge exchange and radiative associatinn in symmetrical ion-atom collisions to continuous EM radiation from weakly ionized gaseous plasmas has been considered within the semiclassical adiabatic theory. The differential (in λ) cross sections for spontaneous photon emissinn and the general expressions fnr the spectral coefficients of emission and absorption are given. The hydrogen and helium plasmas that are representative nf two different optical types of gaseous medium have been studied in a broad range of T and λ, $4000 \leq T\ (K) \leq 20\ 000 \leq \lambda\ (nm) \leq 1000$. The domain nf T and λ, where ion-atom collisioas contribute significantly to continuous plasma spectra, has been established. The case of weakly ionized alkali metal plasmas nf Li and Na has been studied in the same interval of λ but at lower temperatures, $1500 \leq T\ (K) \leq 3500$. the relevance of the results to studies nf laboratory plasmas is discussed.

"MHD disturbances in a coronal potential arcade generated by localized perturbers"
V. M. Čadež and J. L. Ballester
Astron. Astrophys. **296** (1995) 537.

We present an analytical approach which combines Fourier and Laplace transformations to solve the two dimensional boundary value problem of the linear wave excitation in the solar corona by a distinct periodic localized at an arbitrary surface. Due to the physical properties of the corona, we consider a magnetic configuration such as a potential arcade. Depending on the shape of the coronal potential magnetic arcade, the surface on which the perturber is located can be the photosphere itself, the magnetic field surface or any other surface connecting two foot-lines of the arcade which is in a magneto-hydrostatic modes causing fluid motions in the direction perpendicular to the magnetic field in the cross sectional plane of the arcade. We give a particular example which deals with a magnetic arcade whose characteristic magnetic field scale leogth is twice the isothermal scale height of the coronal plasma. The boundary conditions are imposed at the photosphere, in the form of periodic perturbers with various strength distributions along the horizontal direction. The results show a feature of wave channeling which certainly is an effect of interest in coronal heating mechanisms.

"Radiative He^+ (1s) + He ($1s^2$) processes as the source of the DB white dwarf atmosphere electromagnetic continuous spectra"
A. A. Mihajlov, M. S. Dimitrijević, Lj. M. Ignjatović and Z. Đurić
The Astrophys. Jurnal **454** (1995) 420.

The influence of the processes of radiative charge transfer and photoassociation during He^+ + He collisional processes, as well as the process of the photodissociation of the He^+_2 molecular ion, on the formation of the continuous spectrum of the DB white dwarf atmospheres with T_{eff} = 12,000-30,000 K, for log g (gravity) = 7 and 8, is studied within thewavelength range λ = 200-800 nm. It is shown that the contribution of these processes relative to other relevant radiative processes is particularly important for $T_{eff} \leq 16{,}000$ K and increases with the decrease of T_{eff}. Moreover, it is found that the influence of the considered He^+ + He radiative processes is particularly pronounced in the UV range.

"Time evolution of MHD disturbances impulsively excited by a localized perturber in a potential coronal arcade"
V. M. Čadež and J. L. Ballester
Astron. Astrophys. **296** (1995) 550.

An analytical approach to the initial value problem of MHD wave excitation in the solar corona is presented. We use the combined Fourier and Laplce transformation to solve the two-dimensional initial value problem of linear wave excitation. By this procedure, we have been able to obtain the solution for the time dependent two dimensional perturbation velocity field above the solar photosphere. Due to the physical properties of the corona, the low beta approximation has been applied to the considered processes. The perturber is initialty located at a given surface in a particularly chosen frame of reference. Depending on the shape of the coronal potential magnetic arcade, this surface can be the photosphere itself, a magnetic field surface, or any other inside a magnetic arcade in hydrostatic equilibrium with the surrounding plasma. The considered excited perturbations are the fast magneto-acoustic waves which cause fluid motions, in the normal direction to the magnetic field, in the cross sectional plane of the arcade. We present an example of a given perturber located at the photosphere, showing the induced velocity field time evolution.

"MHD waves in coronal arcades"
V. M. Čadež, J. L. Ballester and R. Oliver
Publ. Obs. Astron. Belgrade. **49** (1995) 109.

The MHD wave behavior in the solar corona with magnetic field having the shape of arcades is investigated. It is shown that a particular analytical solution to the linearized MHD equations can be obtained for perturbations with short wavelengths in the direction of the arcade tunnel. Two possibilities are considered regarding the related wave frequency: the high frequency domain yields MHD waves propagating along the tunnel of the arcade as a fast MHD mode while the low frequencies produce two decoupled wave modes representing the Alfvén and the slow magnetoacoustic wave, both modified by the gravity and the profile of the magnetic field. All these waves are stable, contrary to the case when the magnetic field is purely horizontal and when the magnetic buoyancy instabilities can set in.

"Influence of ion dynamics on the width and shift of isolated He I lines in plasmas. II"
Z. Mijatović, N. Konjević, M. Ivković and R. Kobilarov
Phys. Rev. E (1995).

Stark widths and shifts of the He I 7065-, 6678-, 4713-, and 3188 -Å lines are measured in hydrogen-helium plasma. A repetitively pulsed low-pressure arc is used as a plasma source, while the signal averaging technique is emplnyed to record the line profiles. The electron densities in the range of (2.5-5.9)x 10^{13} cm^{-3} are measured by 10.6 μm laser interferometry. The electron temperatures ranging from 19300 to 23600 K are determined from the ratio of the H_γ line intensity to the underlying continuum, while the gas temperatures from 5000 to 12600 are measured from Doppler component of the He I line profiles. The experimental Stark widths and shifts are compared with the theoretical results obtained from the three sets of semiclassical calculations nf Stark broadening parameters by using the quasistatic and ion-dynamic treatment of the ions. Inclusion of ion dynamics in the width and shift calculations improves the consistency in the comparision between the theory and the experiment and shows the systematic discrepancy between three semiclassical calculations. Three results suggest the possibility of the high precision electron-density diagnostics.

"Kelvin-Helmholtz instability of compressional MHD surface waves"
D. Jovanović and J. Vranješ,
Univ. Beograd. Publ. Elektrotehn. Fak. Ser. Teh. Fiz. (1995) 3.

"Curvature effects on drift waves"
J. Vranješ and D. Jovanović
Phys. Scripta **52** (1995) 708.

Using a two fluid plasma description we study a simultaneous effects of the magnetic field shear, and variation of curvature-related terms along the field lines, on drift waves. This variation leads to a linear coupling of different modes which can change the stability of the system by a complete elimination of the shear effects.

"Coronal MHD perturbation field generated by localized perturbers in a photospheric active region"
V. M. Čadež, R. Oliver and J. L. Ballester
Solar Phys. **159** (1995) 229.

We investigate two-dimensional boundary value problem of the linear wave excitation in the solar corona by a pair of periodic perturbers localized at the photosphere. The physical properties of the corona allow us to consider a magnetic configuration such as a potential arcade which is in a magneto-hydrostatic equilibrium with the surrounding plasma. The model excludes the Alfvéo mode and since the slow mode is absent in a potential arcade, the excited waves are then the fast magneto-acoustic modes. The characteristic magnetic field scale length is twice the scale height of the coronal plasma, assumed isothermal and the induced fluid motions are io the direction perpendicular to the magnetic field, in the cross-sectional plane of the arcade. A particular example of two localized perturbers in a photospheric active region is given, pointing out the effects produced in the perturbed fields by the variation of the different parameters involved. Such example shows that, while a modification of the linear size or the horizontal wave number of the perturbers does not affect significantly the propagating disturbances, the variation of the perturbers' frequency produces important effects. Such effects can be summarized by saying that low-frequency perturbers are able to disturb the whole coronal region just above them, producing a channeling feature. Moreover, for high frequencies the perturbations grow with z all the way from the photosphere while for very low frequencies evanescent waves are dominant, although thanks to the influence of the medium their amplitude starts to grow from some z on.

"Impurity effects on linear and nonlinear ion-temperature-gradient-driven modes"
D. Jovanović and V. Horton
Phys. Plasmas **2** (1995) 1561.

Linear and nonlinear stages in development of the ion-temperature-gradient driven drift-wave instability are studied analytically io the presence of shear flows, magnetic shear, inhomogeneity, and curvature. In the linear regime, it is shown that the toroidal η_i mode can be destabilized by a small amount of impurities only if there exists an impurity build-up at the plasma edge. The slab η_i mode is destabilized by a small amount of inhomogeneities, and stabilized by a larger impurity coatent when the inhomogeneity and main ions density profiles are close to each other. In the nonlinear regime two types of coherent structures are found: generalized Hasegawa-Mima dipole vortex in the weak magnetic shear case, and a periodic, vortex-chain solution in the strong shear case, which corresponds to the saturated, large amplitude drift-tearing mode.

CONFERENCES: Invited lectures, progress reports and contributions

"Polarization properties of self-quided cylindrical modes in nonlinear media"
N. B. Aleksić and S. Vuković
V Int. Workshop on Nonlinear and Turbulent Phenomena in Physics, Kiev (1992).

We present a simple analytical investigation of guided waves with orthogonal polarizations (TE and TM modes) that are coupled via nonlinearities in Kerr-type media. The formation of stationary guided solitons with hybrid TE-TM polarization is demonstrated.

"Plasma vortices"
D. Jovanović
XVI SPIG, Beograd, Book of Contributed papers (1993) 304.

In this review, main vortex types are studied to some detail. Stability of drift- and shear-Alfvén-type vortices under small perturbations is discussed, as well as their production by particle beams and radio-frequency waves. Linear stability of drift-wave vortices propagating in the direction of the ion diamagnetic drift is proved in a numerical experiment. In the case of shear-Alfvén vortices it could not be proved analytically, but a strong evidence is found that an eventual instability is followed by a self-organization process which may yield a new coherent structure. We also study the interaction between vortices and particles, and demonstrate the creation of a quasi three-dimensional electron hole/vortex structure by particle trapping. Finally, the nonlinear stadium of the ion-pressure gradient instability in a toroidal geometry is studied, and the properties of the corresponding vortices are investigated.

"Annulment of drift wave shear damping in tokamaks"
T. A. Davydova, D. Jovanović, J. Vranješ and J. Weiland
XVII SPIG, Beograd, Book of Contributed papers (1994) 306.

The threshold for parametric excitation of drift waves in a sheared slab geometry is calculated for a drift-wave pump which has a standing wave structure along the magnetic field, and the coupling is achieved by the Hasegawa-Mima vector product-type nonlinearity. The usual shear damping is counteracted by the parametric interaction which causes the reversal of the direction of the drift wave group velocity, and the nonlinear eigenvalue problem is solved analytically using Taylor's strong coupling approximation. We study also the effects of nonuniformity of the magnetic field across a magnetic surface. In that case the value of the threshold can become arbitrarily small, depending oo certain plasma parameters.

"Nonlinear tearing mode & vortex chains"
D. Jovanović and J. Vranješ
International Topical Plasma Physics Workshop, Trieste (1995).

We study the nonlinear stage of a tearing mode, whose island width exceeds the tearing layer thickness, and the wavelength is of the order of collisionless skin depth. A coherent solution is found in the form of a moving vortex chain. It is the result of a self-organization process, which adjusts the profile of the sheared poloidal magnetic field and excites a localized perpendicular sheared plasma flow, consisting of three counterstreaming jets. Numerical solution shows a twin chain of plasma vortices, coupled with a single chain of magnetic islands, whose width is of the of order collisionless skin depth. Adiabatic evolution of the vortex chain in the presence of small viscosity reveals its finite lifetime. The chain destruction may occur either directly, or through a sequence of bifurcations (corresponding to abrupt changes of the vortex chain parameters) to magnetic field stochastization within a layer of the collisionless skin depth scale, which occurs before the magnetic island overlapping.

"Nonlinear surface waves in plasmas"
S. Vuković, N. B. Aleksić and D. Timotijević
XXII ICPIG, New York (1995).

Evolution of electromagnetic surface waves that can propagate along the plane boundary of linear and nonlinear media, as well as, in nonlinear cylindrical waveguides is reviewed and stability analysis presented. If the media are anisotropic bisoliton solutions are found.

"Magneto-hydrodinamic echo in strongly inhomogeneous plasma"
Yu. M. Aliev, V. M. Čadež and S. M. Revenchuk
XX ICPIG, Barga, Italy (1991) 178.

"Influence of ion-atom collisions on the absorption of radiation in helium plasma"
A. A. Mihajlov and M. S. Dimitrijević
Dynamique des Ions, des Atomes et des Molwcules, Bourges (1991).

"Ion-atom complexes and the recombination in stellar plasma"
A. A. Mihajlov and M. S. Dimitrijević
Workshop on Atmosph. Early-Type Stars, Kiel (1991).

"Ion-atom complexes and the absorption of radiation in stellar plasmas"
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A. A. Mihajlov, N. N. Ljepojević and M. S. Dimitrijević
Lecture Notes in Physics, 401, *The Atmosph. of Early-Type Stars*, Germany (1991) 365.

"Influence of titanium on U-shaped d. c. arc plasma"
M. Tripković, I. Holclajtner-Antunović and G. Malović
Proc. of *XX Int. Conf. Phenom. Ioniz.Gases*, Pisa, Italy (1991) 1369.

"Spatially resolved spectroscopic diagnostics of U-shaped argon stabilized d. c. arc plasma"
I. Holclajtner-Antunović, M. Tripković, G. Malović and Z. Raspopović
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XXVII Col. Spect. Int., Bergen, Norway, Book of abstracts, B-PO-6 (1991).

"Matrix effect and excitation conditions in ICAP"
M. Tripković and I. Holclajtner-Antunović
XXVII Col. Spect. Int., Bergen, Norway, Book of abstracts, B-PO-6 (1991).

"Stationary guided solitons with nonlinear polarization"
S. Vuković and N. B. Aleksić
EQEC 91 Technical Digest, Edinburgh, NDFr 23 (1991).

"The resonant apsorption of a propagating MHD fast wave in a structured plasma"
V. K. Okretič and V. M. Čadež
ICPP, Innsbruck (1992).

"Radiactive charge exchange an radiative ion-atom recombination as a source of continual EM radiation from astrophysical plasma"
A. A. Mihajlov and M. S. Dimitrijević
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"Stark roadening of Al III lines in the arc of electrodynamic macroparticle accelerator"
M. S. Dimitrijević, Z. Đurić, A. A. Mihajlov and M. M. Popović
X International Conference on *Gas discharges and their Applications*, Contrib. Papers, Swansea, UK (1992) 726.

"Quasi-three-dimensional electron holes in magnetized plasmas"
D. Jovanović and W. Horton
Sherwood fusion theory meeting, Santa Fe, USA (1992).

"Ion-atom radiative collisions in the solar atmosphere"
A. A. Mihajlov, M. S. Dimitrijević and Lj. Ignjatović
XVIII ICPEAC, Contr. Papers, Aarhus, Denmark (1993) 825.

"Ravnotežni sastav plazme u argonom stabilisanom luku U-oblika"
I. Holclajtner-Antunović, M. Tripković i Z. Raspopović
IX Jugoslovenski kongres hemije i hemijske tehnologije, Herceg Novi, Izvodi radova (1992). (in Serbian)

"Temperature u indukovano spregnutoj plazmi u prisustvu litijuma"
M. Tripković i I. Holclajtner-Antunović
IX Jugoslovenski kongres hemije i hemijske tehnologije, Herceg Novi, Izvodi radova (1992). (in Serbian)

"Spektrohemijsko odredjivanje malih koncentracija Pt, Au, Pd u složenim osnovama"
M. Todorović, M. Tripković, I. Holclajtner-Antunović i V. Kovačević
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"Ravnotežni sastav induktivno spregnute argonske plazme"
I. Holclajtner-Antunović, M. Tripković i Z. Raspopović
I Savetovanje Društva fizikohemičara Srbije, "Fizička hemija '92", Beograd, Izvodi radova (1992) 142. (in Serbian)

"Radijalna raspodela gustine zračenja u argonom stabilisanom luku U-oblika"
G. Malović, M. Tripković i I. Holclajtner-Antunović
I Savetovanje Društva fizikohemičara Srbije, "Fizička hemija '92", Beograd, Izvodi radova (1992) 144. (in Serbian)

"Radiative ion-atom processes as a source of continual EM radiation from low temperature helium plasma"
A. A. Mihajlov, M. S. Dimitrijević and A. M. Ermolaev
XVIII ICPEAC, Contr. Papers, Aarhus, Denmark (1993) 826.

"Static electroconductivity tensor of plasma in a magnetic field"
V. M. Adamyan, Z. Đurić, A. M. Ermolaev, A. A. Mihajlov and I. M. Tkachenko
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"Ion-atom radiative collisions and continuous optical spectra in helium reach DB white dwarf atmosphere"
A. A. Mihajlov, M. S. Dimitrijević and Lj. Ignjatović
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"Matematical model of inductively coupled argon plasma used in spectrochemistry"
I. Holclajtner-Antunović, M. Tripković, V. Georgijević and Z. Raspopović
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"The parametric analysis of inductively coupled argon plasma used in spectrochemistry"
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"Upper hybrid vortices"
T. A. Davydova and J. Vranješ
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"Continuous absorption coeficients in the visible and ultraviolet spectrum regions of xenon plasma"
D. Đorđević and M. M. Popović
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"Drift wave excitation by a standing pump wave"
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"Nonuniformity of vortex velocities"
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"Laser induced changes in TiB_2 thin film"
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"Ion-atom collisions and electron recombination in astrophysical hydrogen plasma"
A. A. Mihajlov, M. S. Dimitrijević and Lj. Ignjatović
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V. Čadež and J. Ballester
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B. Gaković, T. Nenadović, B. Todorović, S. Jovićević and N. Popović
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"The equilibrium plasma composition of U-shaped d. c. arc"
G. Malović, I. Holclajtner-Antunović i M. Tripković
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"The computer modeling of added lithium influence of Ar inductively coupled plasma"
Z. Raspopović, I. Holclajtner-Antunović, V. Georgijević and M. Tripković
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Z. Raspopović, M. Tripković, I. Holclajtner-Antunović i V. Georgijević
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"Spektrohemijsko odredjivanje plemenitih metala u geološkim materijalima korišćenjem niskostrujnog luka U-oblika"
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"Laser induced damages in protective TiB_2 coatings"
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J. Weiland, D. Jovanović and J. Vranješ
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XXIX Col. Spect. Int., Leipzig (1995) 152.

"The computer simulation od added Li influence on the ICAP"
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"Teorijska analiza uticaja vode na svojstva indukovano spregnute plazme"
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N. Aleksić, J. Vranješ, D. Jovanović i V. Marić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 341.
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"Uticaj uvrtanja linija magnetnog polja na driftne talase"
J. Vranješ i D. Jovanović
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"Nelinearni površinski talasi u neizotropnim sredinama"
N. B. Aleksić, S. Vuković i V. I. Zasenko
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 345.
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"Uticaj nečistoća na stabilnost driftnih moda u prisustvu gradijenta jonske temperature"
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"Ispitivanje prostorne raspodele gustine zračenja i parametara plazme argonom stabilisanog luka U - oblika"
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"Nelinearni driftni talasi u magnetski konfiniranoj fuzionoj plazmi"
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"Numeričko modeliranje pražnjenja u induktovno spregnutoj argonskoj plazmi na atmosferskom pritisku"
Z. M. Raspopović
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П 0104: ФИЗИКА ОКСИДНИХ И ПОЛУПРОВОДНИХ МАТЕРИЈАЛА

P0104: PHYSICS OF OXIDE AND SEMICONDUCTOR MATERIALS

PUBLICATIONS: Books, Monographs and Articles

"Pronounced Phonon Softening in the Far-Infrared Spectra of $YBa_2(Cu_{1-x}Zn_x)_3O_7$"
R. Gajić, J. Schutzmann, J. Betz, T. Zetterer, H. H. Otto, P. E. Obermayer, K. F. Renk
Solid State Communications **78** (1991) 65.

We report on measurement of the FAR-IR reflection spectra of the $YBa_2(Cu_{1-x}Zn_x)_3O_{7-y}$ ($y \cong 0$) ceramics for different Zn concentration (x = 0.01, 0.03 and 0.5) and temperatures. All spectra show a pronounced phonon softening of the 291 cm^{-1} mode for cooling of the samples from 300 to 10 K. The largest frequency shift of 12 cm^{-1} is observed for x = 0.01. We attribute this increase of the phonon softening to the suppression of screeening caused by Zn doping.

"Angular dispersion and polarization mixing in GaAs/AlAs superlattices grown along the (012) direction"
Z. V. Popović, M. Cardona, E. Richter, D. Strauch, I. Tapfer, K. Ploog
Phys. Rev. B **43** (6) (1991) 4925.

Results of lattice-dynamical calculations of the GaAs/AlAs superlattice grown along the (012) direction are compared with Raman-scattering data. Confined phonon modes and the in-plane (interfacelike) optical modes are clearly observed at frequencies in excellent agreement with theoretical predictions. The confined phonons of the (012) - oriented superlattice have mixed longitudinal and transverse character, as a consequence of the low symmetry of this superlattice (C_s point group). Special emphasis is placed on the angular dispersion and mixed polarization of superlattice modes.

"Raman spectra of $Nd_{1.85}Ce_{0.15}CuO_4$"
Z. V. Popović, A. Sacuto, M. Balkanski
Solid State Communications **78** (1991) 99.

We present the polarized Raman scattering spectra of the $Nd_{1.85}Ce_{0.15}CuO_4$ single crystal at room temperature. In addition to the three known Raman active phonons of this high temperature oxide at 227 cm^{-1} (A_{1g}), 330 cm^{-1} (B_{1g}), an 447 cm^{-1} (E_g), the remaining E_g symmetry mode at 122 cm^{-1} is clearly observed. We also discuss the origin of the 137 cm^{-1} and 584 cm^{-1} modes and the 323/335 cm^{-1} splitting of the B_{1g} mode.

"On the magnetic structure of Bi_2CuO_4"
J. Konstantinović, G. Stanišić, M. Ain, G. Parette
J. Phys.: Condensed Matter **3** (1991) 381.

We present here the results of Rietveld refinements of our neutron investigation on the magnetic structure of Bi_2CuO_4. On each copper site we measured a magnetic moment of $m = (0.45 \pm 0.02)\ \mu_B$ at T = 19 K, incompatible with the determination of $m = (0.93 \pm 0.06)\ \mu_B$ at T = 1.5 K obtained by Garcia-Münoz and co-workers. Otherwise, we do in general agree with the conclusions of their work and that of Troc and co-workers, and confirm that the magnetic arrangement below $T_N = (47.5 \pm 0.5)$ K can be viewed as a simple two-sublattice antiferromagnetic structure with rods of parallel moments along the c-axis.

"Far-infared study of localzed states in $Pb_{0.75}Sn_{0.25}Te$(In) single crystal"
N. Romčević, Z. V. Popović, D. Hohlov, A. V. Nikorich, W. Konig
Phys. Rev. B **43** (1991) 6712.

Far-infrared reflectivity spectra of a 1.2 at.% In-doped $Pb0.75Sn_{0.25}Te$ single crystal and galvanomagnetic data are presented. The infrared spectra were analyzed with use of a fitting procedure based on the plasmon-phonon interaction model. The plasma frequency was found to decrease at cooling from 300 to 30 K and a sharp drop in wp was observed between 20 and 10 K. In addition, at T less than 20 K, a new structure on the reflectivity spectra is clearly observable. It may be associated with localized states in In-doped $Pb0.75Sn_{0.25}Te$.

"Far-infrared study of $Pb_{0.75}Sn_{0.25}Te$(In) single crystals"
N. Romčević, Z. V. Popović, D. Hohlov, A. V. Nikorich, W. Konig
Infrared Physics **31** (1991) 225.

We present far-infrared reflectivity spectra of $Pb_{0.75}Sn_{0.25}Te$ single crystals doped with 0.5 at % of indium. The experimental spectra are analysed using a numerical fitting procedure based on the plasmon-phonon interactinn model. The plasma frequency is found to decrease on cooling from 300 to 30 K and a sharp drop in wp was observed between 30 K and 5 K. If the free carrier distribution over sample thickness is taken into account, experimental and calculated spectra agree well over lhe above temperature range. The results of galvanomagnetic measurements are also presented.

"Melting and soldification in laser-irradiated HgCdTe - a numerical analysis"
M. M. Jevtić, M. J. Šćepanović
Appl. Phys. A **53** (1991) 332.

The results of the numerical analysis of the effects induced by pulsed Nd :YAG and ruby laser on $Hg_{0.8}Cd_{0.2}Te$ are presented. The proposed model facilitates the planning of HgCdTe laser processing and the choice of the processing parameters such as: melt depth, melt duration of the surface layer and melt front velocity, as well as the irradiation parameters. The influence of the optical parameters and the temperature dependence of the HgCdTe thermal parameters on the results of laser irradiation are specially analyzed.

"Elastic moduli and elastic Debye temperature of policrystalline $Hg_{0.77}Mn_{0.23}Se$"
O. Žižić, Z. V. Popović, G. Čogurić, Z. Stojanov
Phys. Stat. Sol (b) **166** (1991) K75.

Thc three-component $Hg_{1-x}Mn_xSe$ alloy for x less than 0.385 is a HgSe-MnSe solid solution of zincblende type crystal structure. If manganese replaces Hg, the band structure of $Hg_{1-x}Mn_xSe$ undergoes a change: depending on its composition x, the alloy becomes either a zero or narrow gap semiconductor. The elastic moduli, compressibility β, the bulk modulus B, the shear modulus E_e, Young modulus E_Y, and Poisson's ratio μ, may be obtained acoustically, i.e. by measuring the speed of sound. The $Hg_{0.77}Mn_{0.23}Se$ polycrystal studied was grown by the Bridgman method at lhe Institute of Physics of the Polish Academy of Sciences. The ultrasound (5 MHz) propagation time was measured using the pulse-echo overlap method. Also, the FIR reflectivity spectrum nf $Hg_{0.77}Mn_{0.23}Se$ in the 50 to 650 cm^{-1} range measured at room temperature an a Bruker IFS 113v spectrometer is shown. Three oscillators may be clearly observed at 99, 138, and 208 cm^{-1}. We present values obtained for ultrasound longitudinal and transverse velocities, density, and elastic Debye temperature, also as parameters in plasmon-phonon interaction model, transverse and longitudinal frequencies, damping constants, plasma frequency, free-carrier relaxation time, and dielectric constants. We concluded that longitudinal and transverse ultrasound waves propagate in $Hg_{0.77}Mn_{0.23}Se$ dominantly via the HgSe lattice, and manganese atoms even at concentration of x = 0.23 have nn significant effect.

"Free carrier scattering in $Hg_{0.77}Mn_{0.23}Se$ at low temperatures"
O. Žižić, Z. V. Popović, A. Milutinović, A. Kuljbačinski
Phys. Stat. Sol (b) **168** (1991) K103.

The ternary alloys $Hg_{1-x}Mn_xSe$, formed by substitution of magnetic Mn^{2+} ions in HgSe have been the subject of recent studies because of their interesting electrical, magnetic, and optical properties. In the temperature range where the alloy is in a paramagnetic state there are three different mechanisms of free carrier scattering, depending on the temperature range, on phonons, on ionized impurities, and on locafized spins. It has been shown that the scattering of free carriers on localized spins of Mn^{2+} ions increases with the increase of spin concentration. In this note, the kinetic parameters of $Hg_{1-x}Mn_xSe$ alloys are given under conditinns when their spin polarization is significant. Electrical measurements (resistivity, Hall and Shubnikov-de Haas effect) were taken on single-crystalline $Hg_{0.77}Mn_{0.23}Se$ specimens which were obtained by the modified Bridgman method at the Institute of Physics of the Pofish Academy of Sciences. The far-infrared reflectivity measurements were done at T = t0 K in the range 50 to 650 cm^{-1} on a Bruker IFS-113 V Fourier spectrometer.

"Far-infrared spectra of $Hg_{1-x}Mn_xSe$"
G. Čogurić, Z. V. Popović, D. Stojanović, O. Žižić, W. Konig
Solid State Communications **77** (1991) 555.

The far-infrared reflectivity spectra of $Hg_{1-x}Mn_xSe$ (x = 2%, 6%, 8%, 9%, 14% and 16%) were measured in the 50 tn 650 cm^{-1} range at room temperature. These spectra were fitted using the plasmon-phonon interaction model. Plasmon and phonon characteristic parameters were determined. It is shown that $Hg_{1-x}Mn_xSe$ phonons exhibit two-mode behaviour.

"Vibrational Spectroscopy and comparative study of trans-polyacetylene, poly p-phenylene and poly phenylene vinilene"
D. Raković, R. Kostić, L. A. Gribov, S. A. Stepanyan, I. E. Davidova
Synth. Metals **41-43** (1991) 275.

Theoretical vibrational spectra of trans-polyacetylene (PA), poly p-phenylene (PPP) and poly p-phenylene vinylene (PPV) are presented, based on a single-periodic-chain model and a harmonic potential with parameters transferred from trans-hexatriene, toluene, and p-divinyl benzene, respectively. The out-of-plane degrees of freedom and the infrared absorption intensities were included in the calculations. The calculations evince the absence of tbe in-plane C-H bending infrared absorption band of tbe trans-vinylene portion of trans-PA and PPV, which is a consequence of a delocalized π - electron system. The electron-phonon cnupling in PPP aad PPV is relatively weak - in contrast to trans-PA, where the frequencies of the principal Raman liaes are significantly lowered. As a consequence, the PPV is an example of pristine polymer with well delocalized π- electron system, but without significant electron-phonon coupling.

"Infrared and Raman spectra of CdO"
Z. V. Popović, G. Stanišić, D. Stojanović, R. Kostić
Phys. Stat. Sol (b) **165** (1991) K109.

Cadmium oxide is the only II-VI compound with a cubic structure of the NaCl type. This crystal structure has O_h space group symmetry with only one optically active mode (IR-active F_{1u} mode). The assignment of this mode in CdO is rather difficult because of the high free carrier concentration. Namely, CdO is an n-type semiconductor of non-stoichiometric composition (oxygen deficient). Thus, single crystals and sintered samples usually exhibit a free electron concentration greater than 10^{19} cm^{-3}. The infrared spectra of sintered CdO samples were analysed using a photon-plasmon-phonon interaction model. One oscillator with a TO frequency at (262 ± 2) cm^{-1} (300 K) was observed. In this short note we present infrared and Raman spectra of sintered CdO samples. In addition to the $w_{TO} = 262$ cm^{-1} oscillator, two-phonon vibration modes may also be observed. The assignment of these modes is discussed.

"Phonon properties of differently orineted GaAs/AlAs superlattices"
Z. V. Popović
Publ. Elektr. Fak. Ser. Fizika 1 **5** (1992).

We present space group analysis, Raman and Brillouin scattering selection rules and the phonon Raman spectra of GaAs/AlAs superlattices grown on GaAs substrates of five orientations. Antiresonant behaviour for the folded acoustic modes with transverse polarisation is reported for incident laser lines near the first heavy hole-electron exciton transition of the GaAs quantum wells. A possible explanation of this effect is alsn given.

"Phonon softening in the far-infrared spectra of $YBa_2(Cu_{1-x}Ni_x)_3O_7$"
R. Gajić, M. J. Konstantinović, Z. V. Popović, W. Konig, S. Zec, I. Bradarić
Solid State Comunnications **81** (1) (1992) 85.

The reflectivity of $YBa_2(Cu_{1-x}Ni_x)_3O_7$ ceramics was measured as a function of temperature and the Ni concentration (x = 0.01, 0.03, and 0.05). The obtained spectra are presented in the range 260 to 340 cm^{-1} which contains the two out-of-plane modes of the CuO_2 plane showing the highest phonon softening. The modes at 280 and 310 cm^{-1} soften around 5-6 and 3 cm^{-1}, respectively, upon cooling of the samples from 300 to 10 K. The softening is almost independent of the Ni content and equivalent to the effect observed in undoped $YBa_2Cu_3O_7$. Contrary to Zn doping, these results show that a partial substitution of copper with magnetic Ni ion does not affect much the phonon softening and superconductivity in the YBaCuO system.

"Plasmon-phonon coupling in $YBa_2Cu_3O_7$"
R. Gajić, E. K. H. Salje, Z. V. Popović, H. L. Dewing
J. Phys. Condens. Mater. **4** (1992) 9643.

The *E* parallel to *c* far-infrared reflection spectra of a $YBa_2Cu_3O_7$ single crystal were fitted for three different temperatures (10 K, 60 K and 100 K) using phononic oscillators, a mid-infrared excitation and a low-energy plasmon. The plasmon frequency changes from 600 cm^{-1} in the normal state to 365 cm^{-1} in the superconducting state. Some consequences of strong plasmon-phonon interaction for the pairing mechanism are discussed.

"Light scattering by magnons in Bi_2CuO_4 single crystal"
M. J. Konstantinović, Z. V. Popović, S. D. Dević, A. Revcolevschi, G. Dhalenne
J. Phys. Condens. Mater. 4 (1992) 7913.

The polarized Raman scattering spectra of Bi_2CuO_4 single crystals were measured at temperatures between 10 and 300 K. In addition to the Raman-active phonon modes, two new structures at 14 and 150 cm^{-1} appear at temperatures below 50 K. These modes, which are assigned as one- and two-magnon modes, have E_g symmetry and E_g and B_{1g} symmetry, respectively. Their temperature dependences agree well with previous results of antiferromagnetic resonance experiments.

"Polarized far-infrared and raman spectra of Bi_2CuO_4 single crystal"
Z. V. Popović, G. Kliche, M. Konstantinović, M. Revcolevschi
J. Phys. Condens. Mater. 4 (1992) 10085.

We present the polarized far-infrared and Raman spectra of Bi_2CuO_4 single crystals at 300 and 10 K in the spectral range from 30 to 650 cm^{-1}. All infrared-active modes ($10E_u + 5A_{2u}$) as well as 21 Raman-active modes were observed. At low temperatures, for $x'y'$ and $x'z$ polarizations, new structure appears which we assigned as a two-magnon mode. The assignment of the observed vibrational modes is given according to Cartesian symmetry coordinates and a preliminary force constant calculation on the basis of a rigid-ion model.

"Low-temperature far-infrared study of localized states in In-doped $Pb_{0.75}Sn_{0.25}Te$"
N. Romčević, Z. V. Popović, D. Khokhlov
J. Phys. Condens. Matter 4 (1992) 4323.

We present low-temperature far-infrared reflection spectra of In-doped $Pb_{0.75}Sn_{0.25}Te$ single crystal at various doping concentration. These spectra at temperatures below 20 K are fitted using a modified plasmon-phonon interaction model with an additional oscillator, which describes the electron transition from two- to one- electrnn states at the In impurity level. The In- doped $Pb_{0.75}Sn_{0.25}Te$ impurity state energy structure is explained.

"Low-temperature optical and transport properties of $Hg_{1-x}Mn_xSe$ single crystal"
O. Žižić, Z. V. Popović, A. Milutinović, V. A. Kuljbačinski
Semicon. Sci. Technol. 7 (1992) 1484.

The optical and transport properties of semimagnetic semiconductor $Hg_{0.86}Mn_{0.14}Se$ in the temperature range 10 - 300 K have been studied. The far-intrared reflectivity spectra of this alloy were analysed using a numerical fitting procedure, based on the model of plasmon-phonon interaction. The characteristic frequencies of the phonons and plasmons and their temperature dependences were determined. The electron concentration, as defined by the Hall and Shubnikov-de Haas effect, practically does not depend on the temperature or on the applied magnetic field. By combining the results of the optical and transport measurements, the temperature dependences of effective mass and carrier mobility were determined.

"Vibrational spectroscopy of the leucoemeraldine form of polyaniline: Theoretical study"
R. Kostić, D. Raković, I. E. Davidova, L. A. Gribov
Phys. Rev. B **45** (1992) 728.

Theoretical vibrational spectra of the leucoemeraldine form of neutral reduced polyaniline are presented, based on a single-periodic-chain model and a harmonic potential with parameters transferred from the molecules dyphenylamine and *N, N'* - diphenyl-p-phenylenediamine. The out-of-plane degrees of freedom and the infrared-absorption intensities are included in the calculations. Several experimental spectra are analyzed and compared with the theoretical ones. Our comparative analysis enables conclusions concerning packing density, spatial and electronic structure, and electron-phonon coupling of the samples of different origin.

"Infrared spectroscopy and stereochemical structure of poly(p-phenylene vinylene)"
D. Raković, R. Kostić, I. E. Davidova, L. A. Gribov
Synth. Metals **55-57** (1993) 541.

Theoretical infrared (IR) spectra of trans- and cis- forms of poly(p-phenylene vinylene) (PPV) are presented, based on a single-periodic-chain model and harmonic potential with parameters transferred from p-divinyl benzen molecule. The out-of-plane degrees of freedom and the infrared intensities were included in the calculations. The calculations of polarized infrared spectra of cis- and trans-PPV do not show practically any difference. However, as the calculations evince the absence of the in-plane C-H bending infrared absorption band of trans-vinylene portion of experimental infrared spectrum of PPV, which is a consequence of a delocalized π-electron system (similarly to the case of trans-polyacetylene but not cis-polyacetylene), it seems that stereochemical structure of PPV is of the trans-form. Additional X-ray analysis is still necessary to support our conclusion.

"Solution of the inverse spectroscopic problem for the IR spectra of pyrrole"
R. Kostić, S. A. Stepanyan, D. Raković, I. E. Davidova, L. A. Gribov
J. Serb. Chem. Soc. **58** (9) (1993) 659.

The "generalized inverse spectroscopic problem" for pyrrole is solved in the framework of the valence optical theory. The force and electrooptical fields are obtained. The basic factors influencing the positions of absorption bands are obtained and presented. Fields of parameters were transferred to the pyrrole deuterium derivatives and terpyrrole. The agreement of experimental and calculated spectra confirms the chosen model.

"Superconductivity induced phonon anomalies in the Raman spectra of Zn and Ni doped $YBa_2Cu_3O_7$"
R. Gajić, S. D. Dević, M. J. Konstantinović, Z. V. Popović
Zeit. f. Physik B **94** (1994) 261.

Here we present Raman spectra of $YBa_2(Cu_{1-x}Zn_x)_3O_7$ and $YBa_2(Cu_{1-x}Ni_x)_3O_7$ as a function of temperature and Zn or Ni content. The temperature dependence of two modes at 340 and 440 cm^{-1} is analyzed. Similarly to the infrared measurements it is found that Zn substantially suppresses the superconductivity induced phonon softening whereas, Ni does not affect much that effect. Moreover, the superconductivity induced phonon stiffening of the 440 cm^{-1} mode completely disappeared with the Zn doping. We found this behaviour might support the model where Zn acts effectively as a magnetic pair breaker.

"Effects of magnetic ordering on vibrational spectra of Bi_2CuO_4"
M. J. Konstantinović, Z. V. Popović
J. Phys.: Condensed Matter **6** (1994) 10357.

In the present study, Raman scattering selection rules for different spin orientation in Bi_2CuO_4 are compared with polarized Raman scattering spectra. This comparison suggests z - axis orientation of magnetic moments. The temperature dependence of phonon modes is studied and strong spin - dependent behaviour near the Neel temperature is shown for A_{1g} symmetry modes.

"Vibrational properties of cooper metagermanate ($CuGeO_3$) single crystals"
S. D. Dević, M. J. Konstantinović, Z. V. Popović, A. Revcolevschi, G. Dhalenne
J. Phys.: Condensed Matter **6** (1994) L754.

We present the polarized far-infrared and Raman spectra of $CuGeO_3$ single crystals in the temperature range between 10 and 300 K. Assignations of vibrational modes were performed on the basis of factor-group and normal-coordinate analyses. The frequencies of the infrared-active modes are determined using an oscillator-fitting procedure of reflectivity data. In the Raman-scattering spectra, besides phonon modes, two broad structures at about 500 and 1600 cm^{-1} are observed. The temperature dependences of the frequency, full width at half maximum (FWHM) and integrated intensities of these modes suggest their magnetic origin. In the temperature range we considered, no evidence of the spin-Peierls-transition contribution tn the phonon and magnon spectra is found.

"Numerical simulation of mercury diffusion in HgCdTe during laser annealing"
M. Šćepanović, M. Jevtić
Phys. stat. sol. (a) **147** (2) (1994) 289.

The effects of pulsed laser irradiation on the Hg concentcation in HgCdTe are investigated. A model for laser induced diffusion of Hg, taking into account the heat flow transient and the melting and solidification of the surface of HgCdTe under pulsed laser irradiation, is developed. It allows the analysis of the role of irradiation and of diffusion parameters on Hg behavior. Comparison of the calculated compositional depth profiles of Hg with the published experimental data enables the assessment of the values of the diffusion, out-diffusion, and segregation parameters, unknown under laser annealing conditions.

"Numerical simulation of laser induced mercury diffusion in HgCdTe using nonconstant segregation coefficient"
M. Šćepanović, M. Jevtić
Phys. stat. sol. (a) **147** (2) (1994) 379.

The effects of nonequilibrium mercury segregation on Hg concentration changes due to pulsed laser irradiation of $Hg_{1-x}Cd_xTe$ ($x = 0.2$) are investigated. A model that relates the nonequilibrium segregation coeffcient of Hg k' to the velocity of the liquid-solid interface during solidification of the molten region created by the pulsed laser radiation is developed. The functional dependence of k' on the interface velocity is determined by fitting the calculated Hg concentration profiles to the experimental data presently available. With the use of the velocity dependence of k' it is shown that the model gives good agreement with the behavior of the Hg concentration under pulsed Nd:YAG laser irradiation.

"IR study of 1-methylpyrrole and 2,5-dimethylpyrrole"
R. Kostić, S. A. Stepanyan, D. Raković, I. E. Davidova, L. A. Gribov
J. Serb. Chem. Soc. **59** (8) (1994) 574.

The vibrational spectra of 1-methylpyrrole and 2,5-dimethylpyrrole are calculated in the framework of the valence optical theory on the basis of parameters transferred from pyrrole (the inverse spectroscopic problem for pyrrole is solved) and methyl groups. The good agreement of experimental and calculated spectra for both molecules confirms the chosen electrooptical model.

"Behavior of fractal structure characteristics for neutral silica aerogels during the sintering process"
I. Hinić
Phys. Stat. Sol. (a) **144** (1994) K59.

In the present note we examine the behavior of neutral, low-density silica gel during the sintering process. From small-angle X-ray scattering (SAX) we obtained information about the glass net and from the physical adsorption of gases on the porous surface (using BET approximation) we obtained the information about the pores. The glass net can be described by a mass as well as a surface fractal dimension, and the system of pores by the pore size distribution exponent connected with the surface fractal dimension. In the scattering curves for a sintered series of aerogel, two Porod's areas with different fractal dimensions can be seen. The existence of two stages of the sintering process can be connected with the dominance of two different mechanisms of sintering. In the first stage "chemical sintering" is dominating and in the second phase viscous flow.

"Elastic light scattering in the YBCO system"
J. Konstantinović, M. J. Konstantinović, R. Gajić
J. Phys.: Condensed Matter **7** (1995) L365.

We present the measurements of the elasticalty scattered 'plasma' lines intensities as a function of temperature. We found two anomalies at the temperatures $T = T_c$ and $T = 150$ K. This behaviour indicates either the existence of charge fluctuation in the temperature region from T_c to $T = 150$ K, or unusual electronic transitions in the YBCO system.

"Phonons in $CuGeO_3$ single crystal"
Z. V. Popović, S. D. Dević, V. Popov, A. Revcolevschi, G. Dhalenne
Phys. Rev. B **52** (1995) 4185.

Optical phonons in $CuGeO_3$ were studied using polarized far-infrared and Raman-scattering spectroscopies. The frequencies of the infrared-active modes are determined using an oscillator-fitting procedure of reflectivity data. All infrared and Raman active modes, predicted by factor-group analysis, were observed. The assignment of the observed phonons is given according to Cartesian symmetry coordinates, as well as preliminary lattice dynamical calculations on the basis of a shell model.

"Folded phonons from lateral periodicity in (311) oriented GaAs/AlAs superlattices"
Z. V. Popović, M. B. Vukmirović, Y. Raptis, E. Anastassakis, R. Notzel, K. Ploog
Phys. Rev. B **52** (1995) 5789.

We present an analysis of folded acoustic phonon Raman scattering in (311)-oriented GaAs/AlAs superlattices with periodically corrugated interfaces. Besides folded phonons from q parallel to the growth direction, the folded acoustic-phonon modes from additional periodicity along the $[00\bar{1}]$ direction are observed at frequencies that are in complete agreement with continuum model claculations. The influence of surface corrugation on confined optical-phonon modes is also discussed.

"Raman spectra of In-doped PbTe"
N. Romčević, Z. V. Popović, D. R. Khokhlov
J. Phys.: Condesed Matter **7** (1995) 5105.

The non-polarized Raman scattering spectra of indium-doped PbTe single crystals were measured in the temperature range between 10 and 300 K . Well resolved peaks at about 68, 126, 143 cm^{-1} were observed for all temperatures. An additional mode appears at about 115 cm^{-1} for temperature below 100 K. The intensity of this mode increases sharply when the temperature is lowered below 25 K, the temperature where a persistent photoconductivity effect in PbTe(In) appears. This mode is assigned as a local In impurity mode and represents a population of metastable states due to the transfer of electrons from two-electron to one-electron metastable impurity states.

"Vibrational spectroscopy of polypyrrole, theoretical study"
R. Kostić, D. Raković, S. A. Stepanyan, I. E. Davidova, L. A. Gribov
J. Chem. Phys. **102** (7) (1995).

Theoretical vibrational spectra of polypyrrole are presented, based on a single-periodic-chain model and harmonic potential in-plane and out-of-plane parameters transferred from the pyrrole molecule. The infrared-absorption intensities were included in the calculations for the first time in polypyrrole. Experimental spectra are analyzed and compared with theoretical ones. Some modes in the experimental spectra indicate the presence of nonplanar conformation. Also, Raman frequencies were compared with experimental ones. Significant effects of electron-phonon coupling are absent.

CONFERENCES: Invited lectures, progress reports and contributions

"Fizika i tehnologija kvantnih poluprovodničkih struktura"
Z. V. Popović,
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 71.

"Optical Spectroscopy of $La_{1-x}Pr_xCa_{0.7}Ba_{1.3}Cu_3O_{1-y}$"
J. Betz, R. B. Gajić, M. N. Iliev, C. E. Infante, P. E. Levy, K. E. Lipinska-Kalita, D. M. Matcev, A. J. Pal, R. D. Vispute
Final Report of *Experimental Workshop on High Temperature Superconductors and Related Materials*, Trieste, Italy (1991) 3.

"Properties of the Zn Doped High-Tc Oxides"
R. Gajić
Final Report of *Experimental Workshop on High Temperature Superconductors and Related Materials*, Trieste, Italy (1991) 101.

"A modified extended Huckel calculations for Q1D-graphites"
D. Raković, R. Kostić, S. Krstić, I. Davidova, B. L. Fayfel, L. A. Gribov
Mat. Res. Soc. Symp. Proc. **214** (1991) 183.

"Formiranje i redukcija oksida na elektrohemijski talo`enim legurama bakar-bizmut"
A. Despić, R. Stevanović, G. Stanišić
J. Serb. Chemical Society **56** (2) (1991). (in Serbian)

"Phonon softenig of FIR mode in Y-Ba-Cu-O"
R. Gajić, M. Konstantinović, Z. V. Popović
Proc. of *Condesed Matter and Materials Physics Conf.*, Birmingham (1991) 87.

"Nature of the persistent photoconductivity effect in PbSnTe(In)"
I. I. Ivancuk, D. R. Khokhlov, A. V. Nikorich, Z. V. Popović, N. Romčević
Proc. *8th Int.Conf. on Ternary and Multinary Compounds*, Kishenev (1991) 318.

"Superconductivity Induced Phonon Self-Energy Effects in $YBa_2Cu_3O_7$"
R. Gajić
Zbornik za prirodne nauke, Novi Sad **85** (1993) 11.

"Phonon softening in the infrared and Raman spectra of YBa $(Cu_{1-x}M_x)_3O_7$, M=Zn, Ni"
R. Gajić, S. Dević, M. Konstantinović, Z. V. Popović
Zbornik za prirodne nauke, Novi Sad **85** (1993) 103.

"Spin-dependent Phonon Raman scattering in Bi_2CuO_4"
M. J. Konstantinović, Z. V. Popović
Zbornik za prirodne nauke, Novi Sad **85** (1993) 307.

"Behavior of structure fractal characteristics for neutral silica aerogels during the sintering process"
I. Hinić
Zbornik za prirodne nauke, Novi Sad **85** (1993) 371.

"Transport properties of PbTe1-xSx alloys"
J. Miljković, Z. V. Popović, N. Romčević
Zbornik za prirodne nauke, Novi Sad **85** (1993) 155.

"Behavior of mercury in HgCdTe during laser annealing"
M. Šćepanović, M. Jevtić
Zbornik za prirodne nauke, Novi Sad **85** (1993) 183.

"Simulation of laser induced diffusion of indium in $Hg_{(1-x)}Cd_xTe$"
M. Šćepanović, M. Jevtić
Proc. 2nd Serb. Conf. on Microel. and optoel. - MIOPEL'93, Niš, **1** (1993) 211.

"Uticaj laserskog odgrevanja na promenu koncentracije žive u $Hg_{(1-x)}Cd_xTe$"
M. Šćepanović, M. Jevtić
XXXVII konf. ETRAN, Beograd, Zbornik radova, IX-SD (1993) 3. (in Serbian)

"Polarized far-infrared and Raman spectra of CuO single crystal"
Z. V. Popović, M. J. Konstantinović, W. Konig
Proc. *13th Gen. Conf. EPS, Cond. Mat. Division*, Regensburg (1993) 1384.

"Folded Phonons in (311) (GaAs)/(AlAs) Superlattices"
Z. V. Popović, J. Spitzer, M. Cardona, R. Notzel, K. Ploog
Proc. *13th Gen. Conf. EPS, Cond. Mat. Division*, Regensburg (1993) 1353.

"Phonon-phonon coupling in $YBa_2Cu_3O_7$"
R. Gajić, E. K. H. Salje, Z. V. Popović, H. L. Dewing
XIII Jug. Simpozijum: Fizika kond. stanja materije, Vrnjačka Banja (1993) 56.

"Dielektrične osobine sistema $YBa_2Cu_3O_7$ - Al_2O_3"
J. Konstantinović, J. Dojčilović, S. Dević
XIII jug. simp. Fizika kond. materije, Vrnjačka Banja (1993) 40. (in Serbian)

"Transportne osobine $PbTe_{1-x}S_x$ legura"
J. M. Miljković, N. Romčević, Z. V. Popović
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"Ultrasonic study of the narrow-gap semiconductor PbTeS at low temperature"
V. N. Nikiforov, A. N. Vasil'ev, N. Romčević
Mezdunarodni symposium: *"Poverhnostnie volni v tverdih telah i sloistih strukturah"*,
S. Petersburg (1994) 56.

"Efekti neravnotežne segregacije žive izazvane laserskim odgrevanjem $Hg_{(1-x)}Cd_xTe$"
M. Šćepanović, M. Jevtić
XXXVIII konf. ETRAN-a, Niš, Zbornik radova, IV (1994) 7. (in Serbian)

"Uticaj magnetskog uredjenja na spektre Ramanovog rasejanja kod Bi_2CuO_4 monokristala"
M. J. Konstantinović, Z. V. Popović
Fizička hemija materijala, SANU, Beograd (1994). (in Serbian)

"Proučavanje procesa sinterovanja neutralnih silika gelova male gustine"
I. I. Hinić, G. M. Stanišić
Fizička hemija materijala, SANU, Beograd (1994). (in Serbian)

"Svojstva $Pb_{1-x}Sn_xTe$ legura dopiranih indiumom"
N. Romčević, Z. V. Popović
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"Raman spektri monokristala $YBa_2Cu_3O_{6+x}$ i $YBa_2(Cu_{0.97}Zn_{0.03})_3O_{6+x}$"
R. Gajić, A. Jelisijević, B. Prelesnik, Z. V. Popović
XI jug. sav. opšta i primenjena spektrosk., Novi Sad, Zbornik radova (1995) 87. (in Serbian)

"Elastično rasejanje svetlosti u YBCO sistemima"
M. J. Konstantinović, J. Konstantinović
XI jug. sav. opšta i primenjena spektrosk., Novi Sad, Zbornik radova (1995). (in Serbian)

"Analiza promene optičkih i strukturnih parametara silikatnih gelova u toku procesa sinterovanja"
I. I. Hinić, G. M. Stanišić, Z. V. Popović
Jug. konf. *Teorija i tehnologija sinterovanja TEOTES '95*, Čačak (1995). (in Serbian)

"Raman rasejanje na fraktonima u silika gelu"
I. I. Hinić, G. M. Stanišić, Z. V. Popović
XI jug. sav. opšta i primenjena spektrosk., Novi Sad (1995) 85. (in Serbian)

"Infracrvena spektroskopija lokalizovanih stanja u indijumom dopiranim $Pb_{1-x}A_xTe$ (A = Mn (x=0.017); Sn (x = 0.18); x = 0) legurama"
N. Romčević, Z. V. Popović
XI jug. sav. opšta i primenjena spektrosk., Novi Sad (1995) 77. (in Serbian)

"Daleka infracrvena spektroskopija $PbTe_{1-x}S_x$ (x = 0.02 i x = 0.05)"
J. M. Miljković, N. Romčević, Z. V. Popović
XI jug. sav. opšta i primenjena spektrosk., Novi Sad (1995) 79. (in Serbian)

"Temperaturno ponašanje filmova nalik dijamantu"
N. Romčević, B. Tomčik
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"Far-infrared study of In-doped $Pb_{1-x}Mn_xTe(In)$"
N. Romčević, Z. V. Popović
XXXIX Konferencija ETRAN-a, Zlatibor (1995).

"Pecularities of the far-infrared reflection spectra of the doped lead-tin tellurides revealing the persistent photoconductivity effect"
A. I. Belogorokhov, I. I. Ivanchuk, D. R. Khokhlov, Z. V. Popović, N. Romčević
Fall Meeting of the Materials Research Society, Boston (1990).

THESES: Ph.D. and M.S.

"Vibraciona spektroskopija provodnih polimera poli(para-fenilen vinilena) i polianilina",
R. Kostić
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"Fononski spektri visokotemperaturskih superpr ovodnih oksida tipa $YBa_2(Cu_{1-x}M_x)_3O_7$ dopiranih magnetnim i nemagnetnim primesama (M=Zn, Ni)"
R. Gajić
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"Proučavanje vibracionih i magnetskih osobina bakar-oksidnih materijala (Bi_2CuO_4 i CuO)"
M. J. Konstantinović
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"Fononske osobine $Hg_{1-x}Mn_xSe$"
G. Čogurić
Elektrotehnički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Fizika primesnih autolokalizovanih stanja kod poluprovodnih legura tipa $Pb_{1-x}Sn_xTe(In)$"
N. Romčević
Fizički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Fraktalne karakteristike poroznih silika"
I. Hinić
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"Proučavanje faznog prelaza kod PbS-PbTe poluprovodnih legura spektroskopskim metodama"
J. M. Miljković
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П 0114: ИСТРАЖИВАЊА КОНТРОЛИСАНЕ ТЕРМОНУКЛЕАРНЕ ФУЗИЈЕ ПОМОЋУ ПЛАЗМА-ФОКУСА

P0114: CONTROLLED THERMONUCLEAR FUSION INVESTIGATION WITH PLASMA FOCUS

PUBLICATIONS: Books, Monographs and Articles

"Detection of light charged particles from plasma focus by CR-39 "
R. Antanasijević, J. Vuković, S. Popović and M. Popović
Nucl. Tracks Radiat. Meas. **19** (1-4) (1991) 555.

The analsis of D^+ beam, emitted from plasma focus has been carried out. CR-39 was pretteated by different processes for destroying the background existing before the exposing by the particles produced in the plasma focus. The analysis and yield of produced D^+ detected in CR-39 has been carried out. Mesuring the diameters of the the tracks, estimated energy of D^+ is about 0,5 MeV. Total number of emitted D^+ was 10 particles/pulse. Also, some preliminary results on imaging etched CR-39 with Atomic Force Mcroscope (NanoScope AFM) are shown.

"Measurement of gross alpha-activity in some thermal water sources in Yugoslavia by SSNTDs"
R. Benderac, D. Ristić, R. Antanasijević, J. Vuković
Nucl.Tracks Radiat.Meas. **19** (1-4) (1991) 745.

The possible application of the CN-BDH (type 1) nitrocellulose detector synthetized in laboratorial condition as well as the CR-39 detector for the measurement of gross alpha-activity of geothermal and mineral water has been instigated.

"The atomic force microscope (AFM) imaging of polymer nuclear track detector type CR-39 irradiated by alpha particles and etched"
J. B. Vuković, R. Antanasijević
Inst. Journal for Light and Electron Optics **55** (1991) 341.

The AFM was proposed 5 years ago and derived from the STM (scanning tunneling microscope) (1). The device does not need a conducting specimen and also no thin, because records contours of force. This force, changes from attractive to repulsive exerts on the probe tip. The force deflects the tip, whose movements are monitored by a laser beam reflected from this tip to photodiode sensor. Some preliminary application of AFM (NanoScope II System STM/AFM) in the field of Nuclear tracks in solids (NTS) were performed for the surface imaging of allyldiglicol carbonate (CR-39) polymer. On figures we present AFM microgrps of the alpha irradiated and etched (sol. NaOH) at different 3 magnification (side of micrographe: 15000 nm, 5000 nm, 1479 nm). In 3D recontruction micrographs the black spots responds to alpha tracks. We hope that polymer molecules chains can be imaged together with breaks of the chains by ionizing particles by outsta-atomic resolution of AFM.

"Melting and soldification in laser-irradiated HgCdTe - a numerical analysis"
M. M. Jevtić, M. J. Šćepanović
Appl. Phys. A **53** (1991) 332.

The results of the numerical analysis of the effects induced by pulsed Nd: YAG and ruby laser on $Hg_{0.8}Cd_{0.2}Te$ are presented. The proposed model facilitates the planning of HgCdTe laser processing and the choice of the processing parameters such as melt depth, melt duration of the surface layer and melt front velocity, as well as the irradiation parameters. The influence of the optical parameters and the temperature depeodence of the HgCdTe thermal parameters on the results of laser irradiation are specially analyzed.

"Majority carrier mobility in highly-doped n-type Si"
M. B. Živanov, M. M. Jevtić
Solid State. Electr. **35** (1992) 1261.

A numerical analysis of drift and Hall mobility of majority carriers has been made as a function of impurity concentration (from $N_D=10^{20}$ to $6x10^{21}cm^{-3}$) in n-Si at temperatures ranging from 250 to 400 K. A detailed physical model and a self-consistent method for determining the screening length and the Fermi energy level was used. At higher doping levels ($N_D>4x10^{20}cm^{-3}$), the correction of the effective mass is taken into account. Numerical results have been compared with know experimental results from the literature. Good agreement is obtained.

"Measurement of fluences and energies of D^+ emitted from the plasma focus in capacitor bank energies interval of 1-30 KJ"
R. Antanasijević, D. Šević, A. Zarić, I. Lakićević, S. Popović, J. Vuković, Dj. Konjević, J. Purić, M. Ćuk
Nucl. Tracks Radiat. Meas. **22** (1-4) (1993) 535.

Diagnostics of D^+ ions emitted from the D-plasma focus (PF) have been performed with CR-39 and CA 80-15 detectors. Fluences and energies of D^+ ions were measured for the capacitor bank energy range of 1-20 kJ. Angular distribution of D^- was measured using a pin hole camera placed at different positions in PF chamber. Energy of D^+ ions was estimated by diameters measurement of D^+ - tracks. Incident angle was 90°.

"Preliminary observations on possible implications of new Bohr orbits (resulting from electromagnetic spin-spin and spin-orbit coupling) in "*cold*" quantum mechanical fusion processes appearing in strong "*plasma focus*" and "*capillary fusion*" experiments"
R. Antanasijević, I. Lakičević, Z. Marić, D. Šević, A. Zarić, J. P. Vigier
Physics Letters A **180** (1993) 25.

The theoretical iaterpretation of recently observed "excess heat" (i.e. break-even) in low intensity electrolytic and discharge experiments (with both deuterium and hydrogen) as resulting from a new type of non-nuclear quantum phenomena (i.e. spin-spin and spin-orbit couplings added to the usual Coulomb potential in specially structured dense media) leads to the prediction that "fusion ashes" of deuterium (or deuterium compunds now in vanishingly small quantities) will grow with the current intensity input, thus increasing the excess energy output. To test this prediction one can study the dynamic of fusion reactions in simple capacitor bank discharges into deuterated media, both in plasma focus (PF) and capillary fusion (CF) type experiments.

"Infrared plasma reflectivity minimum in heavily doped n-Si"
M. M. Jevtić, M. B. Živanov
Infrared. Phys. **34** (1) (1993) 75.

This paper presents a numerical analysis of infrared (IR) plasma reflectivity minimum in ultra heavily (UHD) n-Si (impurity concentration N up to $6x10^{21}cm^{-3}$) by using a self-consistent method (SCM) and a complex physical model. The necessity of taking into account the dependence of effective mass on impurity concentration is shown. The scattering on defects (N_{def} =$5x10^{17}cm^{-3}$) and dislocation (N_{ds}=$5x10^{11}cm^{-2}$) is included. The approximate relation for the wavelength $\lambda_m(N)$ of the reflectivity minimum is given. The results obtained are compared with the experimental results for n-Si and satisfactory agreement is found.

"Majority carrier mobility in ultra heavily doped n-type Si in the presence of defects and dislocations"
M. B. Živanov, M. Jevtić
Solid-State Electron. **36** (6) (1993) 891.

The paper describes the numerical analysis of scattering effects in the presence of defects (to $5x10^{17}cm^{-3}$) and dislocations (to $5x10^{11}cm^{-2}$) on the relaxation time and mobility of major carriers in ultra heavily doped n-Si (to $6x10^{21}cm^{-3}$) in the temperature range from 250 to 400 K. A detailed physical model was used with self consistently determined Fermi energy and screening length. The obtained total average relaxation time and mobility agree well with the experimental results.

"Improved implementation of the Princen-Bradley filter bank "
D. Šević, M. Popović
IEEE transactions on signal processing **42** (11) (1994) 3260.

An improved implementation of the Princen-Bradley filter bank is proposed. The new implementation is based on the use of the fast Fourier transform algorithm of real-valued sequences. Compared to the previous solutions, it has less additions, simpler structure of modules, and permits parallel execution.

"A new look at the comparison of the fast Hartley and Fourier transforms"
M. Popović, D. Šević
IEEE Transactions on Signal Processing **42** (8) (1994) 2178.

In this correspondence a fair comparative analysis of algorithms for fast Hartley transform (FHT) and real valued fast Fourier transform (RVFFT) is presented. The complexity analysis and runtime comparisons were conducted and explained simulataneously. The complexity analysis shows great similarity between RVFFT and FHT. The run-time comparisons also show negligible differences, with some small advantages to RVFFT. The influence of the compiler on the executinn time may be more significant than the choice of the algorithm. Also, a new and more accurate model for the prediction of execution time of the algorithm is proposed.

"A new efficient implementation of the oddly stacked Princen-Bradley filter bank"
D. Šević, M. Popović
IEEE Signal Processing Letters **1** (11) (1994) 166.

An improved implementation of the oddly stacked Princen-Bradley filter bank is proposed. The new implementation is based on the same approach as suggested by Duhamel, where the complex fast Fourier transform algorithm of length equal to that of the number of subbands in used in order to obtain a significant reduction of number of arithmetic operations. In our implementation, the analysis filter bank is similar to Duhamel's, with some minor differences. However, the synthesis filter bank is quite different, having easy and elegant merging of output rotations and windows and reduced arithmetic complexity.

"Numerical simulation of mercury diffusion in HgCdTe during laser annealing"
M. Šćepanović, M. Jevtić
Phys. Stat. Sol. A **143** (1994) 289.

The effects of pulsed laser irradiation on the Hg concentration in HgCdTe are investigated. A model for laser induced diffusion of Hg, taking into account the heat flow transient and the melting and solidification of the surface of HgCdTe under pulsed laser irradiation, is developed. It allows the analysis of the role of irradiation and of diffusion parameters on Hg behaviour. Comparison of the calculated compositional depth profiles of Hg with the published experimental data enables the assesment of the values of the diffusion, out-diffusion, and segregation parameters, unknown under laser annealing conditions.

"Scanning probe microscopy (tunneling, atomic force, confocal and acoustic) in particle track detectors"
J. B. Vuković, R. Antanasijević
Radiation Measurements **25** (1-4) (1995) 745.

The review of modern Scanning probe microscopy (SPM) observation of SSNTD is presented. Papers on Scanning tunneling microscopy (STM) and Scanning force microscopy (SFM) in Particle track detectors (PTD) have already appeared by other reaserchers (Marburg 1990,Beijing 1992). Atomic and submolecular resolution could be achieved. Geometrical structure of the etched tracks has a role in contract and this is connection of STM and SFM with conventional optical microscopy analysis of tracks on and solids. In Electgronic optical microscopy (EOM) nowadays we have a new a new promising SPM which produces images formed with the laser light from a limited zone in focal plane. This is Confocal scanning optical microscopy (CSOM), which allows the user to indenpendently image different layers. The track image in detector (as the sum of slices) can be processed to provide all 3-D information. Also, there is a possibility to introduce Scaning acoustic microscopy (SAM) asa new SPM in analysis of etched tracks on and in solids (gass and crystals). Acoustic images are effective in microfractographic studies (finest cracks) and there is a real possibility to detect etched tracks as the surface and subsurface disccontinuities.

"Discrimination of positive particles emitted in deuterium plasma focus device using SSNTD"
Ž. Todorović, R. Antanasijević, D. Šević, A. Zarić, Dj. Konjević, J. Vuković, J. Purić and M. Ćuk
Radiation Measurements **25** (1-4) (1995) 265.

The yields of different positive particles emitted in deutherium plasma focus device were measured. The particles, among the other particles, were detected. CR-39 and LR-115 (Kodak) SSNTD were used.

"Realization of an in-place unscrambler for prime factor algorithm"
M. Popović, D. Šević
Signal Processing **46** (1995) 249.

In this paper a new algorithm is proposed for in-place unscrambing of output data in a prime factor algorithm for the computation of discrete Fourier transform. Lengths of the transform for which in-place unscrambing is possible are determined, and the simple digit reverse counter algorithm is used for the unscrambing. All truly in-order io-place prime factor algorithms have some kind of limitation, so this new algorithm can be viewed as a supplement to previous solutions, increasing the number of cases where a simple solution is possible. The new algorithm is illustrated by a short program segment written in C programming language.

"Numerical simulation of laser induced mercury diffusion in HgCdTe using nonconstant segregation coefficient"
M. Šćepanović, M. Jevtić
Phys. Stat. Sol. A **147** (2) (1995) 379.

The effects of nooequilibrum mercury segregation on Hg concentration changes due to pulsed laser irradiation of $Hg_{1-x}CdTe$ (x=0.2) are investigated. A model that relates the nonequilibrum segregation coefficient of Hg, k', to the velocity of the liquid-solid interface during solidification of the molten region created by the pulsed laser radiation is developed. The functional dependence of k' on the interface velocity is determined by fitting the calculated Hg concentration profiles to the experimental data presently available. With the velocity dependence of k' it is shown that the model gives good agreement with the behaviour of the Hg concentration under pulsed Nd: YAG laser irradiation.

"Noise as a diagnostic and prediction tool in reliability physics"
M. M. Jevtić
Rev. paper, *Microelectron. Rel.* **35** (3) (1995) 455.

A review of the possibility of using noise measurement in analysis and prediction of electron device reliability is given. The noise as an informative parameter for device reliability and its advantages and disadvantages are discussed. A review of qualitative and quantitative noise reliability indicators for diodes, transistors and integrated circuits as well as the methods for failure and defect analysis are presented.

CONFERENCES: Invited lectures, progress reports and contributions

"Analysis of Hall mobility in the ultra heavy doped n-Si"
M. B. Živanov, M. M. Jevtić, D. A. Tjapkin
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M. M. Jevtić
II savetovanje - Aktuelni projekti i problemi merenja, nadzora i upravljanja, Tuzla, Zbornik radova (1991) 1.1. (in Serbian)

"Analiza minimuma refleksije plazme u infracrvenoj oblasti u veoma jako dopiranom n-Si"
M. M. Jevtić, M. B. Živanov
XXXV konf. ETAN-a, Ohrid, IV (1991). (in Serbian)

"Induction motor inverter phase current measurement by means of a current transformer"
D. Stanojević, M. Stefanović
Conference Proc. (Intelligent Motion) *PCIM '91*, Nirnberg, Nemačka (1991) 292.

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Z. Tatarović, V. Slavković, M. Stefanović
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"Measurment of fluences and energy of d^+ emited from plasma focus capacitor bank energies interval of 1-30 kJ"
R. Antanasijević, I. Lakićević, S. Popović, A. Zarić, D. Ščvić, J. Vuković, Dj. Konjević
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"Analiza vremena relaksacije u veoma jako dopiranom n-Si"
M. B. Živanov, M. Jevtić
XXXVI konf. ETAN-a, Beograd, Zbornik radova, XIII (1992) 47. (in Serbian)

"Efekti gradijenta temperature na lasersko dopiranje Si"
M. Subotić, M. Jevtić
XXXVI konf. ETAN-a, Beograd, Zbornik radova, XIII (1992) 11. (in Serbian)

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M. Subotić, M. Jevtić
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M. B. Živanov, M. M. Jevtić
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"Present status of Belgrade facilities in the plasma focus and capillary fusion experiments"
R. Antanasijević, I. Lakićević, Z. Marić, D. Šević, A. Zarić, J. P. Vigier
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R. Antanasijević, I. Lakićević, D. Šević, A. Zarić, Dj. Konjević, J. Vuković, J. Purić, M.Ćuk
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"Computationally efficient subband coding of images"
D. Šević, M. Popović
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Konferencija *Telsiks '93*, Niš (1993). (in Serbian)

"Behaviour of mercury in HgCdTe during laser annealing"
M. Šćepanović, M. Jevtić
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"Low-frequency noise nf suspended gate MOST's"
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"Simulation of laser induced diffusion of indium in Hg(1-x)Cd(x)Te"
M. Šćepanović, M. Jevtić
Proc. *2nd Serb. Conf. on Microel. and optoel.-MIOPEL '93*, Niš (1993) 211.

"Jedan postupak za analizu niskofrekventnog suma"
M. V. Marković, M. M. Jevtić
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"Približne zavisnosti fizičkih parametara od koncentracije primesa u veoma jako dopiranom n-Si"
M. B. Živanov, M. M. Jevtić
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"Uticaj laserskog odgrevanja na promenu koncentracije žive u Hg(1-x)Cd(x)Te"
M. Šćepanović, M. Jevtić
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M.Stefanović, D.Stanojević
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J. Purić, M. Ćuk, V. Milosavljević, R. Antanasijević, D. Šević, A. Zarić
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J. Vuković, R. Antanasijević
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J. B.Vuković, R. Antanasijević
Nuclear tracks in solids, Dubna (1994) 88.

"Discrimination of positive particles emitted in deutherium plasma focus device using SSNTD"
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"Image coding using vector quantization and decomposition into 10 subbands"
D. Šević, M. Popović
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D. Šević i M.Popović
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M. Jevtić
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XXXVIII konferencija ETAN, Niš (1994) 27. (in Serbian)

"Invertor sinusoidalnog napona iz aku-baterije"
D. Stanojević, M. Stefanović
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"Modularni koncept sistema napajanja digitalne telefonske centrale"
M. Pantić, M. Stefanović, N. Sokolović, D. Stanojević
II Simpozijum TELFOR'94, Beograd, Zbornik radova (1994) 491. (in Serbian)

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D. Stanojević, V. Božović, M. Stefanović, Ž. Spasojević
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D. Šević, A. Zarić, R. Antanasijević, Dj. Konjević, M. Ćuk, J. Purić
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"Istraživanje superteskih elemenata u geološkim uzorcima"
A. Zarić, D. Šević, R. Antanasijević, Dj. Krmpotić
IX Kongres fizičara Jugoslavije, Petrovac na Moru (1995) 585. (in Serbian)

"Analiza X-zračenja emitovanog iz deuterijumskog plazma fokusa"
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M. Jevtić, M. Marković
XXXIX konf. ETRAN, Zlatibor, Zbornik radova IV (1995). (in Serbian)

"Uticaj raspodele defekata u p-n spoju na niskofrekventne fluktuacije struje"
M. Marković, M. Jevtić, S. Tomić
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S. Pavljašević, N. Sokolović, M. Stefanović
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"Prigušenje psofo-šuma kod baterijski napajanih invertora"
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III Simpozijum TELFOR'95, Beograd, Zbornik radova (1995) 737. (in Serbian)

"Karakteristike laserskog merača daljine na bazi Nd:YAG kristala, realizovanog u Institutu za fiziku, i laserskog merača daljine na bazi Nd stakla"
D. Joksimović, Ž. Spasojević, D. Jovanović, S. Jevtović
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THESES: Ph.D. and M.S.

"Istraživanje superteških elemenata u geološkim uzorcima"
A. Zarić
Fizički fakultet, Univerzitet u Beogradu (1993) (Ph.D. thesis in Serbian).

"Poboljšanja razlaganja slike na podopsege i kodovanja podopsega slike"
D. Šević
Elektrotehnički fakultet, Univerzitet u Beogradu (1995) (Ph.D. thesis in Serbian).

"Analiza algoritama za diskretnu Hartlijevu i Furijeovu transformaciju sa primenom u digitalnoj obradi signala"
D. Šević
Elektrotehnički fakultet, Univerzitet u Beogradu (1991) (M.S. thesis in Serbian).

"Neutronska radiografija uzoraka sa pretežno lakim elementima pomoću izvora 252 CF"
V. Pavelkić
Fakultet za fizičku hemiju, Univerzitet u Beogradu (1993) (M.S. thesis in Serbian).

П 0103: ФИЗИКА КОНДЕНЗОВАНОГ СТАЊА И НОВИХ МАТЕРИЈАЛА

P0103: CONDENSED MATTER PHYSICS AND NEW MATERIALS

PUBLICATIONS: Books, Monographs and Articles

"Strange attractor in the reflectivity of a phase-conjugate mirror"
M. R. Belić and D. Timotijević
Phys. Rev. A **43** (1991) 6420.

Wave equations describing optical phase conjugation in photorefractive crystals are solved using a technique that transforms a boundary-value problem into an initial-value problem. Boundary conditions are satisfied using an iterative map constructed in the parameter space. Within the iterative procedure unstable situations arise, leading to a chaotic response of the crystal. A strange attractor is discovered in the reflectivity of the crystal, existing in the multiparameter space of the single-interaction-region four-wave-mixing process.

"Multigrating phase conjugation: chaotic results"
M. R. Belić, D. Timotijević and W. Krolikowski
J. Opt. Soc. Am. B **8** (1991) 1723.

Slowly varying envelope wave equations describing degenerate four-wave mixing (4WM) in photorefractive phase-conjugate mirrors are solved exactly, in terms of quadratures. Multigrating 4WM geometry is assumed, with the transmission and reflection gratings contributing equally and with the counterpropagating pump-pump interaction accounted for. The original boundary-value problem is transformed into an initial-value problem, which is treated by an iteration procedure. It is shown that within the iterative boundary-fitting procedure the multistability of solutions takes place and that the intensity reflectivity of the mirror may become chaotic. The strange attractor thus arising is analyzed with the use of standard methods of nonlinear dynamics.

"Magnetic field dependence of the critical currents in high T_c superconductors"
Lj. Dobrosavljević-Grujić and Z. Radović
Physica C **185** (1991) 2313.

It is shown, within a simple model calculation, that the critical current density of an S/N/S junction in a high parallel magnetic field decays exponentially. The comparison of the theoretical results with experimental data for the Pb/Cd/Pb junction and YBCO films is given.

"High pressure and lifetime τ of ^2E level in ruby"
B. Jovanić, Lj. Zeković and B. Radenković
Physics Scripta **43** (1991) 446.

"Vortex and nonvortex nucleation of superconductivity in ferromagnetic-superconducting-ferromagnetic triple layers"
M. Ledvij, Lj. Dobrosavljević-Grujić, Z. Radović and J. R. Clem
Phys. Rev. B **44** (1991) 859.

Superconducting nucleation fields for ferromagnetic-superconductinng -ferromagnetic (M/S/M) triple layers are calculated when the magnetic field is applied parallel to the S/M interfaces, the S layer is of arbitrary thickness d, and the M metals are identical and very thick. Both vortex and nonvortex nucleation are considered and the thickness d_{cr} at which the vortices start to nucleate is determined. Since the superconductivity is significantly suppressed near the S/M interfaces, the thickness d_{cr} substantially increases with respect to the case of a single S film.

"Phase diagram of superconductor-ferromagnet superlattices"
Z. Radović, M. Ledvij and Lj. Dobrosavljević-Grujić
Solid State Communic. **80** (1991) 43.

The perpendicular upper critical field $H_{C2\perp}$ of superconductor-ferromagnet superlattices is calculated by solving exactly the Usadel equations. Characteristic new ground state configurations are brought about by the exchange effect leading to an oscillatory dependence of $H_{C2\perp}$ on the ferromagnetic layer thickness.

"Transition temperatures of superconductor-ferromagnet superlattices"
Z. Radović, M. Ledvij, Lj. Dobrosavljević-Grujić, A. I. Buzdin and J. R. Clem
Phys. Rev. B, **44** (1991) 759.

The transition temperature T_c of superconductor-ferromagnet superlattices is calculated by solving exactly the Usadel equations. Characteristic ground-state configurations are predicted with nontrivial phase difference $0<\varphi\leq\pi$ between neighboring superconducting layers. An unusual oscillatory dependence of T_c oa the ferromagnetic-layer thickness is obtained. For short-period superlattices it is found that the transition changes from second to first order. A comparison of theoretical results with experimental data for V/Fc superlattices is given.

"Phase diagram of superconducting-normal-metal superlattices"
Z. Radović, M. Ledvij and Lj. Dobrosavljević-Grujić
Phys. Rev. B **43** (1991) 8613.

The transition temperatures and the perpendicular upper critical fields of superconducting-normal-metal superlattices are calculated by solving exactly the Usadel equations. For thin films our results differ substantially from previous approximate result.

"Red fluorescence spectra as new means of determining the rate of damage to photosynthesis apparatus in plants caused by stress"
B. Jovanić, Lj. Zeković and B. Radenković
J. Biolog. Phys. **17** (1991) 57.

"Temperature dependence of the lower critical field and strong pinning in high-temperature superconductors"
D. Davidović and Lj. Dobrosavljević-Grujić
Phy. Rev. B **43** (1991) 2809.

We show, within the framework of the Ginzburg-Landau theory, that both the conventional and the anomalous temperature dependence of the low critical field observed in high-temperature superconductors may result from the flux penetration through a set of separated microdefects. Microdefects modeled by normal layers with proximity-induced superconductivity can produce drastic enhancement of the lower critical field at low temperatures and can provide strong-pinning centers. The pinning interaction between an isolated vortex and the normal layer is primarily magnetic at high temperatures. At low temperatures, magnetic interaction is reduced, due to the increase of the normal-layer coherence length.

"New results on the phase diagram of $(TMTSF)_2 FSO_3$"
P. Auban, V. Čelebonović, S. Tomić, D. Jerome and K. Bechgaard
Synthetic Metals **41-43** (1991) 2281.

"A note on the thermal component of the equation of state of solids"
V. Čelebonović
Earth, Moon and Planets **54** (1991) 145.

"Two- and four-wave mixing with saturable absorption and gain"
D. Timotijević, M. Belić and R. W. Boyd
IEEF J. of Quant. Elect. **28** (1992) 1915.

An exact solution to a model of two- and four-wave mixing in photorefractive media with saturable gain and absorption is presented. Pump depletion effects are accounted for, and the procedure for matching two-point boundary conditions is given. Possibilities of multistable solutions are investigated, and procedures on how to deal with such situations are outlined. It is found that the energy transfer between waves is less effective in the nonsaturated regime as compared to the saturated regime. It is also established that the nonsaturated system is more stable than the saturated under the same conditions.

"High pressure phase transition - examples of classical predictability"
V. Čelebonović
Earth, Moon and Planets **58** (1992) 203.

"C_{60} - an astrophysical problem transferred into solid state physics"
V. Čelebonović
Bull. Astron. Belgrade **146** (1992) 41.

"Ising models with interfaces, defect lines, and walls"
W. Selke, N. M. Švrakić and P. J. Upton
Z. Phys. B **89** (1992) 231.

The transverse fluctuations of meandering interfaces in two-dimensional SOS models containing walls and defect lines may lead to a singularity in the correlation function. Corresponding Ising models below the bulk critical temperature are studied using an exact analytical transfermatrix method and Monte Carlo simulations. Typically, a rather smooth behavior is observed in static and dynamic quantities.

"Wetting at the grain boundary in the planar Ising model"
D. Todorović and N. M. Švrakić
Z. Phys. B **87** (1992) 355.

In this paper the conditions of pinning of an interface in a 2D Ising ferromagnet with defect connections in a solid-on-solid (SOS) limit are given. It is known that in this case the localization of interface is formally equivalent to the bound state of quantum particle in temperature dependent effective potential. We show that a wetting transition occurs whenever the couplings on the two sides of the defect are different.

"Chaos in phase conjugation: physical vs numerical instabilities"
M. Belić and Z. Ljuboje
Opt. and Quant. Elect. **24** (1992) 745.

Four-wave mixing equations in photorefractive media are approximated by different dynamical models and treated by different numerical methods. It is shown that the onset of instabilities and irregular behavior in the same crystal, with a single wave mixing region, may be dependent both on the model used and the numerical method applied. Long-time irregular dynamics following from any finite-order difference schemes should be viewed with caution.

"Symmetries of photorefractive four-wave mixing"
P. Stojkov and M. Belić
Phys. Rev. A **45** (1992) 5061.

A symmetry analysis of degenerate four-wave-mixing equations in photorefractive crystals is carried out. Using underlying SU symmetries, a systematic derivation of conserved quantities is performed, and a method of integration of the equations is introduced. Five conserved quantities are found, suggesting that the initial four complex equations can be expressed in terms of three real quantities (Euler angles or other). However, due to the form of the equations, only one independent variable is found necessary to solve the problem.

"Symmetries of two-wave mixing in photorefractive crystals"
P. Stojkov, D. Timotijević and M. Belić
Opt. Lett., **17** (1992) 1406.

We consider symmetries of two-wave mixing equations in photorefractive crystals, using group theoretical methods. Symmetry groups for both the equations and conserved quantities are determined, and the corresponding generators are written explicitly. Results obtained for plane-parallel polarized two-wave mixing are used to introduce the method for solution and the form of solutions for cross-polarized two-wave mixing.

"Computational chaos in nonlinear optics"
M. Belić, Z. Ljuboje, M. Sauer and F. Kaiser
Appl. Phys. B **55** (1992) 109.

A few models of nonlinear optical systems, known experimentally to possess both stable and unstable dynamical modes, are approximated by different dynamical models and integrated by different numerical methods. It is shown that the onset of instabilities and chaotic behavior in the same physical system may be dependent on the model used and on the numerical method applied. Finite order difference schemes should be applied with caution to infinite dimensional dynamical systems displaying irregular behavior.

"Lifetime of ruby R1 line under ultrahigh pressure"
B. Jovanić
Chem. Phys. Lett. **190** (1992) 440.

"Pressure induced phase shift of photoacustic signal in ruby as new method for pressure measurement"
B. Jovanić
Meas. Sci. Technol. **3** (1992) 979.

"The pressure dependence of ruby fluorescence lifetime as a new optical method for pressure measurement"
Z. M. Jakšić, V. V. Urošević, Lj. Zeković and B. Jovanić
High Press. Res. **9** (1992) 247.

"New spectroscopic investigation of SrB_4O_7:Sm^{2+} at high pressure"
V. V. Urošević, Z. M. Jakšić, Lj. Zeković and B. Jovanić
High Press. Res. **9** (1992) 251.

"Vortices in anisotropic type-II superconductors"
J. R. Clem, Z. Hao, Lj. Dobrosavljević-Grujić and Z. Radović
J. Of Low Temperat. Phys. **88** (1992) 213.

We present a generalized variational model of an isolated vortex, valid in the anisotropic case when the external magnetic field is along one of the symmetry directions. We discuss the effects of the field anisotropy on the core and magnetic pinning of individual vortices.

"Wave mixing in photorefractive crystals with saturable couplings: stable solutions and instabilities"
M. Belić and D. Timotijcvić
Opt. Communicat. **96** (1993) 283.

Two-wave and four-wave mixing in photorefractive media with saturable gain and saturable absorption is analyzed. Solutions to wave equations are found in terms of quadratures and implicitly given functions. Different models of saturation are compared. It is found that for weak couplings energy transfer between waves is less effective in the strong unsaturated regime as compared to the saturated, while for strong couptings both regimes are equalty effective. The existence of multiple solutions in four-wave mixing is established. It is shown that the unsaturated system is more stable than the saturated.

"Low temperature fluctuations of vortices in layered superconductors"
Y. Q. Song, W. P. Halperin, L. Tonge, T,. J. Marks, M. Ledvij, V.G. Kogan and L. N. Bulaevskii
Phys. Rev. Lett. **70** (1993) 3127.

Data on the ^{205}Tl NMR frequency shift and linewidth due to the magnetic field variation in the mixed state of $Tl_2Ba_2Ca_2Cu_3O_{10}$ are presented. These data, which are commonly used to extract the London penetration depth, show a near linear temperature dependence at $T<<T_c$. We offer an explanation of this effect as being caused by thermal fluctuations of vortices in weakly coupled layered systems. We argue that the fluctuations cannot be ignored in interpretation of NMR and muon-spin-resonance data for materials with large penetration depths even at low T.

"A note on the melting of iron under high pressure"
V. Čelebonović
Earth, Moon and Planets **61** (1993) 39.

"Temperature and lifetime of R1 line for $(3d)^3$ ions in crystal with corundum structure"
B. Jovanić
Matica Srpska **85** (1993) 297.

"Critical currents in superconductor-normal metal-superconductor junctions"
Lj. Dobrosavljević-Grujić and Z. Radović
Supercond. Sci. Technol. **6** (1993) 537.

Critical currents of superconductor-normal metal-superconductor junctions in a parallel magnetic field are studied theoretically. It is found that the supercurrent amplitude can be strongly suppressed by the magnetic field, due to the rapid field-dependent decay of the pair condensation amplitude inside the normal barrier. For a thick normal layer, and/or for high fields, an exponential decay of the critical current with increasing field is obtained.

"Theoretical calculation of pressure induced shoft of phoroacoustic phase signal in alexandrite ($BeAl_2O_4:Cr^{3+}$)"
B. Jovanić, Lj. Zeković and B. Radenković
Chem. Phys. Lett. **216** (1993) 47.

"Flux penetration and pinning in superconductor-ferromagnet superlattices"
Lj. Dobrosavljević-Grujić, B. Vujičić and Z. Radović
Physica C **235** (1994) 2749.

Flux penetration in superconductor-ferromagnet superlattices is studied theoretically. The parallels lower critical field is calculated and the characteristic temperature and layer thickness dependence is discussed. It is found that strong flux pinning and high critical current densities are obtained for superlattices with thin ferromagnetic and thick high-temperature superconducting layers.

"Unified method for solution of wave equations in photorefractive media"
M. Belić and M. Petrović
J. Opt. Soc. Amer. B **11** (1994) 481.

A unified but simple method for solution of four-wave mixing equations in photorefractive crystals in both transmission and reflection geometries is presented. The method is applied to the problems of dnuble phase conjugation and two-wave mixing with crossed polarizations in cubic crystals.

"Exact solution to cross polarization two-wave mixing in cubic photorefractive crystals"
M. Belić and M. Petrović
J. Opt. Soc. Amer. B **11** (1994) 1142.

Slowly-varying envelope wave equations for the cross-polarization two-wave mixing in cubic photorefractive crystals are solved exactly, using a novel analytical method. The method allows both the transmission (codirectional) and the reflection (contradirectional) geometry of the process to be treated equally, and yields simple explicit expressions.

"Uran i Neptun - nekoliko reči o unutrašnjoj strukturi"
V. Čelebonović
Vasiona **XLII** (1994) 77. (in Serbian).

"Vectorial two-beam mixing in photorefractive crystals"
M. Petrović and M. Belić
Opt. Commun. **109** (1994) 338.

An exact solution to vectorial two-beam mixing in photorefractive crystals is obtained. Both the transmission and the reflection geometry of the process are treated equally using our novel solution procedure. Some applicative potential of the vectorial two-wave mixiog is explored.

"Transverse effects in double phase conjugation"
M. R. Belić, J. Leonardy, D. Timotijević and F. Kaiser
Opt. Commun. **111** (1994) 99.

Spatial and dynamical effects in double phase conjugate mirrors are investigated analytically and numerically. A variety of spatial and temporal effects are observed, such as beam-bending, self-defocusing, mode oscillations and irregular pattern formation. We conclude that in more than one spatial dimension the double phase conjugate mirror is a convective oscillator. For strong beam couplings and strong diffraction we find that the oscillation threshold is not well defined, and that the double phase conjugate mirror becomes unstable. An improved agreement with experimental results is obtained.

"Macroscopy theory of layered superconductors"
Lj. Dobrosavljević-Grujić
Natural Sciences **85** (1994) 19. (Matica Srpska, Novi Sad)

"muSR and NMR line shapes in layered superconductors"
P. Miranović and Lj. Dobrosavljević-Grujić
Natural Sciences **85** (1994) 121. (Matica Srpska, Novi Sad)

"Random sequential adsorption: line segments on disordered substrates"
D. Milošević and N. Švrakić
Natural Sciences **85** (1994) 27. (Matica Srpska, Novi Sad)

"Optical computing with photorefractive ring oscillators"
M. Belić
Asian J. of Phys. **4** (1995) 53.

Potential applications of photorefractive ring resonators io optical computing are reviewed. Using an electronics-like point of view of photorefractive optical circuits, we propose a model of an optical transistor based on the operation of photorefractive ring oscillators. Both unidirectional and bi-directional rings are considered as models for different optical logic gates. We also discuss applications such as optical amplification, polarization rotation, and switching. We comment on the advantages and disadvantages that such arrangements offer. The role of transverse effects and instabilities in the operation of these devices is discussed briefly.

"Fizika i astrofizika materije pod visokim pritiskom; neki rezultati i neki problemi"
V. Čelebonović
Publ. Obs. Astron. Belgrade **48** (1995) 139. (in Serbian)

"Dense matter physics, the origin of rotation and all that - a tribute to Pavle Savić"
V. Čelebonović
Publ. Obs. Astron. Belgrade **151** (1995) 37.

"Photorefractive ring oscillators"
M. Petrović and M. Belić
J. Opt. Soc. Amer. B **12** (1995) 1028.

The theory of photorefractive ring oscillators is considered using our unified solution method. Both unidirectional and bi-directinnal ring resonators are analyzed, based on the two-wave mixing process with crossed polarizations and the four-wave mixing process with parallel polarizations in photorefractive crystals. Symmetries between the transmission and the reflection geometry of these processes are highlighted and utilized to write down analytical expressions for oscillation conditions in all the cases. Symmetry breaking is noted in the four-wave mixing between the transmission and the reflection grating case. An optical transistor based on photorefractive rings is proposed.

"Photorefractive ring resonators with vectorial two-beam coupling: theory and applications"
M. Petrović and M. Belić
Phys. Rev. A **52** (1995) 671.

Oscillation conditions for unidirectional ring resonators containing cubic photorefractive crystals are analyzed. The coupling of pump beams tn intracavity modes is presumed to occur via the vectorial two-beam coupling in the crystal. It is also presumed that the intracavity field as well as the pump field are composed of two orthognnally polarized components. The solution of slowly-varying envelope wave equations in the degenerate and steady-state limit is used to determine the grating action and to derive threshold conditions for both the transmission and the reflection geometry of the wave mixing process. A number of special cases of wave mixing coupling constants is considered. Potential applications of two-wave mixing rings in different photorefractive devices, such as optical amplifiers, switches and logic circuits are discussed.

"Spatio-temporal effects in double phase conjugation"
M. R. Belić, J. Leonardy, D. Timotijević and F. Kaiser
J. Opt. Soc. Amer. B **12** (1995) 1602.

Spatial and temporal effects arising in photnrefractive crystals during the process of double phase conjugation are analyzed numerically, using a novel beam propagation method. Slowly-varying envelope wave equations in the paraxial approximation are solved under appropriate boundary conditions. Our analysis includes dynamical effects caused by the build-up of diffraction gratings in the crystal and the turn-on of phase conjugate beams, as well as spatial effects caused by the finite transverse spread of beams. Various phenomena are obscrved, such as the self-bending and self-defocusing of phase conjugate beams, convective flow of energy nut of the interaction region, mode oscillations, and irregular spatial pattern formation. For real beam coupling constant and constructive interaction of interfcrence fringes in the crystal no chaos is found. However, for complex coupling constant and/or induced phase mismatch in the grating, a transition to spatio-temporal chaos is observed. We confirm that under stable operating conditions the transverse double phase conjugate mirror is a convective amplifier, rather than an oscillator. An improved agreement with experimental results is obtained.

"Flux pinning and critical current in layered type II superconductors in paralleled magnetic fields"
V. Prokić, D. Davidović and Lj. Dobrosavljević-Grujić
Phys. Rev. B **51** (1995) 1270.

We have shown, within the Ginzburg-Landau theory, that the interaction between vortices and normal metal layers in high-T_c superconductor/normal metal superlattices can cause high critical current densities j_c. The interaction is primarily magnetic, except at very low temperatures T, where the core interaction is dominant. For a lattice of vortices commensurate with an array of defects in a parallel magnetic field H, stroog magnetic pinning is obtained, with a non-monotonic critical current dependence on H, and with j_c of the order of 10^7-10^8 A/cm^2.

"Vortex lattices in layered superconductors"
V. Prokić, D. Davidović and Lj. Dobrosavljević-Grujić
Phys. Rev. B **51** (1995) 6013.

We study vortex lattices in a superconductor /normal metal superlattice in a parallel magnetic field. Distorted lattices, resulting from the shear deformations along the layers, are found to be unstable. Under field variation, non-equilibrium configurations undergo an infinite sequence of continuous transitions, typical for soft lattices. The equilibrium vortex arrangement is always a lattice of isocell triangles, without shear.

"Vortex induced strain and flux lattices in anisotropic superconductors"
V. G. Kogan, L. N. Bulaevskii, P. Miranović and Lj. Dobrosavljević-Grujić
Phys. Rev. B **51** (1995) 15344.

Strains in superconductors which accompany vortex nucleation and arise due to difference in the specific volumes of the superconducting and normal phases are evaluated. The strain in anisotropic materials causes an extra intervortex interaction, which is long range as compared to a stronger but finite range London force. In materials with a strong pressure dependence of superconductivity (as $NbSe_2$) the strain induced interaction affects the structure of the flux lattices. For the field parallel to the c axis of $NbSe_2$ the flux lattice is locked on the crystal, the fact which cannot be explained either by London or by harmonic elastic interactions; possible role of anharmonic elastic interactions of vortices for this case is discussed.

"Ginzburg-Landau theory of vortex lattice structure in deformable anisotropic superconductors"
P. Miranović, Lj. Dobrosavljević-Grujić and V. G. Kogan
Phys. Rev. B **52** (1995) 12852.

Correlation between the crystal lattice and the vortex lattice in anisotropic (uniaxial) type-II superconductors due to magneto-elastic interactions is studied theoretically. Within the strain-dependent Ginzburg-Landau model, the energy of the magneto-elastic interaction of the vortex lattice is evaluated with the δV-effect (difference of specific volumes of normal and superconducting phase) as the main source of the elastic strain. For $NbSe_2$ in tilted fields near the upper critical field H_{c2}, the vortex lattice is the same as obtained within the London model in fields well below H_{c2} with magneto-elastic interactions taken into account.

"On the strain induced vortex mass in anisotropic superconductors"
P. Miranović and Lj. Dobrosavljević-Grujić
Phys. Lett. A **207** (1995) 225.

Strain induced vortex inertial mass in a deformable superconductor is evaluated as a function of crystal symmetry. Vortex mass and its anisotropy depend on the orientation of the vortex within the crystal, as shown for $NbSe_2$ (hexagonal crystal symmetry). In $YBa_2Cu_2O_7$ (orthorhombic symmetry), for a vortex parallel to $\vec{c}$ axis, inertial mass is of the nrder of 10^6 electron masses per cm. This is two orders of magnitude greater than the mass estimated in the model of elastically isotropic crystal.

CONFERENCES: Invited lectures, progress reports and contributions

"Phase diagram of superconductor - ferromagnet superlattices"
Z. Radović and Lj. Dobrosavljević-Grujić
Int. Conf. *Superconductors Multilayers and Superlattices* (L. A. California, 1994)
Proc. **2157** (1994).

Recent progress in the proximity effect theory of superconductor-ferromagnet superlattices is reviewed. The phase diagram (transition temperature T_C and upper critical fields H_{C2}) is obtained within the quasiclassical theory of superconductivity. Characteristic features in T_C and H_{C2} (T) dependence on layers thicknesses, including the predicted unusual oscillatory variations and new inhomogeneous superconducting state with nontrivial phase difference between neighboring superconducting layers, are discussed in comparison with experimental data for V/Fc and Nb/Gd superlattices.

"Phase conjugation with saturable gain and saturable absorption"
M. R. Belić, D. Timotijević and R. Boyd
Technical Digest on Photorefractive Materials, Effects and Devices (Optical Society of America, Washington) **14** (1991) 428.

"Lifetime of R1 line of $(3d)^{3+}$ ions in different crystals"
B. Jovanić, Lj. Zeković, V. V. Urošević and B. Radenković
XI Gen. Cong. Cond. Matter. Div. Exeter (1991) PB 79.

"New spectroscopic investigation of SrB_2O_7: Sm^{2+} at hogh pressure"
V. V. Urošević, Z. Jakšić, Lj. Zeković, and B. Jovanić
XXIX Ann. Sci. Meey. EHPRG Thessaloniki (1991) TU 17.

"The pressure dependence of ruby fluoroscence lifetime as new optical method for pressure measuremetn"
Z. Jakšić, V. V. Urošević, Lj. Zeković, and B. Jovanić
XXIX Ann. Sci. Meey. EHPRG Thessaloniki (1991) TU 16.

"The pressure dependence pf phase shift of photoacoustic signal in ruby as new method for pressure measurement"
B. Jovanić, Lj. Zeković and B. Radenković
XII Gen. Cong. Cond. Matter Div. Praha, (1992) 6P:b149.

"New method for measuring pressure in alexandrite ($BeAl_2O_2$: Cr^{3+})"
Lj. Zeković, B. Jovanić, B. Radenković and V. Urošević
XII Gen. Cong. Cond. Matter Div. Praha, (1992) 6P:b151.

"A note on C_{60} under high pressure"
V. Čelebonović
Europhys. conf. Abstracts A **16** (1992) 143.

"Fractal dimension of electron trajectories in low current gas discharges"
A. Ž. Piper, D. V. Timotijević i Z. Petrović
XVI SPIG, Beograd, Book of Contributed papers (1993) 70.

"Effect of high pressure on fluorescence lifetime τ of $^2E \rightarrow {}^4A_{2g}$ transition in MgO: Cr^{3+}
I: Theoretical consideration"
B. Jovanić, Lj. Zeković and B. Radenković
ICL'93 Conecticat, (1993) Th4-82.

"Makroskopska teorija slojevitih superprovodnika"
Lj. Dobrosavljević-Grujić
XIII JSFKM, Vrnjačka Banja (1993). (in Serbian)

"Haos u optičkoj konjugaciji"
M. Belić
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"Raspodela fluksa u uniaksijalnim supcrprovodnicima -eksperimentalna detekcija"
P. Miranović i Lj. Dobrosavljević-Grujić
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"Električna provodljivost kvazi-jednodimenzionalnih organskih provodnika"
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XIII JSFKM, Vrnjačka Banja (1993). (in Serbian)

"Tunelna struja kroz spojeve superprovodnik/magnetni metal/superprovodnik"
Lj. Dobrosavljević-Grujić i B. Vujičić
XIII JSFKM, Vrnjačka Banja (1993). (in Serbian)

"Vorteksne rešetke u slojevitim superprovodnicima u paralelnom i slabom magnetnom poju"
V. Prokić, D. Davidović i Lj. Dobrosavljević-Grujić
XIII JSFKM, Vrnjačka Banja (1993). (in Serbian)

"Real-time određivanje spektra generalisanih dimenzija"
A. Ž. Piper i D. V. Timotijević
XIII JSFKM, Vrnjačka Banja (1993). (in Serbian)

"Some possible astrophysical applications of diamond anvil cells"
V. Čelebonović
Publ. Obs. Astron. Belgrade 44 (1993) 103.

"Flux pinning and critical current in heterogeneous superconductors"
V. Prokić, D. Davidović i Lj. Dobrosavljević-Grujić
Int. Conf. *Superconductors Multilayers and Superlattices* (L. A. California, 1994)
Proc. **2157** (1994) 50.

"Photoacoustic fluorescence quantum efficiency and pressure in ruby"
B. Jovanić and Lj. Zeković
XIV GCCMD Madrid, (1994) MoAA3Po003.

"Optical properties of cotyledons od sycamore (Acer Pseudoplatanus L)"
B. Jovanić, M. T. Bogdanović and M. Tomašević
FEST Brno (1994) 10 25 (S1 45).

"Radiative quantum efficiency for ruby R1 line and high pressure"
B. Jovanić, B. Radenković and Lj. Zeković
XXXII Anual Meet. Europ. High Press. Res. Group Brno (1994) 25.

"Dense matter theory: a simple classical approach"
P. Savić and V. Čelebonović
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"The electrical conductovity of the organic conductors under high pressure"
V. Čelebonović and H. J. Schulz
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"The electron gas on a 1D lattice: a simple expression for the chemical potential"
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"A high-resulution, high-speed data aquisition system based on PC computer"
Z. Maričić, B. Jovanić and A. Nikolić
YU INFO' 95. Brezovica, Zbornik radova, Knjiga 1 (1995) 473.

"Koegzistencija superprovodnosti i feromagnetizma"
Z. Radović, Lj. Dobrosavljević-Grujić i B. Vujičić
Plenarna predavanja, *IX Kongres fizičara Jugoslavije*, Petrovac na Moru, Zbornik radova (1995) 85. (in Serbian)

"NMR linije u funkciji magnetnog polja kod slojevitih superprovodnika"
P. Miranović i Lj. Dobrosavljević-Grujić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 213.
(in Serbian)

"Oscilacije magnetnog momenta u slojevitim superprovodnicima"
V. Prokić i Lj. Dobrosavljević-Grujić
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 257.
(in Serbian)

"Hemijski potencijal elektronskog gasa na jednodimenzionalnoj rešetki"
V. Čelebonović
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 161.
(in Serbian)

"Merenje vremena života R linije u YAG: Cr^{3+}, MgO: Cr^{3+} i $MgAl_2O^4$: Cr^{3+} kristalima primenom nove metode pobudivanja"
B. Jovanić, B. Radenković i Lj. Zeković
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 177.
(in Serbian)

"Karakterizacija tankih oksidnih slojeva na aluminijumu galvanoluminiscentnom metodom"
I. Belča, Lj. Zeković, B. Jovanić. Lj. Ristovski i G. Ristovski
IX Kongres fizičara Jugoslavije, Petrovac na Moru, Zbornik radova (1995) 145.
(in Serbian)

THESES: Ph. D. and M. S.

"Efekti blizine u slojevitim superprovodnim strukturama"
M. Ledvij
Fizički fakultet, Univerzitet u Beogradu, (1991) (Ph. D. theses in Serbian).

"Nestabilnosti i haosi u faznokonjugovanim ogledalima"
D. Timotijević
Fizički fakultet, Univerzitet u Beogradu, (1991) (M. S. thesis in Serbian).

"Vorteksne rešetke u visokotemperaturskim superprovodnicima i njihova detekcija"
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П 0110: ЕКСПЕРИМЕНТАЛНА ФИЗИКА ВИСОКИХ ЕНЕРГИЈА

P0110: EXPERIMENTAL HIGH ENERGY PHYSICS

PUBLICATIONS: Books, Monographs and Articles

"On the determination of reaction product parameters using polycarbonate track detector Makrofal"
D. L. Lazić and Ž.Todorović
Nucl. Instrum. Meth. B **61** (1991) 239.

The improved Makrofol detection technique was applied in the study of intermediate mass and heavy fragment production in the interactinn of 8.8 GeV alpha particles with gold nuclei. The imitations of the applied technique were discusses and the uncertainties of results obtained by the standard version of this technique were put forward. Fragments produced in the experiment were identified and an event by event model-free analysis was performed in order to separate different production mechanisms.

"Interpretation of the 3-pronged events from the ^{236}U+Au reaction registered within CR 39 solid state nuclear track detectors"
J. Ralarosy, M. Debeauvais, J. C. Adloff, M. Zamani, F. Fernandez, S. Jokić, Ž. Todorović
Nucl. Tracks. Radiat. Meas. **19** (1991) 651.

Reactions of 15 MeV/n ^{236}U on Au have been studied by means of CR 39 solid state nuclear detectors. Among the differeot events observed , all 3-pronged events were selected and examined. It is found that at final state the quasi totality of these events, say 87%, proceed by fission reactions. Analysis io the contex of participant-spectator model has shown evidence for two different fission processes. Fission events derived from the break-up of the participant nuclei represent 78% of the events, whereas 9% issue from the spectator. The mean kinetic energy loss is 11% of the incident energy.

"On the use of SSNTD in relativistic heavy ion Physics and study of open questions"
B. A. Abruzov, H. Barth, H. Baumbach, R. Brandt, V. S. Butsev, H. H. Cui, E. Ganssauge, B. Grabež, S. L. Guo, G. Haase, M. Heck, H. A. Khan, M. I. Krivopustov, B. A. Kulakov, E. J. Langrock, S. Manzoor, F. Pille, I. E. Qureshi, M. Rommel, M. I. Shazad
Nucl. Tracks Radiat. Meas. **19** (1991) 557.

Taking an historic perspective on the development of relativistic physics in general and relativistic heavy ion physics in particular, it can be shown that many observations were first made with nuclear emulsions and other SSNTD detectors, later confirmed with cooventional counter techniques and/ or radiochemical techniques. It is quite possible that SSNTD can make similar contributions when studying the open and controversal problems of today. In this article we consider the anomalon phenomeoon as to be one such problem.

"Application of CR-39 detector to investigation of intermediate mass fragment production in reaction $^{40}Ar+^{208}Pb$ at E/A=19.6 MeV/u"
B. Grabcž, D. L. Lazić
Nucl. Tracks Radiat. Meas. **19** (1991) 609.

The intermediate-mass fragments (IMF s) production in the interaction of ^{40}Ar +208Pb at E/A=19.6 MeV/u was investigated using CR-39 detector. Exit channels with up to three intermediate-mass fragments were observed. The correlation functions between IMF and heavy residue and between two IMF s were determined and discussed.

"Intermediate mass fragment production in interaction $^{40}Ar+^{208}Pb$ at E/A=19.6 MeV"
B. Grabcž
Phys. Rev. C **45** (1992) 5.

The intermediate mass fragment production in the interaction $^{40}Ar + ^{208}Pb$ at E/A=19.6 MeV was studied using a CR-39 plastic track detector. Exit channels with up to three intermediate mass fragmenst were observed. It seems that events having at least one intermediate mass fragment originate from central collisions. The relative velocity correlation functions were detrmined for these events and discused.

"Two-particle azimuthal correlations in light nuclei collisions at 4.2A GeV/c"
Lj. Simić, S. Backović, H. N. Agakishiev, E. N. Kladinskaya, A. P. Cheplakov
Phys. Rev. C **45** (1992) 2417.

Two-particle azimuthal correlations are studied in 4..2A GeV/c dC, αC, and CC collisions with a propane bubble chamber at JINR Dubna Synchrophasotron. It is found that the azimuthal correlations are different for various pairs of secondary particles, and that they also depend on the mass of the projectiles and on the collision centrality. The majority of the observed characteristics can be accounted for by the kinematic correlations calculated from the model of independent nucleon-nucleon collisions. The only exception is the effect of close pairing of like particles considered to be due to the identical particle effect for pion pairs and to short-range strong interactions fnr proton pairs.

"Temperature of negative pions in inelasic (d,α,C)+(C, Ta) collisions at 4.2A GeV/c"
S Backović, D. Salihagić, Lj. Simić, D. Krpić, S. Drndarević, R. R. Mekhdiyev, A. P. Cheplakov, H. N. Agakishiev, E. N. Kladnitskaya, S. Yu. Sivoklokov
Phys. Rev. C **46** (1992) 1501.

The slopes of the noninvariant center-of-mass energy spectrum of negative pions in inelastic collisinns of d, α ,C nuclei with C and Ta targets at 4.2 A GeV/c are studied. The temperatures of the negative pion are obtained using the Bnltzmann distribution. The two-temperature shape of c.m.. energy spectra is observed. The values of temperature do not depend significantly both on collision "centrality" and nn atomic weight of the projectile nuclei. The experimental results are compared with the quark-gluon string model. The influence of resonances and directly produced pions on temperature values is studied.

"The Boltzmann temperature of negative pions in inelastic (d,α,C)+(C, Ta) collisions at 4.2 A GeV/c"
S. Backović, D. Salihagić, Lj. Simić, D. Krpić, R. R. Mekhdiyev, A.P. Cheplakov, Yu. Sivoklokov
JINR Rapid Communications **53** (1992) 58.

The slopes of the noninvariant center-of mass energy spectrum of negative pions in elastic collisions of nuclei d, α ,C with C and Ta targets at 4.2 A GeV/c are studied. The temperatures of the negative pions are obtained using the Boltzmann approximation of the spectra. The two-temperature shape of c.m. energy spectra is observed. The values of temperature do not depend significantly both on collision "centrality" and on atomic weight of the projectile nuclei. The experimental results are compared with the calculations in the framework of the quark-gluon string model. The influence of resonances and directly produced pions on temperature values is studied.

"The projectile mass dependence of spectra and cross sections of π^- mezons produced at fixed angles in nucleus-nucleus interactions at 4.2A GeV/c"
G. N. Agakishiev, S. Backović, V. Boldea, S. Ditsa, I. A. Ivanovskaya, T. Kanarek, E. N. Kladnitskaya, D. Krpić, R. R. Mekhtijev, D. Salihagić, Lj. Simić, R. Togoo, G. P. Toneva, A. P. Cheplakov
Sov. J. Nucl. Phys. **55** (1992) 736.

Invariant cross sections of π^- meson produced at fixed angles as functions of their kinetic energy in dTa, αTa, and CTa interactions at 4.2A GeV/c are presented. It is shown that the shape of pion spectra at energies larger than O.1 GeV and at emission angles $\theta>20^0$ is independ on the type of projectile within an accuracy of 10%. The projectile mass dependences of π^- production cross sections at fixed angles is also investigated. At small angles the π^- production cross section determines number of interacting nucleons from projectile while at large angles this cross section determines number of interacting nucleons from target.

"Target and projectile mass dependence of spectra and cross sections of protons with energy less than 0.4 GeV at fixed angles in oucleus-nucleus interactions at 4.2 GeV/c per nucleon"
S. Backović, V. Boldea, S. Ditsa, V. N. Emelyanenko, T. Kanarek, E. N. Kladnitskaya, D. Salihagić, Lj. Simić, R. Togoo, G. P. Toneva, L. M. Shcheglova
Sov. J. Nucl. Phys. **56** (4) (1993) 211.

Spectra and cross sections of protons with kinetic energy in interval 50-400 MeV at fixed angles from 0 to 180° are investigated for (p, d,α, C)+C and (d, α, C)+Ta interactions at 4.2A GeV/c. In both interactions with carbon and tantalum target the shape of the proton spectra in the investigated energy interval and at emission angle $\theta>30^0$ does not depend on the type of the projectile The spectra are well described by the exponentials in kinetic energy. Also the shape of the proton spectra with kinetic energy from 200 to 400 MeV for wide angle interval (10-180°) is independent on target mass.

"Target and projectile mass dependence of spectra and cross sections of protons with energy larger than 0.4 GeV at fixed angles in nucleus-nucleus interactions at 4.2A GeV/c"
G. N. Agakishiev, S. Backović, R. Bekmirzaev, T. Kanarek, E. N. Kladnitskaya, M. M. Muminov, D. Salihagić, Lj. Simić, A. N. Solomin, G. P. Toneeva, L. M. Shcheglova
Sov. J. Nucl. Phys. **56** (10) (1993) 170.

Spectra and cross sections of protons with kinetic energy (T>0.4 GeV) at fixed angles from 0 to 90° for (p, d, α,C)+C and (d,α,C)+Ta interactions at 4.2A GeV/c are presented. It is shown that the shape of the proton spectra at emission angle θ>30° is independ on the type of the projectile for both interactions with carbon and tantalum target. The target and projectile mass dependence of the cross sections of the proton yield at fixed angles is also investigated. The cross sections are well described by the function of the form A_p^{α}. The values of α parametar show a strong A_p dependence for the protons emitted in the forward hemisphere in interactions with tantalum target.

"Production of fragments with A>16 in interactions of 6.3 GeV deuterons with Th, Bi, Au and Ag"
Ž. Todorović
Z. Physik A **345** (1993) 53.

Polycarbonate track detectnr Makrofol, sensitive to fragments with A>16 was used to register products of interactions of 6.3 GeV deuterons with Th, Bi, Au and Ag. Cross sections for the production of events with one, two and thre fragments have been determined and their variation as a functinn of the Z^2/A of the target analyzed. Possible mechanisms proposed and discussed. Geometric characteristics of binary events were used in order to identify those binary events which resulted from the process of fission. The results were compared with corresponding proton data.

"Light fragment production in the 3.65 A GeV $^{12}C+^{208}Pb$ reaction"
B. Grabež
Phys. Rev. C **48** (1993) 2144.

We investigated the emission of light fragments from the ^{208}Pb target induced by 3.65 A GeV ^{12}C projectiles. The events are classified according to the number of beavy fragments. Two mechanisms of the production of light fragments are observed.

"Target fragmentation in 3.65 GeV $^{12}C+^{208}Pb$ reaction"
B.Grabež
Nucl. Tracks Radiat. Meas. **22** (1993) 583.

The light fragment emission from 3.65 A GeV $^{12}C+^{208}Pb$ reaction was investigated by using CR-39 plastic track detector. It was observed that the light fragments can be produced by the two different mechanisms.

"Centrality dependence of pion and proton spectra in C+C and C+Ta interactions at 4.2 GeV/c per nucleon"
Lj. Simić, S. Backović, D. Salihagić, A. P. Cheplakov, E. N. Kladnitskaya, R. R. Mekhdiyev
Phys. Rev. C **52** (1995) 356.

Target and centrality dependence of pion and proron distributions is studied in C+C and C+Ta collisions at 4.2 GeV/c per nucleon using the 2-m propane bubble chamber. The experimental data are compared with the Monte Carlo quark-gluon string model (QGSM). The pion and proton transverse momentum spectra at midrapidity are well discribed by the twocomponent thermal model. The shape of the proton rapidity distribution strongly depends on the collision centrality and reflects the stopping power of colliding nuclei. The pion rapidity distribution is Gaussian in shape regardless of the target mass number and collision centrality. The QGSM complectly reproduces main features of pion and proton rapidity spectra as well as pion transverse momentum spectra. The model does not fully reproduce the features of the proton transverse momentum spectra.

"Production of fragments in $^{4}He+^{197}Au$ reaction at 12.7 GeV"
Ž. Todorović , S. Savović, S. Jokić
Radiat. Measurem. **25** (1995) 257.

The emission of fragments (A>16) from reaction of ^{4}He with ^{197}Au has been studied at bombarding energy of 12.7 GeV. Policarbonate Makrofol in sedndwich from was used as a detector. Fragments produced in the experiment were identified and an event by event model-free analysis was performed. The decay channels ending with one, tweo or more (three, four) fragments were detected. A classification scheme based on the multiplicity (M_H) of heavy fragments (A>40) was used in order to define multifragmentation (M_H=0), spallation (M_H=1) and fission (M_H=2) events. The various experimental features of the fragmentation process are discussed.

"Discrimination of positive particles emitted in deuterium plasma focus device using SSNTD"
Ž.Todorović, R. Antanasijević, D. Ščvić, A. Zarić, Dj. Konjević, J. Vuković, J. Purić, M. Ćuk.
Radiat. Measur. **25** (1995) 265.

The yields of different positive particles emitted in deutherium plasma focus device were measured . The alpha particles, among the other particles , were detected. CR-39 and LR-115 (Kodak) SSNTD were used.

CONFERENCES: Invited lectures, progress reports and contributions

"Application at Fokker-Planck equation to system U+Ag at 15 MeV/n with 4 and 5 fragments in exit channel"
S. Jokić, S. Savović, Ž. Todorović, M. Zamani, D. Samsonides
1st General Conference at the Balkan Physical Union, Thesaloniki, Greece (1991) 207.

"Correlation of three fragment process with impact parameter in U+Ag at 15 MeV/n"
M. Debeauvais, J. C. Adloff, J. Ralarosy, S. Jokić, S. Savović, Ž. Todorović, M. Zamani, F. Fernandez
7 Adriatic International Conference on Nuclear Physics, Brioni, Croatia (1991) 41.

"Primena Foker-Planck jednačine na sistem (15 MeV/n) U+Ag sa 5-fragmenata u izlaznom kanalu reakcije"
S. Savović, S. Jokić, Ž. Todorović
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 12 (1991) 87.

"Calculation of the drift and diffusion coefficients of the Fokker-Planck equation for the system" (15 MeV/n)U+Ag"
S. Jokić, S. Savović, Ž. Todorović
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 13 (1992) 35.

"The Treetment of (15 MeV/u)U+Ag Reaction by Fokker-Planck equation"
S. Savović, S. Jokić, Ž. Todorović, M. Debeauvais, J. Ralarosy, F. Fernandez
2nd International Conference on Dynamical Aspect of Nuclear Fission, Smolence, Slovakia (1993) 281.

"Multifragment emission in the reaction of U on Ag at 15 MeV/u"
S. Savović, S. Jokić, Ž. Todorović, M. Zamani, D. Samsonides, M. Debeauvais, J. Ralarosy, F. Fernandez
9th EPS Conference, Firence, Italy (1993) 138.

"Uticaj različitih zidnih primena na smanjenje radoaa u zgradama"
D. Miočinović, Ž. Todorović
Kongres fizičara Srbije, Beograd (1994) 337.

"Detekcija nuklearnih reakcija u deuterijumskom plazma fokusu"
R. Antanasijević, A. Zarić, D. Šević, Ž. Todorović, Đ. Konjević, Z. Marić, J. P. Vigier
9. Kongres fizičara SRJ, Petrovac na moru (1995) 469.

"Studija spalacionih mehanizama u reakciji Ne+Al na energiji 8.5 MeV/n"
M. Radivojević, B. Grabež
9. Kongres fizičara SRJ, Petrovac na moru (1995) 561.

"Analiza mogućeg dogadjaja na energiji Z^0 pola"
J. Krstić, V. Damjanović
9. Kongres fizičara SRJ, Petrovac na moru (1995) 521.

"Raspodela po rapiditetu sekundarnih čestica u jezgro-jezgro interakcijama na energijama 4.2 GeV/c po nukleonu i relativistička hidrodinamika"
M. Kornicer, Lj. Simić
9. Kongres fizičara SRJ, Petrovac na moru (1995) 509.

"Povećana produkcija piona sa malim transverzalnim impulsima u jezgro-jezgro interakcijama na 4.2 A GeV/c"
Lj. Simić, I. Mendaš, S. Backović
9.Kongres fizičara SRJ, Petrovac na moru (1995).

"Produkcija dogadjaja sa tri fragmenata u interakcijama He+Au na 12.7 GeV"
Ž. Todorović, S. Savović, S. Jokić
9. Kongres fizičara SRJ, Petrovac na moru (1995) 537.

"Izračunavanje očekivanog broja Higs dogadjaja na energiji Z^0 pola"
J. Krstić, V. Damjanović
9. Kongres fizičara SRJ, Petrovac na moru (1995).

"Fragment correlations in He+Au reaction at 12.7 GeV"
Ž. Todorović, S. Savović, S. Jokić
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 17 (1995) 163.

"Primena Foker-Planck jednačine na sistem (15 MeV/n) U+Ag sa 5-fragmenata u izlaznom kanalu reakcije"
S. Savović, S. Jokić, Ž. Todorović
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 12 (1991) 87.

"Calculation of the drift and diffusion coefficients of the Fokker-Planck equation for the system" (15 MeV/n)U+Ag"
S. Jokić, S. Savović, Ž. Todorović
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 13 (1992) 35.

"Fragment correlations in He+Au reaction at 12.7 GeV"
Ž. Todorović, S. Savović, S. Jokić
Zbornik radova Prirodno-matematičkog fakulteta u Kragujevcu, 17 (1995) 163.

THESES: Ph.D. and M.S.

"Etude et mise au point d'un nouveau principe de calorimetre employant des fibres optiques en quartz"
D. L. Lazić
Universite Louis Pasteur de Strasbourg, 1993. (Ph.D. thesis)

П 1805: ЗАШТИТА АТМОСФЕРЕ

P1805: PROTECTION OF THE ATMOSPHERE

PUBLICATIONS: Books, Monographs and Articles

"Air-pollution problems in Yugoslavia"
Z. B. Vukmirović
in: *Coping with crisis in Eastern Europe's Environment*, Chap. **18**, ed. J. Alcamo, IIASA, Parthenon Publishing Group, Carnforth-England (1992) 287.

This Chapter was written before the Civil War in Yugoslavia in 1991. Despite changes since then the article contains valuable information about this part of the world. Data on ambient air quality and effects on the biosphere have to be evaluated to assess the correct strategy for solving air-pollution problems in Yugoslavia. Priority areas for air-pollution control are heavily populated and industrial areas; areas of special interest to the national economy (cultural, scientific, administrative, and commercial centers); national parks; forested and agricultural areas; and clean water reservoirs and fish ponds.

"An application of multiregression model for evaluation of precipitation chemistry"
S. Rajšić and Z. B. Vukmirović
Idojaras **97** (1993) 163.

Using the five-year data sets for stations from EMEP network of the former Yugoslavia, the multiregression model is successfully applied for evaluation of basic relations relevant for precipitation chemistry. Such type of supervising pollutant transmission in the lower troposphere is appropriate for national monitoring and should be recommended to non-developed countries. A meritorious estimate of exported and imported amounts of pollutants, as well as regional and local contributions, could be established in the episodes with precipitation by applications of the proposed multiregression model with stepwise variable selection.

"Analysis of trace metals in "clean" air"
Z. B. Vukmirović, D. A. Marković, D. S. Veselinović i D. M. Marković
J. Serb. Chem. Soc. **58** (1993) 843.

Since September 1989, a "clean room" was put into operation in the Institute of Physics in order to follow the long-range transport of trace metals in the atmosphere. In accordance with the requirements of work in the "clean room", the differential pulse stripping voltammetry method seemed to be favorable for trace-metal analysis. Providing the detection limits of 0.5 ng ml^{-1} for Cu, 1.0 ng ml^{-1} for Pb, 2.0 ng ml^{-1} for Zn and 0.1 ng ml^{-1} for Cd, and physical parameters of sampling accommodated with the sensitivity threshold, the quality of "clean" air monitoring was assured. As illustrations, the results of measurements of Pb, Cu, Zn and Cd concentrations in the air on Kopaonik Mountain (el. 2017 m) in Serbia are presented. The results indicate that the Lead and Zinc Refinery in Trepca is a major pollutant source producing a plume from a 312 m stack, which effects the slopes on the south-southwest and upper regions of Kopaonik. The levels of concentration found are discussed frnm the aspect of special protection for national parks.

"Effects of ozone on the photosynthetic apparatus and leaf proteins during leaf development in wheat"

G.Y. Nie, M. Tomašević and N. R. Baker

Plant, Cell and Environment **16** (1993) 643.

Leaves of *Triticum aestivum* cv. Avalon were grown in an atmosphere that contained 150 nmole mol^{-1} ozone for 7h each day. After leaves had reached maximum size, the leaf blade was divided into three sections to provide tissue of different age, the youngest at the base of the blade and the oldest at the leaf tip. The ozone treatment was found to decrease significantly the light-saturated rate and quantum yield of CO_2 assimilation and the maximum quantum yield of photosystem II photochemistry in the oldest leaf section. No effects were found on the basal and middle sections of the leaf. These ozone-induced decreases in the photosynthetic parameters were associated with decreases in the efficiency of utilization of light for CO_2 assimilation at the photon flux density under which the leaves were grown. The depression in photosynthetic performance of tissue near the leaf tip was accompanied by large decreases in the contents of total, soluble and thylakoid proteins and chlorophyll. There was also fouod to be a preferential loss of ribulose-1,5-carboxylase-oxygenase. These ozone-induced changes in chlorophyll and protein contents and the photosynthetic activities of the leaf tissue were similar to changes normally associated with leaf scenescence. Two-dimensional polyacrilamide gel analyses of leaf proteins demonstrated the loss of some minor, and unindentified, proteins, whilst another group of minor proteins appeared. It is concluded that daily exposure of the leaf to 150 nmol mol^{-1} ozone for 7h had no effect on the development of the photosynthetic apparatus and its activities during leaf expansion , but it did promote the onset of premature scenescence in fully expanded tissue that resulted io a loss of pigments , proteios and photosynthetic capacity and efficiency.

"Procedure for calculations of missing values in many-year measurements of microconstituents in precipitations"

S. Rajšić, Lj. Rajšić, Z. B. Vukmirović

J. Serb. Chem. Soc. **59** (1994) 399.

To calculate the missing values io multy-year data set or generally for a data base of more dependent variable measurements, an original iterative method was used in order to improve data bases for further statistical analysis.

"Dry deposition of trace metals in Serbia: a contribution to the methodology of measurement"

J. Marendić-Miljković, S. Rajšić and Z. B. Vukmirović

Idojaras **98** (1994) 179.

An automatic wet/dry precipitation collector for trace metal deposition monitoring in rural and remote areas is constructed in the Institute of Physics, Belgrade. The aim is to simulate dry depositioo to natural surfaces in order to estimate the impact of the atmospheric deposition on plants, mainly forests and crops. Dry deposition collector includes polyethylene holder, with two polycarbonate Petri dishes fixed upward and one downward-facing. This design allows both downward and upward fluxes to be measured. A timer for recording the dry period duratioo is also built in. The dry deposition collector was tested in clean air of the Kopaonik mountain, Serbia, in two 5-day episodes (June and November 1991), and in Belgrade (November 1992 through October 1993). In the experimeot at Kopaonik (site height 1225 m amsl, 40 km downwind from the source), 24-hour mean fluxes were in the range of 0.02-2.44 ng m^{-2} s^{-1} for Pb, 0.02-3.5 ng m^{-2} s^{-1} for Cu, and 0.02-5.19 ng m^{-2} s^{-1} for Zn. Fluxes were very inhomogeneous: C_v (coefficient of variation of the mean) was: 0.4-1.2. Ratio of the upward to downward flux, F_R was in the wide range from 0.01 to 16, more than 40% of values being 1.0. At a suburban Belgrade site, 7-day mean fluxes were measured. Average (n=38) downward fluxes were 0.40 (0.20) ng m^{-2} s^{-1} for

Pb, 0.19 (0.14) for Cu, and 0.36 (0.23) ng m^{-2} s^{-1} for Zn (standard deviation in parenthesis). Fluxes were homogeneous,was 0.10-0.14. F_R was found to be 0.18-0.22. With a new-designed dry deposition collector an improvement in correspondence between dry deposition sampling and atmospheric processes is achieved.

"Resuspension of trace metals in Belgrade under conditions of drastically reduced emission levels"
Z. B. Vukmirović, J. Marendić-Miljković, S. Rajšić, M. Tasić and V. Novaković
Water, Air and Soil Pollution (1995).

Deposition rates of trace metals (Pb, Cu, Zn, Cd) were determined at the Meteorological Station in New Belgrade (H_s= 74 m; φ = 44°49' N and λ = 20°24' E) in the hydrological year 1992/93 (1 November - 31 October). The dominant characteristics of the observation period were strong drought and drastically reduced pollutant emissions. Traffic and local sources operated at 0-10% of their capacities. Samples of dry and wet precipitation were taken by an automatic collector at a height of 2 m at weekly intervals. Two petri polycarbonate dishes of 93.5 mm diameter, facing upward, and one, facing downward, were used for dry precipitation sampling. Determination in a "clean room" by differential puls stripping voltammetry provided the low detection thresholds of 0.1, t.0, 0.5 and 2.0 ng/ml, i.e. the measurement of minimal dry deposition rates of 0.02, 0.2, 0.1 and 0.4 μg $m^{-2}d^{-1}$ for Cd, Pb, Cu and Zn, respectively. The mean annual deposition rates, expressed in μg $m^{-2}d^{-1}$, were found to be as follows: 4.5 (down), 26 (up) and 37 (wet) for Pb, 2.1 (down), 13 (up) and 36 (wet) for Cu, and 3.1 (down), 26 (up) and 95 (wet) for Zn. No values above 0.2 μg $m^{-2}d^{-1}$ were found for the Cd dry deposition rate and no Cd concentration higher than 1 ng/ml for precipitation with an amount > 0.5 mm at the weekly interval was detected. Using the XREDS method with a scanning electron microscope, Si, Al, Fe matrix elements and Mg, Ca, S, K, P, Cu, Zn, W were identified as minor constituents of the siogle spherical particles and of the agglomerates present. Pb could not be categorized as a minor constituent of the coarse particles suspended in the air of New Belgrade on the basis of the previous analysis. Analysis of meteorological data showed road dust transport by outgoing SE-ESE wind from the old city of Belgrade (H_s = 100-250 m) as a possible Pb source at the chosen site, which was located in a park. A comparative measurement of Pb deposition on linden leaves was carried out in the vegetation period (1 April - 31 October) of 1993 and 1994 . The Pb distribution on leaves differed in the two growing seasons, while the sum of Pb depositinn rates on the downward and upward oriented petri dishes remained practically equal. The Pb accumulation on linden leaves was higher in 1994, first because of an intensive soil supply by rain water. Besides, "yellow" raio was reported during the night 15/16 April, on 16 and 17 April 1994. A Fe concentration of 2.3 μg/ml and a Pb concentration of 312 ng /ml with a total precipitation nf 12.6 mm were found in the weekly wet sample of 13-20 April. Dry deposition rates of 17 and 84 μg $m^{-2}d^{-1}$ for Cd and Pb, respectively, were measured on the upward facing dishes two weeks later (27 April- 4 May) . The synoptic analysis confirmed the development of the Saharan cyclogenesis and its influence on the Balkan peninsula in the period of 14 to 17 April 1994. In this region the impact of dustfall originating from the Saharan storm was evident either during wet deposition or through resuspension processes.

CONFERENCES: Invited lectures, progress reports and contributions

"Influence of lead on some physiological characteristics of bean and barley"
M. Tomašević, M. Bogdanović and D. Stojanović
Periodicum Biologorum **93** (2) (1991), 337.

"Elektrohemijski sistem za kontinualno merenje pH i provodljivosti atmosferske vode"
D. Veselinović, Z. B. Vukmirović, D. Marković, N. Vukelić, D. Miočinović, Lj. Ignjatović
XII Jugoslovenski simpozij o elektrohemiji, Igman, Knjiga radova (1991) 183. (in Serbian)

"Mogućnost registrovanja intruzije stratosferskog ozona u prizemnom sloju"
D. Marković, D. Veselinović, Z. B. Vukmirović, D. Vukmirović
XXXIII Savetovanje Srpskog hemijskog društva, Novi Sad, Izvodi radova (1991) 227. (in Serbian)

"Pregled najnovijih istraživanja depozicije oblačne vode"
J. Marendić-Miljković i Z. B. Vukmirović
Zaštita Atmosfere **19** (1991) 68.

"Suva atmosferska depozicija tragova metala na Kopaoniku"
J. Marendić-Miljković, Z. B. Vukmirović
I Savetovanje Društva fizikohemičara Srbije "Fizička hemija 92", Izvodi radova (1992) 298. (in Serbian)

"Procena depozicije olova iz atmosfere u oblasti Kopaonika"
Z. B. Vukmirović
I Savetovanje Društva fizikohemičara Srbije "Fizička hemija '92", Izvodi radova (1992) 300. (in Serbian)

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