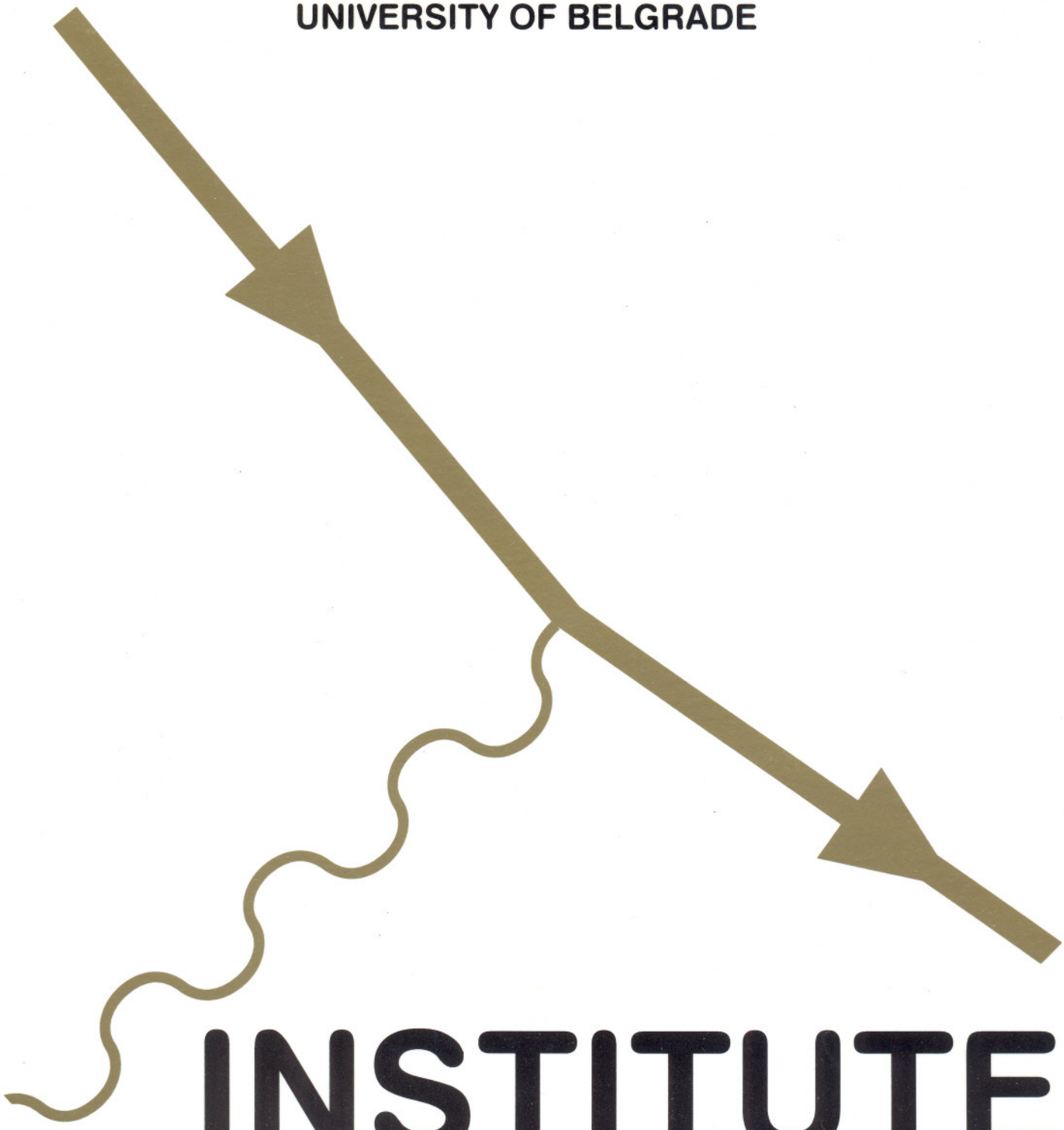
UNIVERSITY OF BELGRADE



INSTITUTE OF PHYSICS

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Institute of Physics

The Institute of Physics in Belgrade celebrates its thirty-fifth anniversary in May 1996. It was co-founded in 1961 by the University of Belgrade and the Government of Serbia.

The IP was created with the following principle objectives in mind:

- To provide facilities for the conducting of original research to its faculty, associates and visitors.
- To help in fostering the growth of advanced studies in and related to physics.
- To provide a forum for scientific contacts between physical scientists from Serbia and their colleagues around the world.
- To form the nucleus of an advanced graduate program in physics, and to work with the Department of Physics of the University of Belgrade in creating a top level physics graduate curriculum.
- To develop applied areas of physics and assist in the development of related technologies.

From a handful of young scientists occupying a couple of offices near the Department of Physics, the Institute has grown and evolved. In 1961 the above goals seemed very far away - now they are a reality. Today the Institute of Physics represents one of the premier research institutions in the region. The IP has a permanent faculty of more than 60 research scientists organized into five centers. At a given time more than 60 graduate students are working at the IP towards their Ph.D.'s. In addition, through its Center for Advanced Studies the Institute intends to attract postdocs and visiting scientists from around the world, and organizes international conferences, summer schools and workshops. The Institute is also host to several small high-tech companies whose products represent a serendipitous result of the research activities in various

fields of fundamental and applied physics conducted at the IP.

The principle activities of the Institute of Physics are oriented towards scientific research in theoretical and experimental physics. Theoretical investigations in quantum field theory, gravitation and into the fundamental and methodological problems of quantum mechanics have a long and successful history here. At the same time there have been important strides in understanding the physics of condensed matter systems, as well as in the development of theoretical atomic and molecular physics. Plasma

Institute of Physics

physics as well as the study of non-linear dynamics have also generated much interest and are being pursued by researchers here both from the theoretical and experimental sides. Significant results have been obtained in the field of laser physics. There is a varied and extensive research program in nuclear physics, as well as in high energy physics. Active areas of research are in the study of gaseous discharges, and in atomic and molecular spectroscopy. The work going on in applied physics forms a natural complement and extension to the above mentioned fundamental research. Of note are results of the Institute's faculty in environmental protection, in designing a wide range of sensing equipment, as well as in the development and manufacture of microwave and light sources.

The Institute maintains strong ties with many similar institutions world wide. This international co-operation includes advanced training of longer and shorter duration, study grants, participation in various international conferences and workshops, joint organization of international summer schools and workshops and joint research programs.

The principle institutions that have a long standing interaction with the Institute of Physics include the International Center for Theoretical Physics (ICTP) in Trieste, the Joint Institute for Nuclear Research in Dubna, and the European Center for Nuclear Research (CERN) in Geneva. There has been a long-standing and particularly fruitful collaboration with France through its National Center for Scientific Research (CNRS), as well as directly through a host of its physics institutions. Apart from active relations with many top universities in the US, the Institute has taken part in important joint projects with the National Institute of Standards and Technology (NIST), and the National Scientific Foundation (NSF) in Washington DC.

Dragan S. Popović

July 1983 was an important date in the history of the Institute of Physics. It was then decided to move the IP to a new location in Belgrade's quite Zemun suburb. The beautiful new location on the Danube river was an ideal one for a large campus. Everything else about the move was less than ideal: the building (an old factory bombed out in World War II) lacked a roof, there were problems getting telephone lines to the site, the University of Belgrade libraries were far away... Still, there was something about the new location that instilled a dream to make it the location for a joint campus for mathematical and physical sciences. One by one, the practical problems were solved in the next few years. After a while the Institute library became the largest repository of physics books and journals in the country.

Recently (November 1994) the IP has acquired title to the land and buildings of its campus. This has made it possible to conduct extensive expansions and renovations. An addition to the main building is scheduled for 1997. In the near future there are plans for a new building for the Center for Advanced Studies, with living accommodations for a larger number of visitors from abroad. These are necessary expansions for CAS to grow into a strong regional center.

These expansions will also make it possible to attract several other related institutions to migrate from their locations all over Belgrade to our Zemun campus. The dream that the Institute campus will in time evolve into a central location for many mathematical and physical institutions is still very much alive.

The thirty-fifth anniversary is a time to look back proudly at the achievements of the past. However, for all these successes we at the Institute of Physics see many more important tasks in front of us. The further integration into the international community of physics institutions is of paramount importance. The fears initially voiced that this interaction would lead to a brain-drain have been shown to be unfounded. Rather than causing the degradation in the quality of research conducted, the greater mobility of our researchers has led to an increase in the free exchange of ideas, and so to an increase in the output and quality of work done at the IP.

It is our belief that Serbia and the south-east region of Europe have a lot to offer the global physics community. The countries of the region have a long

standing tradition of excellence in the physical sciences and in mathematics. The central reason for optimism when speaking of the future of physics in this region is the continued exceptional quality of students that embark on a career in physics.

This brochure was written with two motivations in mind. The obvious one is to serve as a basic source of information to potential graduate students, postdocs and visitors to the research activities conducted by the faculty. The second motivation is just as important - we want to set explicit tasks in front of ourselves with the ultimate wish that, by so doing, we may better the quality of research coming out of the Institute of Physics. With this in mind for the future we set the following important goals:

- The Institute of Physics puts the pursuit of excellence as its first and foremost goal.
- To do this the IP must be an institution open to all. The only valid criteria must be the importance of the individuals contribution to physics.
- The IP must be oriented towards the world scientific community, an institution striving to broaden its niche as an important regional center in southeast Europe.

There is a general feeling of optimism present at the Institute, a vision that we will be able to turn our expectations into reality. This is the task we set before us.

Dragan S. Popović
Director, Institute of Physics

Center for Theoretical Physics

Djordje Šijački

The Center for Theoretical Physics (CTP) is the single largest division of the Institute of Physics, consisting of about half of the permanent faculty of the IP. Research conducted at the center covers a wide range of topics in modern theoretical physics. Currently the members of the CTP are acting as thesis advisers for 14 graduate students working towards their Ph.D.'s.

The research interests of the members of the group for *Classical and Quantum Mechanics* include: quantization of non-relativistic and relativistic systems, investigation of the relation between dynamics and geometry, constraint dynamics, the phase space formulation of QM, and nonorthogonal measures. In addition there is work going on on the magnetic top as a classical model of spin, classical and quantum chaos, adelic QM, the stochastic interpretation of QM, as well as on compatible statistical interpretations of quantum interference and the problem of completeness of QM. Some members of the group are also interested in the mechanism of nuclear reactions at medium energies, the study of dynamic and geometric phases, as well as the problem of decoherence.

The *Particles and Field Theory* group focuses its research on the investigation of various aspects of quantum field theory and gravity. The general topics that bind together the work of the members of the group are string theory, gravitational models in 2D and their relationship to strings, as well as the investigation of gravity as a gauge theory. Much work has been done on the BRST quantization of reducible gauge theories, general structure and the construction of anomalies, canonical quantization of gravity, investigation of problems of defining the path integral measure, as well as on the Hamiltonian analysis of the asymptotic structure of space-time and its relation to conservation laws. From the gravity side research focuses on the investigation of black holes and on Kaluza-Klein theories. There is also an ongoing effort to develop better QCD approximations, and in particular to understand the geometric properties of the confining phase. Related to this are investigations of the gravity-like structure of Yang-Mills theories, as well as the dynamical symmetries of hadrons and nuclei. A recent interest is finite temperature QFT, and its application to cosmology.

The main research interests of the *Condensed Matter Theory* group include different magnetic and transport properties of type II high- T_C superconductors, the internal distribution, relaxation and intrinsic pinning of magnetic flux in layered structures and the interaction between the crystal lattice and vortex lattice due to the magneto-elastic effects, as well as phase diagrams in heterogeneous structures and Josephson phenomena in high-T_C. Ongoing investigations focus on quantum liquids and quantum fluids from the microscopical point of view, on the equation of state of ^{2}D ^{4}He liquid and crystal using variational Monte Carlo methods, as well as on ^{4}He droplets and impurity surface states in He liquids. Recently much work has been done on variational calculations of ground state properties of nuclear systems, and in particular Bose condensation in magnetic traps.

Research activities of the group for *Theoretical Atomic and Molecular Physics* include the study of the semi-classical theory of two-electron atoms, with emphasis on nonlinear dynamics. Work is being done on atomic systems in external fields and on the correspondence between classical and quantum mechanics for highly excited atomic systems. A topic that is extensively being looked into is the study of classical chaotic systems and their quantization. Investigations also focus on quantum mechanical descriptions of the properties of non-classical (coherent, displaced number, and squeezed) states of the harmonic oscillator. Further topics of interest are fractals in Hamiltonian systems and their applications to typical atomic and non atomic systems, near-threshold collision processes, the theory of slow ion-atomic collisions as well as the study of elastic and inelastic collisions of fast electrons by atomic hydrogen and helium in strong laser fields. Work is also being done on many-electron correlations in atomic systems and their influence on photoexcitation, photoionization, and photodetachment.

The group for *Nonlinear Optics and Plasma Dynamics* investigates laser wave mixing processes in different

active and passive media as well as the dynamics of different optical circuits involving such processes - the two-wave and four-wave mixing processes in photorefractive (PR) crystals and the ring circuits built from such elements. The group is conducting fundamental investigations of the PR effects and instabilities. Also being studied are the strong turbulence of drift and shear-Alfven waves in the realistic geometry of tokamaks (inhomogeneities, curvature, impurities), as well as the self-organization and generation of coherent structures, and their role in anomalous transport. A further topic of recent interest is the study of nonlinear effects in the gravitation instability of interstellar gas clouds and in various Solar phenomena.

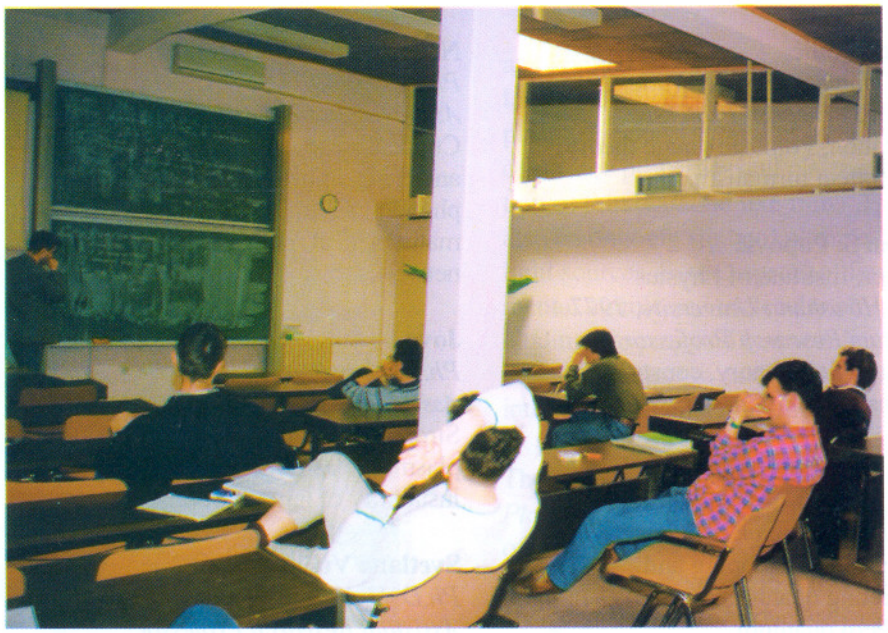
Ljiljana Dobrosavljević-Grujić

Permanent Faculty:

Najdan Aleksić
Ph.D. University of Belgrade, 1991
Assistant Research Professor
Nonlinear electromagnetic surface and guided waves in solids, nonlinear waves in fusion plasmas.

Aleksandar Belić
Ph.D. U. of Illinois at Urbana, 1991
Assistant Research Professor
Microscopic *ab initio* calculations of properties of strongly correlated quantum many-body systems.

Milivoj Belić
Ph.D. CUNY, 1980
Associate Research Professor
Nonlinear optics, nonlinear dynamics, condensed matter physics.



Theory Seminar

Milutin Blagojević
Ph.D. University of Belgrade, 1975
Research Professor
Gauge theory of gravity, Hamiltonian dynamics, BRST quantization.

Aleksandar R. Bogojević
Ph.D. Brown University, 1989
Assistant Research Professor
Quantum field theory, strings, quantum gravity and cosmology.

Vladimir Čadež
Ph.D. University of Belgrade, 1974
Assistant Research Professor
MHD processes in nonuniform plasmas with applications to phenomena in the solar corona.

Ljiljana Dobrosavljević-Grujić
Ph.D. Univ. Paris-Sud, Orsay, 1971
Research Professor
Theory of superconductivity: flux-lines structures, proximity effect, pinning and current transport.

Branko Dragović
Ph.D. University of Belgrade, 1977
Research Professor
Application of *p*-adic numbers and adels in theoretical and mathematical physics.

Tasko P. Grozdanov
Ph.D. University of Belgrade, 1981
Research Professor
Highly excited atoms and molecules in external fields, semiclassical quantization of classically nonintegrable and chaotic systems, slow ion-atom collisions.

Petar Grujić
Ph.D. Univ. College, London, 1972
Research Professor
Theory of atomic structure and processes, history and epistemology of science.

Dušan Jovanović
Ph.D. University of Belgrade, 1984
Associate Research Professor
Nonlinear theory of magnetically confined plasmas: strong turbulence, self-organization, anomalous transport.

Zvonko Marić
Chairman, Institute of Physics Board Member, Serbian Academy of Arts and Sciences
Ph.D. University of Belgrade, 1960
Research Professor
Fundamental and methodological problems in physics, elementary particles, nuclear physics, history and philosophy of physics.

Istok Mendaš
Ph.D. Queens Univ. of Belfast, 1976
Associate Research Professor
Oscillator quantum mechanics: geometric phase, number-phase uncertainty relation.

Aleksandar Miković
Ph.D. University of Maryland, 1990
Associate Research Professor
Quantum field theory, black holes, quantum gravity, string theory.

Center for Theoretical Physics

Ignjat Nikolić
Ph.D. University of Belgrade, 1983
Assistant Research Professor
Gravitation, Poincare gauge theory, Hamiltonian formalism.

Dragan S. Popović
Director, Institute of Physics
Ph.D. Hiroshima University, 1977
Associate Research Professor
Quantum field theory, constrained systems, gravitation.

Mirjana Popović-Božić
Ph.D. University of Belgrade, 1976
Research Professor
Problems in developing and interpreting quantum mechanics in light of modern quantum interferometry, spin models.

Vojislav Radojević
Ph.D. University of Belgrade, 1965
Research Professor
Theoretical and numerical calculations of the structure of atomic systems and processes.

Milun Raković
Ph.D. University of Belgrade, 1990
Assistant Research Professor
Classical, semi-classical and quantum treatment of highly excited atomic systems, quantization of integrable and chaotic systems.

Branislav Sazdović
Ph.D. University of Belgrade, 1982
Associate Research Professor
Quantum field theory, strings, BRST quantization, anomalies, SUSY.

Nenad Simonović
Ph.D. University of Belgrade, 1993
Assistant Research Professor
Semiclassical theory of two-electron systems, three-body fragmentation processes near the threshold.

Djordje Šijački
Director, Center for Theoretical Physics
Ph.D. Duke University, 1974
Research Professor
(Super) symmetries, QCD approximations, gauge theories of gravity, world spinors

Nenad Švrakić
Ph.D. U. of Illinois at Urbana, 1979
Associate Research Professor
Condensed matter, phase transitions and critical phenomena, cooperative phenomena, irreversible kinematics, mathematical models in biology, neural networks.

Jovo Vranješ
Ph.D. University of Belgrade, 1993
Assistant Research Professor
Strongly nonlinear processes in fusion plasmas, plasma self-organization, instability of large astrophysical clouds.

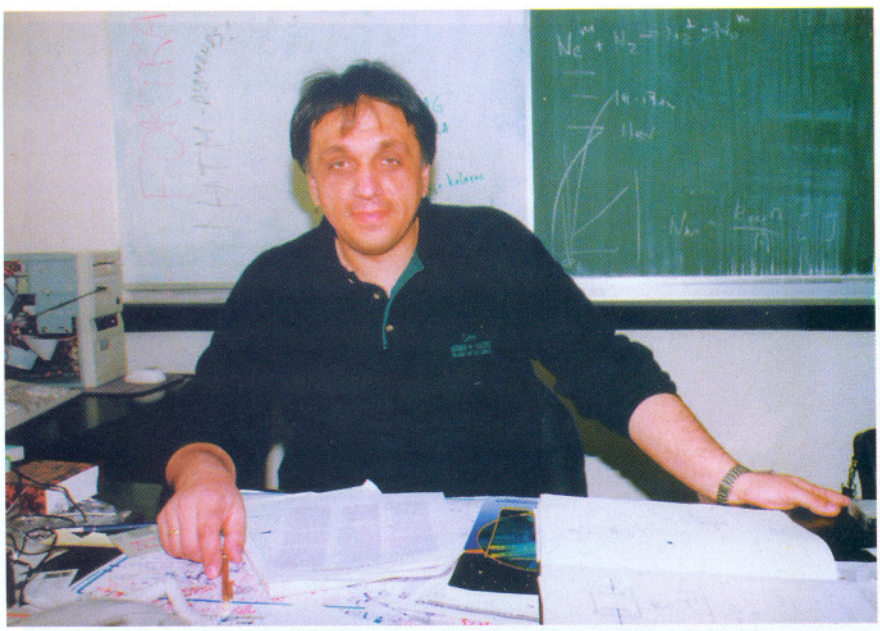
Svetlana Vučić
Ph.D. University of Belgrade, 1988
Assistant Research Professor
Electron-atom collisions, collisions in a strong laser field.

Slobodan Vuković
Ph.D. University of Belgrade, 1974
Research Professor
Plasma turbulence, soliton propagation, nonlinear phenomena, optical fibers.

Milutin Blagojević

Zvonko Marić

Center for Experimental Physics



Zoran Petrović

The main objective of the Center for Experimental Physics is to apply experimental techniques and models to the study of fundamental processes in physics, chemical physics and atmospheric physics and chemistry. In addition the CEP is host to a number of applied physics projects.

The central activity of the *Laboratory for Multidisciplinary Research* is the study of high pressure effects on the optical features of lasers and of various materials. Other activities include the investigation of the effects of external influences such as electric fields, high pressure, nicotine and stress on light absorption of plants. The experimental techniques utilized include optical emission spectroscopy, photo-acoustic spectroscopy, systems for the generation of high pressure.

The *Laboratory for Atomic, Molecular and Laser Spectroscopy* is involved in the investigation of multi-photon processes in SF_6 molecules induced by CO_2 lasers in the presence of buffer gases. Excitation and relaxation processes under the effect of typical buffers such as Ar atoms and CH_4 and N_2 molecules are being investigated with the purpose of determining optimal multi-photon absorption processes for SF_6. Experimental techniques include laser absorption and photo-acoustic spectroscopy.

The *Gaseous Electronics Laboratory* investigates the physics of electron and ion swarms. Measurements are made of excitation and transport coefficients and of distribution functions. The work on swarms includes the development of momentum transfer theory for swarm transport in mixtures of reaction gases, as well as Monte Carlo simulations for non-equilibrium and non-local transport in DC ad RF fields. The experimental data is used in conjunction with numerical techniques to solve Boltzmann equations and to determine electron scattering cross sections. Experimental techniques include spatially resolved emission spectroscopy and particle energy analysis. Basic properties of gas discharges such as volt-ampere characteristics, constrictions, oscillations, self organization and excitation kinetics are studied by applying field measurements, optical emission spectroscopy, mass and energy analysis and laser absorption and scattering. These techniques are applied to low current Townsend regime discharges, normal glow discharges, capacitively and inductively coupled RF discharges, microwave discharges and pseudo sparks. Some aspects of plasma chemistry and surface reactions are also studied. Plasma processing is studied both from fundamental and applied points of view. In particular: this includes plasma etching, plasma cleaning as well as modification of surface properties and plasma deposition of thin diamond like films. There is also an ongoing study of plasmas for light sources. Some aspects of fundamental atomic and molecular physics including trapping and laser cooling of ions and atoms are studied through an international collaboration.

The main activity of the *Laboratory for Plasma Spectroscopy* is the investigation of basic processes that influence the excitation of trace elements in different discharge sources (arcs, inductively coupled argon plasma) with the purpose of decreasing the detection boundary and increasing precision. In addition new methods in analytical spectroscopy are being developed and applied in the determination of various elements in different bases. Modeling of processes in spectroscopic plasma sources supplements the experiments that are mostly based on high resolution emission spectroscopy.

The *Laboratory for Plasma Physics* studies the kinetic and optical properties of low temperature plasma. A central place in the work is the development of quantum mechanical and semi-classical methods for determining the kinetic coefficients of fully ionized plasmas in external fields. Also studied are the effects of electrostatic screening on the emission and absorption spectra of non-ideal plasmas. There is an ongoing study of a group of collision processes that play an important role in low temperature laboratory and astrophysical plasmas. This includes radiation and ionization recombination processes in ion-atom and electron-ion-atom collisions.

The *Atmospheric Physics Laboratory* studies high current electric discharges and the processes generated in them, as well as the optical and electrical characteristics of the plasmas created in these discharges. The laboratory also studies

pollution sources as well as the transport of pollutants. Another field of interest centers on luminescence technologies including sources, methods of measurement and specific devices.

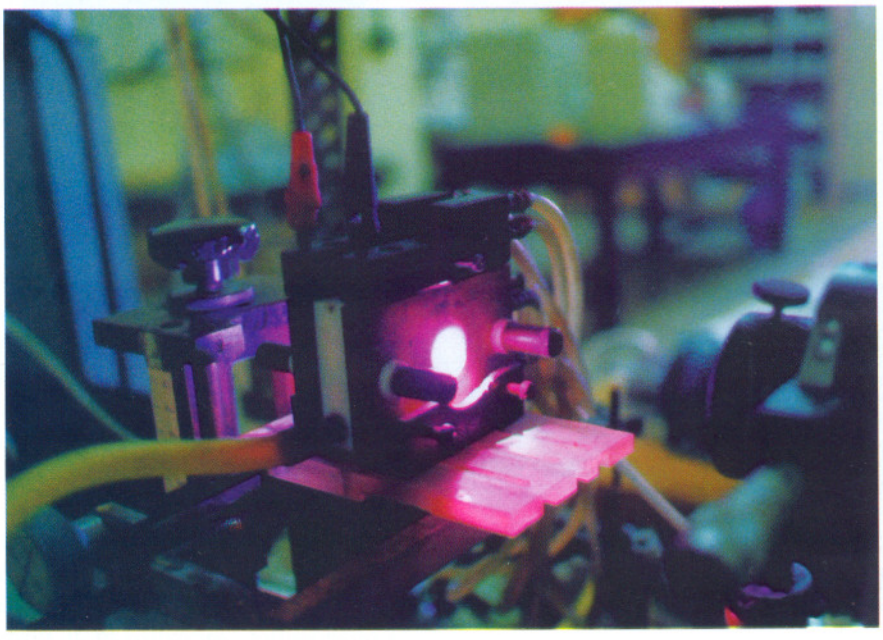
The *Environmental Protection Laboratory* develops special devices and methods for the detection of pollutants in ambient air. Transport and transformation processes of micro constituents and pollutants in the lower troposphere are investigated. The development of physical methods of aerosol characterization is continuously carried out with the aid of a pure room (pureness of 100) and the corresponding diagnostic techniques. All these activities lead to the preparation of a systematic study of the processes of exchange of microconstituents and pollutants in the atmosphere and biosphere. The project is a part of an international effort to monitor air pollution in Europe. A further project is to develop methods for the detection of toxic, explosive and polluting gases.

Currently 17 Ph.D. students are working with members of the CEP faculty.

Permanent Faculty:

Dragutin Djordjević
Ph.D. University of Belgrade, 1992
Assistant Research Professor
Plasma physics, optical properties of low temperature plasma, general optics, optoelectronics.

Marko Popović



Zoran Djurić
Ph.D. University of Belgrade, 1996
Assistant Research Professor
Non-ideal plasma and its properties, atomic and transport processes in low temperature plasma.

Branislav Jelenković
Ph.D. University of Belgrade, 1983
Research Professor
Physics of ionized gases, atomic and molecular physics.

Branislav Jovanović
Ph.D. University of Belgrade, 1991
Associate Research Professor
Effects of high pressure on optical properties of materials.

Jelena Jovanović-Kurepa
Ph.D. University of Belgrade, 1972
Associate Research Professor
Laser spectroscopy and its methods, multiphoton processes in polyatomic molecules.

Dragan Marković
Ph.D. University of Belgrade, 1995
Assistant Research Professor
Electrochemistry, electroorganic chemistry, mechanisms of anodic oxidation processes of some phenolic compounds.

Anatolij Mihajlov
Ph.D. University of Belgrade, 1981
Research Professor
Non-ideal plasma and its properties, atomic and transport processes. in low temperature plasma.

Slobodan Ničković
Ph.D. University of Belgrade, 1982
Assistant Research Professor
Modeling of air transport in the atmosphere, air pollution, transport prediction.

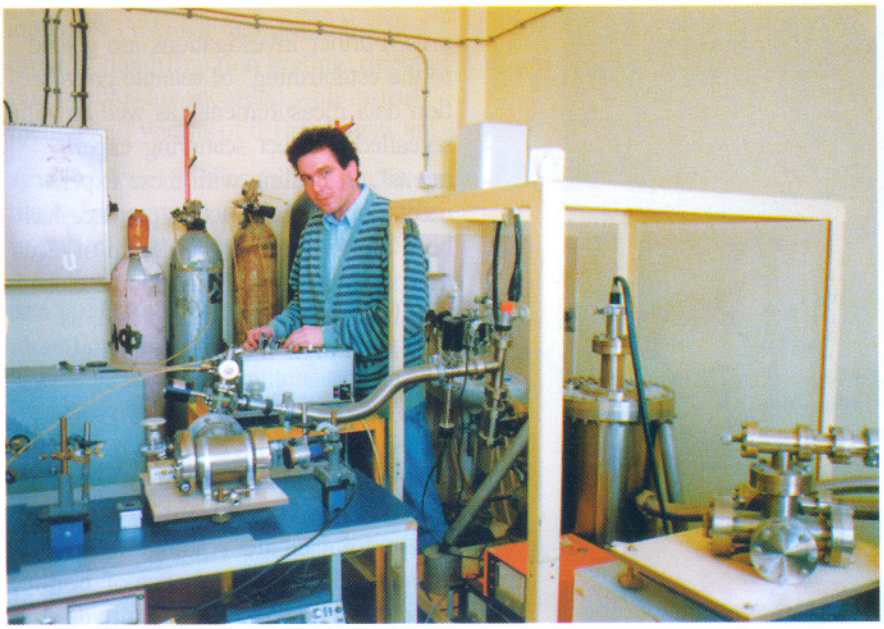
Zoran Petrović
Director, Center for Experimental Physics
Ph.D. ANU - Canberra, 1985
Research Professor
Physics of ionized gases, atomic and molecular collisions, plasma diagnostics and modeling, microwave techniques, plasma chemistry.

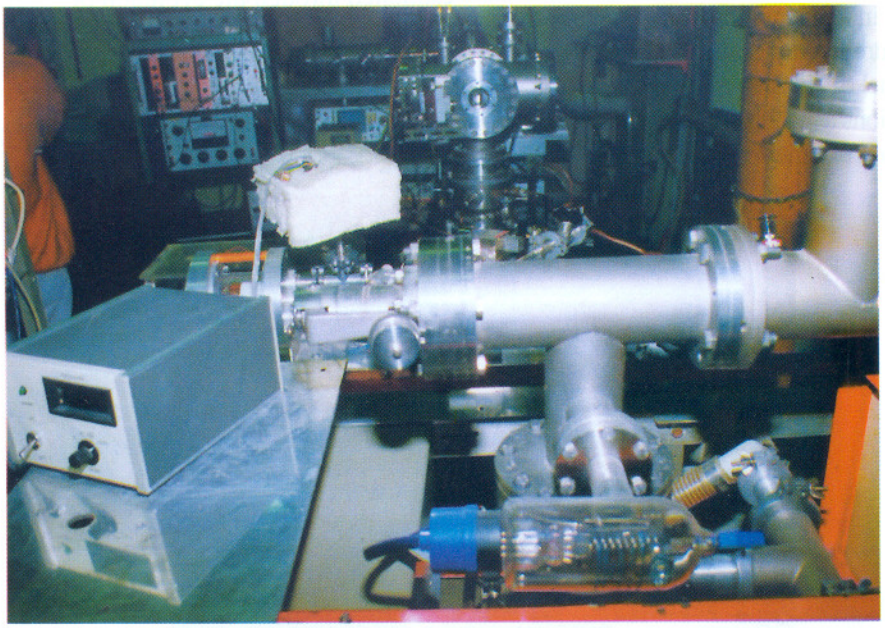
Marko Popović
Ph.D. University of Belgrade, 1972
Research Professor
Physics of ionized gases, physics of the atmosphere.

Svetlana Radovanov
Ph.D. University of Belgrade, 1986
Assistant Research Professor
Plasma diagnostics and applications, plasma chemistry.

Slavica Rajšić
Ph.D. University of Belgrade, 1991
Assistant Research Professor
Transport and transformation processes of pollution elements in the atmosphere.

Center for Experimental Physics





Mirjana Tasić
Ph.D. University of Belgrade, 1989
Assistant Research Professor
Physical characterization of aerosols in the atmosphere.

Branko Tomčik
Ph.D. University of Belgrade, 1991
Assistant Research Professor
Plasma surface treatment, film deposition, film characterization, plasma etching.

Mirjana Tripković
Ph.D. University of Belgrade, 1977
Associate Research Professor
Plasma spectrochemistry, analytical spectroscopy.

Zorka Vukmirović
Ph.D. University of Belgrade, 1973
Associate Research Professor
Chemistry of the atmosphere, transport and transformation processes of pollution in the atmosphere.

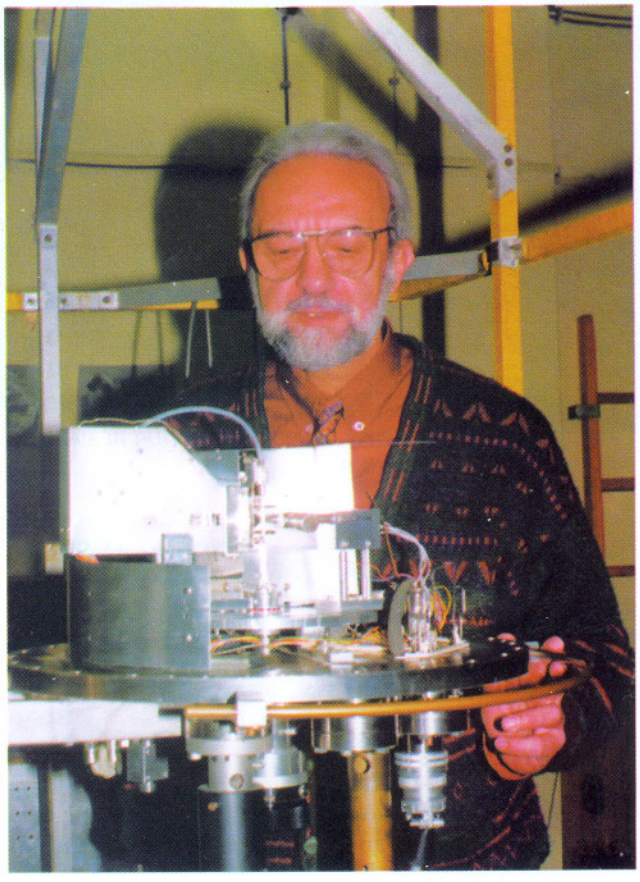
Center for Atomic and Subatomic Physics

Bratislav Marinković (right)

The research activity of the Center for Atomic and Subatomic Physics deals chiefly with electron-atom and electron-molecule collisions, plasma spectroscopy, optoelectronics and lasers, nucleus-nucleus interactions, nuclear disintegrations as well as with Z-boson decay processes.

The *Laboratory for Atomic Collision Processes* conducts experimental investigations of electron-atom or electron-molecule collisions, focusing on electron spectrometry and electron impact ionization. Electron spectrometry covers elastic scattering, as well as excitation of atoms and molecules by electron impact. High resolution electron spectra (20 to 50 meV) are obtained in energy loss, impact energy, residual energy (threshold spectroscopy) and optical excitation function modes. Measurements are performed in a high vacuum utilizing crossed beam arrangements. Differential cross sections are measured both for elastic scattering and electron excitations. Electron impact ionization covers measurements of total and partial ionization cross sections, dissociative attachment, angular and energy distributions of positive and negative fragments. Much work is focused on resonance phenomena. Resonances, as temporarily negative ions, are investigated in terms of vibrational excitations of hydrogen molecules, in the elastic channel of electron-metal atom binary collisions as well as in the optical and electron excitation functions of helium atoms. Further investigations are geared to the establishing of reliable cross section data measurements, as well as with so-called "perfect scattering experiments". In dealing with these experimental situations much experience has been accumulated in the design of electron spectrometers, formation of electron beams, in particle detection, as well as in high vacuum technology

The *Laboratory for Plasma Spectroscopy and Lasers* investigates plasma broadening and the shifting of spectral lines in plasmas generated by a low pressure pulsed arc. An ongoing study of the isoelectronic sequence of boron has investigated the temperature dependence of Stark widths and shifts. The influence of different ions has been estimated through the evolution of plasma composition data. The influence of forbidden perturbing levels has also been included. All of these plasma measurements are performed with a 1m monochromator of inverse linear disper-

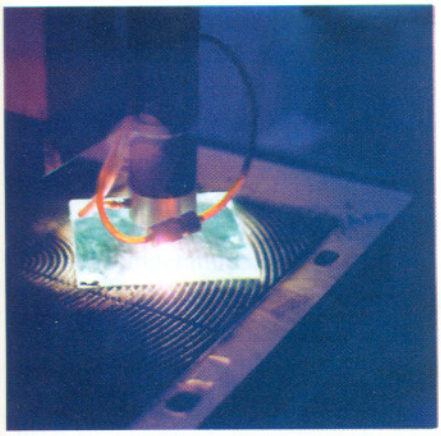


Milan Kurepa, Associate Member

sion of 8.33 Angstrom/mm in the first order of the diffraction grating. Spectral line profiles are recorded with instrumental half widths of 0.165 Angstrom.

Another set of studies focuses on the radiative properties of rare earth plasmas in pulsed discharges induced by a Nd-YAG laser. Neodymium oxide serves as a target in a helium atmosphere. The identification of neodymium ion spectra as well as the relative intensity measurements of the lines are a part of this investigation. Radiation from the plasma cell has been focused and monitored by a 0.5 m Ebert spectrograph with an inverse linear dispersion of 1.6 nm/mm.

In the *Laboratory for Optolelectronics and Lasers* experimental investigations center on the study of the physics of solid state lasers (Nd-YAG) and on holography. New methods are being utilized for the efficient pumping of laser active media in Nd-YAG systems, including the use of non-imaging optics. Research in holography covers computer generated holograms. Under development are new algorithms for optimization and production of holograms. These include genetic optimization algorithms as well as algorithms with simulated annealing. A set up for hologram photolithography with resolution of 100 lines per mm is being developed. Investigations in optical neural networks cover different topologies of neural networks where a hologram is a part of an optical computer.



Dejan Pantelić

The *Laboratory for High Energy Physics* studies strong interactions in nucleus-nucleus interactions in the energy region from 10 MeV to a couple of GeV per nucleon. Processes of multiparticle production (pions, protons and strange particles) and processes of the disintegration of nuclei (multifragmentation, fission and spallation) have been covered. The main goal of these investigations is to obtain new information about the behavior of nuclear matter under extreme conditions.

Electroweak interactions are being studied in electron-positron annihilation processes at center of mass energies of 100 GeV and 180 GeV. Under investigation

Center for Atomic and Subatomic Physics

Permanent Faculty:

Danica Cvejanović
Ph.D. University of Belgrade, 1974
Associate Research Professor
Electron spectrometry, coincidence measurements.

Slobodan Cvejanović
Ph.D. University of Belgrade, 1974
Associate Research Professor
Electron spectrometry, (e,2e) and (gamma,2e) spectrometry, photoionization, electron optics.

Iztok Čadež
Ph.D. University of Belgrade, 1975
Associate Research Professor
Electron collisions with atoms and molecules, hydrogen reactions at metal surfaces.

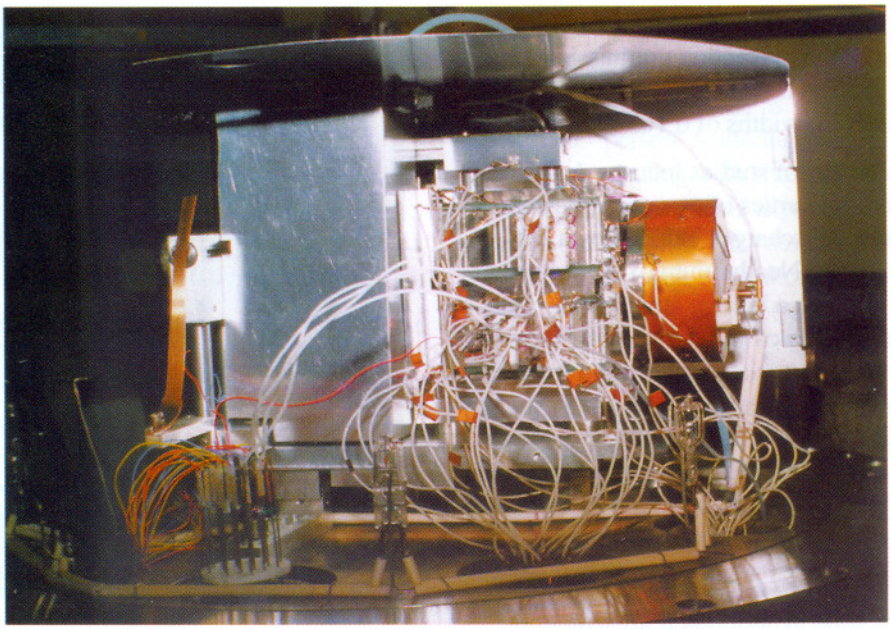
Bojana Grabež
Ph.D. Phillips Univ. - Lehn, 1984
Associate Research Professor
Experimental investigation of hadron-nucleus and nucleus-nucleus collisions at various energies.

Jozo Jureta
Ph.D. University of Belgrade, 1978
Associate Research Professor
Electron spectrometry, associative ionization, vacuum physics.

Jelena Krstić
Ph.D. University of Belgrade, 1986
Associate Research Professor
Electroweak phenomena and interactions in high energy elctron-positron collisions.

Ilija Lakičević
Ph.D. University of Belgrade, 1982
Research Professor
Plasma physics, thermonuclear fusion, laser applications.

Bratislav Marinković
Director, Center for Atomic and Subatomic Physics
Ph.D. University of Belgrade, 1989
Assistant Research Professor
Electron spectrometry, vacuum physics.



Dejan Pantelić
Ph.D. University of Belgrade, 1989
Assistant Research Professor
Optics, optical signal processing, holography.

Duška Popović
Ph.D. University of Belgrade, 1994
Assistant Research Professor
Electron spectrometry, nonclassical states of quantum oscillators.

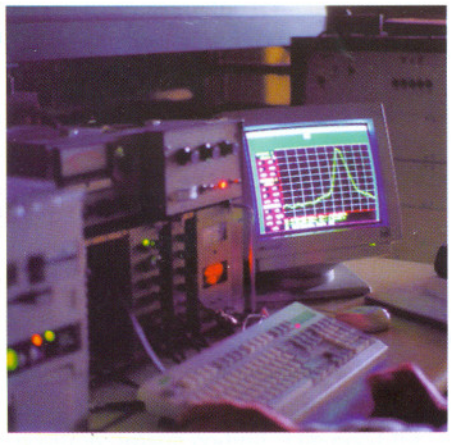
Ljiljana Simić
Ph.D. University of Belgrade, 1982
Associate Research Professor
Experimental high energy physics.

Živojin Todorović
Ph.D. University of Belgrade, 1972
Research Professor
Processes of nuclear disintegration: fission, multifragmentation, spallation

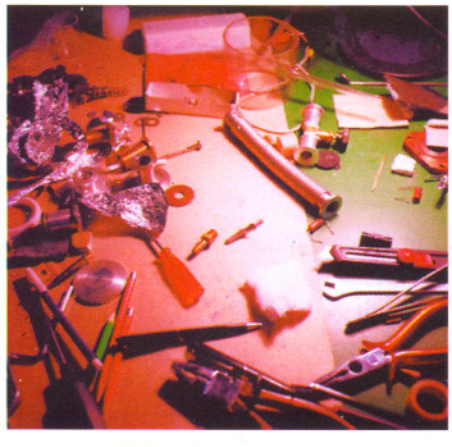
Center for Solid State Physics and New Materials

Zoran Popović

The Center for Solid State Physics and New Materials (CSSPNM) is mainly concerned with optical spectroscopy of semiconductors and high T_C superconductors. The principal interests of the laboratory are vibrational properties of these materials. Present experimental methods include Raman scattering and far infra-red spectroscopic measurements, luminescence measurements, as well as other optical measurements in a wide spectral range under high pressure and low temperature. In addition, electronic properties are investigated using Hall effect experiments. There is also a substantial theoretical effort in computing phonon and magnon dispersion of the materials under investigation. An up-to-date list of materials and systems of interest includes the following: elemental semiconductors (crystalline, amorphous and disordered), III-V semiconducting compounds, oxygen perovskites, silica-glasses and copper-oxide superconductors. The samples under study are ceramics, bulk crystals, thin films and superlattices.



The experimental techniques utilized in the synthesis of samples include sintering methods, sol-gel technology, single chrystal growth techniques (Bridgeman), as well as thin-film technology (spattering) including photolithography and impurity doping.



Close collaborations with teams at the Max-Planck Institute in Stuttgart, University Paris-Sud, Moscow State University (MGU), University of Athens and University of Sofia have enabled the CSSPNM to extend the variety of experimental techniques at its disposal. The topics in the focus of recent activities are the vibrational and electronic properties of various superlattices, the light scattering by spin waves in copper based oxides and impurity effects in semiconductors and high T_C superconductors, light scattering in disordered systems, to mention a few.

The Center for Solid State Physics and New Materials is host to 13 graduate students in various phases of completion of their Ph.D. requirements.

The applied projects of the center are closely related with the above research topics and deal chiefly with the development of high T_C superconductors, thin-film technology, as well as optical materials and components.

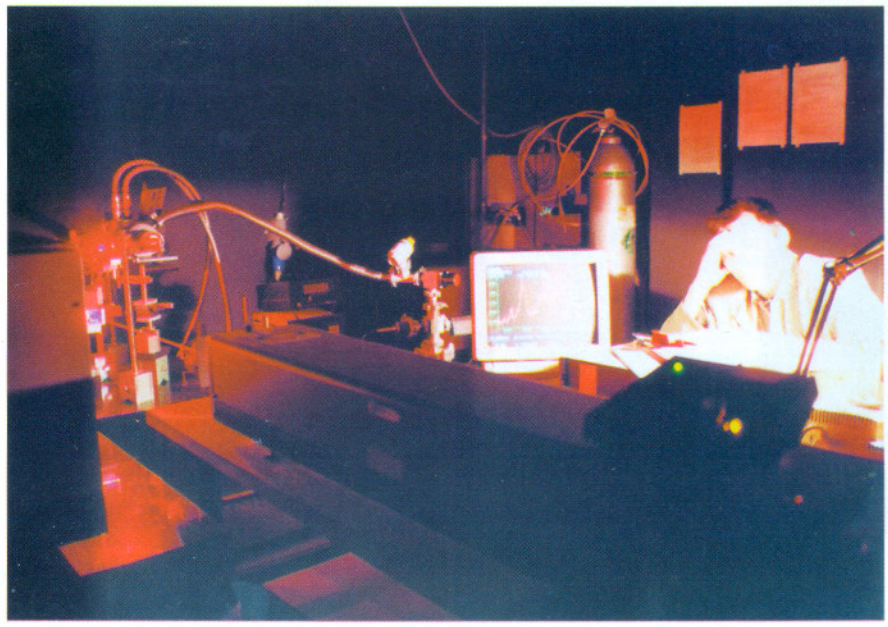
Permanent Faculty:

Ivan Ćirić
Ph.D. University of Sarajevo, 1988
Assistant Research Professor
Dominant reaction, degree of doping, semiconducting sensors, carbon monoxide sensors.

Radoš Gajić
Ph.D. University of Belgrade, 1993
Assistant Research Professor
Solid state physics, optical properties of solids, far infra-red and Raman spectroscopy.

Milan Konstantinović
Ph.D. University of Belgrade, 1994
Assistant Research Professor
Solid state physics, optical properties of solids, far infra-red and Raman spectroscopy.

Center for Solid State Physics and New Materials

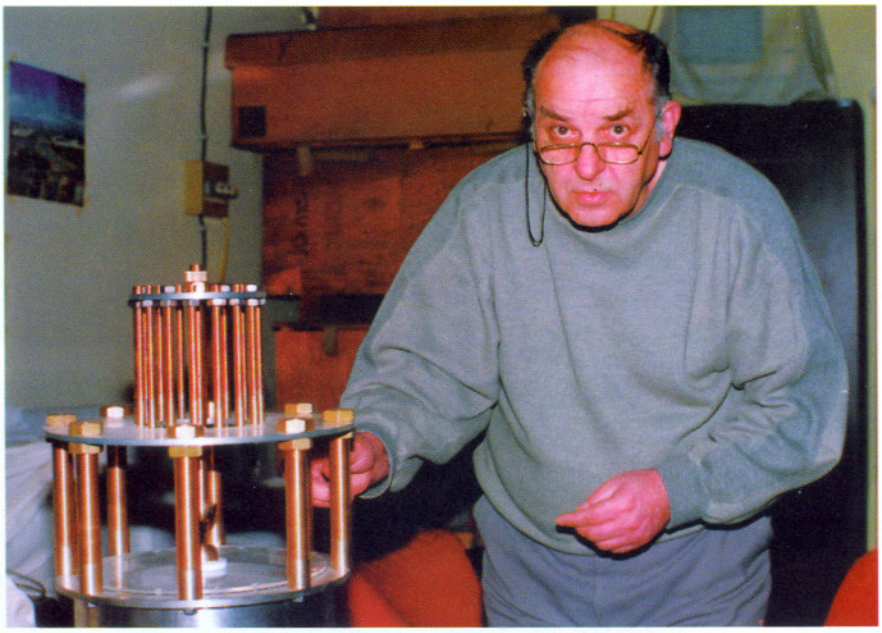


Radmila Kostić
Ph.D. University of Belgrade, 1992
Assistant Research Professor
Solid state physics, optical properties of solids, far infra-red and Raman spectroscopy.

Zoran Popović
Director, Center for Solid State Physics and New Materials
Ph.D. University of Ljubljana, 1984
Research Professor
Solid state physics, optical properties of solids, far infra-red and Raman spectroscopy.

Goran Stanišić
Ph.D. University of Belgrade, 1985
Associate Research Professor
Sintering of superconducting and ceramic materials, semiconducting alloys, silica glasses.

Center for Applied and Technical Physics



Radovan Antanasijević

The principal research activity of the Center for Applied and Technical Physics (CATP) deals with the investigation of nuclear processes induced by electrical discharges in deuterated media. These processes are obtained in two different kinds of experiments: in electrical discharges through a deuterium gas (plasma focus), as well as in electrical discharges in liquid substances in capillaries (capillary fusion).

A study is made of the production of very intense neutron beams, as well as of beams of charged particles and soft X-rays. A sophisticated array of techniques is being developed for neutron detection. These include: liquid scintillators, positive particle SSNTD, as well as soft X-ray Roentgenographic methods. The said techniques are being used to detect the products of D-D reactions.

An analysis of the tracks of positive charged particles is under way using a combination of standard optical methods as well modern methods based on electronic microscopes (SeM, TEM, AFM).

The capillary fusion and plasma focus experimental facilities are complementary to facilities for fusion plasma confinement and allow the possibility of studying important processes in the field of controlled thermonuclear fusion. For this reason we are developing a way to measure the temperature of plasmas using interferometric methods. Also, we are modeling neutron transport through the first wall (blanket) of a plasma machine. A study is under way to gauge the effects of crystal structure on rare nuclear processes.

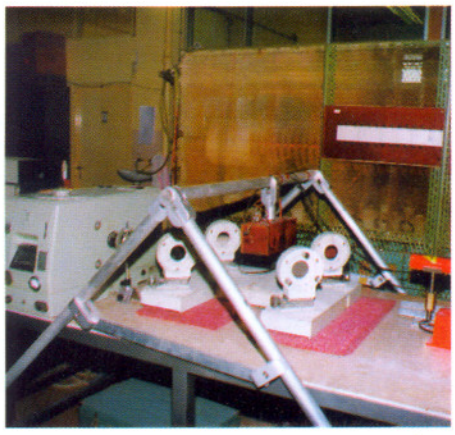
Much of the applied research at the CATP is closely related to the above fundamental research. There is an ongoing investigation of neutron radiography, radiation protection, image decomposition, image coding. The need for high accuracy in many of these measurements has made it necessary to become proficient in digital signal processing.

One of the important applied physics activities in the center is in the field of power electronics, pulsed power supplies, and very high power pulse generators.

The study of fluctuation processes in semiconductor devices and materials proceeds in two different directions. The first is the investigation of failure mechanisms and the diagnosing of defects using noise measurements. The second studies processing and degradation of semiconductor materials used in microelectronics due to irradiation by various lasers.

Our research and development has also led to the development of a host of sensors for humidity and rain that have been successfully integrated into an automated data acquisition system used by the food industry. Members of the center have also worked on the development of high temperature solar collectors.

Currently four graduate students are working at the CATP on their Ph.D.'s.



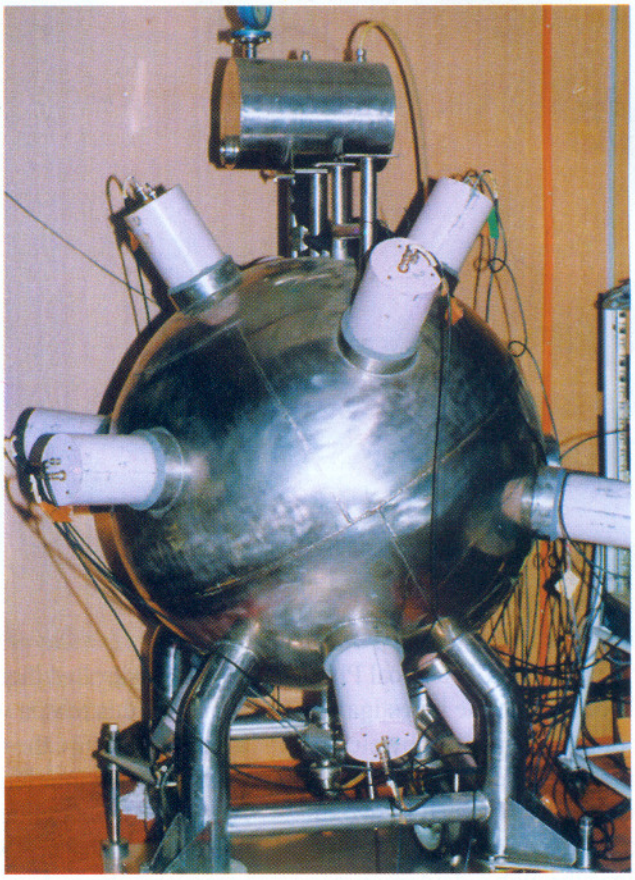
Center for Applied and Technical Physics

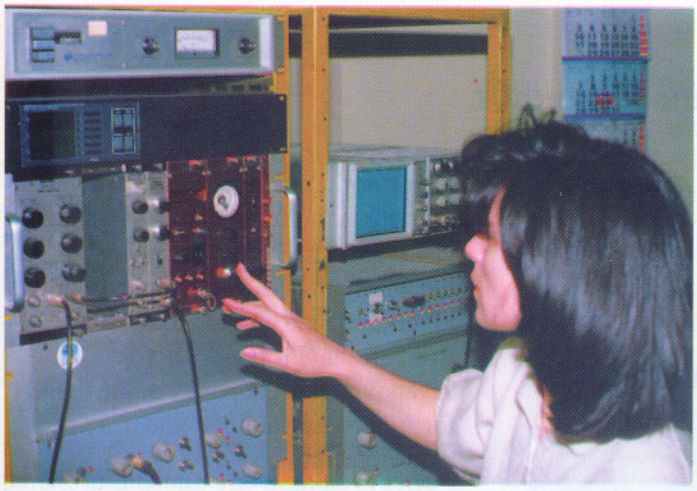
Permanent Faculty:

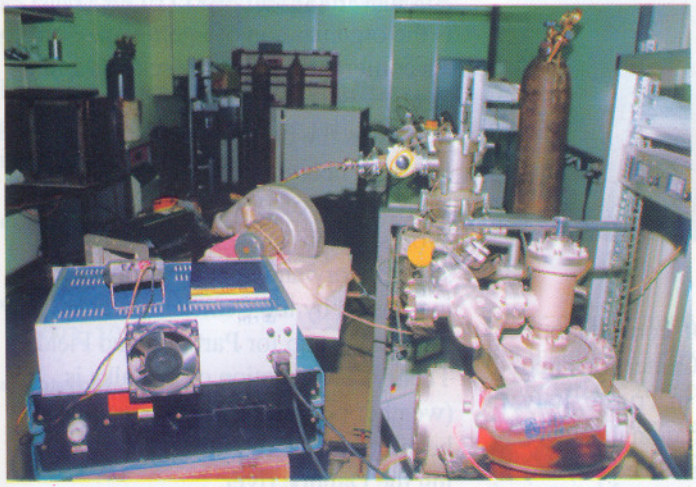
Radovan Antanasijević
Director, Center for Applied and Technical Physics
Ph.D. University of Belgrade, 1974
Research Professor
Nuclear physics, fusion reactions, radiation detection.

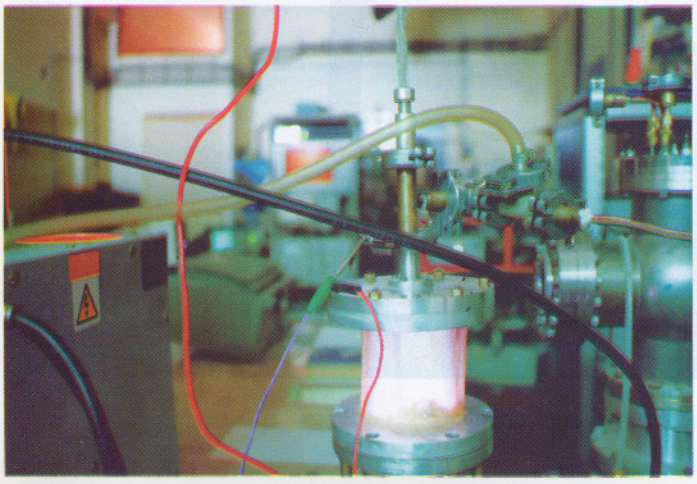
Milan Jevtić
Ph.D. University of Belgrade, 1977
Research Professor
Semiconductor physics, fluctuation processes, sensors.

Dragutin Šević
Ph.D. University of Belgrade, 1995
Assistant Research Professor
Nuclear physics, fusion reactions, data gathering.









Center for Advanced Studies

Participants of Danube Workshop 1991

The Center for Advanced Studies (CAS) is the newest addition to the Institute of Physics family. The CAS was promoted in 1991 to extend and support research at the forefront of physics. The principle role that the center is to play is to facilitate the further development of international collaboration of scientists at the Institute of Physics with their colleagues at physics institutions world wide.

The concept of the Center for Advanced Studies was formulated in part as a result of a series of consultations with the International Center for Theoretical Physics (ICTP) in Trieste, Italy. It was conceived as a regional center for southeast Europe modeled on, and with strong ties to the ICTP. The center is headed by a scientific board.

The basic task of the Center for Advanced Studies is to offer short and medium term positions to scientists from abroad to work at the Institute of Physics. This includes postdoc positions for one or two years, as well as visiting professor positions of varying duration. Starting in the summer of 1996 all the visitors will be housed in the newly renovated physics guest house - a gift to the Belgrade physics community from the late Professor Djordje Živanović. It is the policy of the Center for Advanced Studies not to offer permanent faculty positions.

Another important aspect of the center is the organization of international physics conferences, summer schools and workshops. In fact, the center's first activity was the organization of the High Energy Theory meeting Danube Workshop in June of 1991. The Danube Workshop has since become an annual string theory and quantum gravity meeting hosted by the Center for Theoretical Physics' group for Particles and Field Theory. The location of the talks is (weather permitting) in the Institute's beautiful open amphitheater overlooking the Danube river.

View of the Danube from the open amphitheater

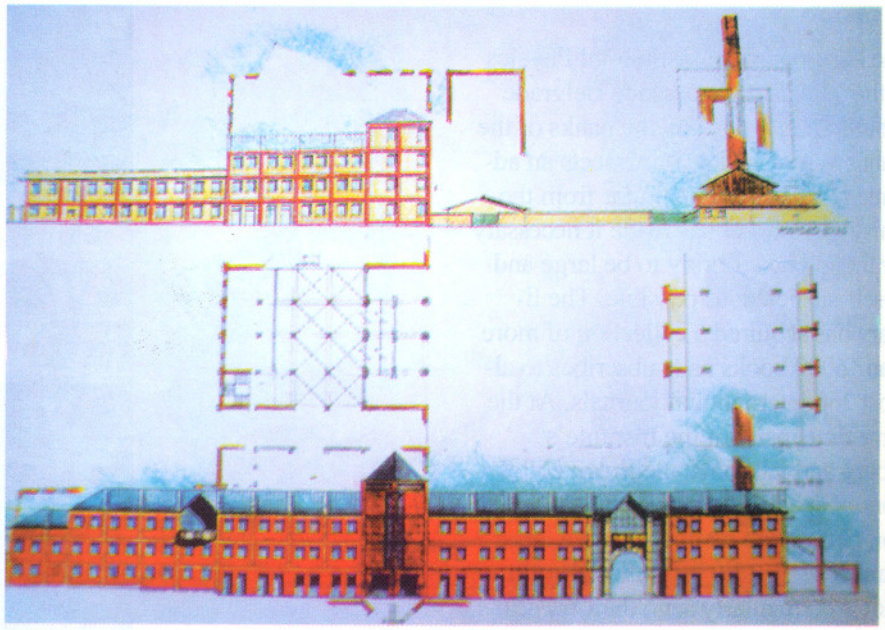
Seminars and Conferences

The director of the Institute of Physics, in consultation with members of IP's scientific council, invites distinguished researchers to give talks at the Institute's prestigious Physics Colloquium. The colloquiums are given monthly and are generally attended by the whole faculty, by the graduate students working at the IP, as well as by many visitors from nearby physics institutions. The Institute of Physics is also host to a wide range of weekly specialized seminars.

In the last few years the Institute has organized or co-organized the following international meetings:

- Adriatic Meeting on Particle Physics (1983, 1986, 1989)
- SPIG (1984, 1986, 1988, 1990, 1993, 1994)
- International Conference on Classical Dynamics in Atomic and Molecular Physics (1988)
- Danube Workshop (1991, 1992, 1993, 1994, 1995)
- Modern Physics and its Social Implications (1981).

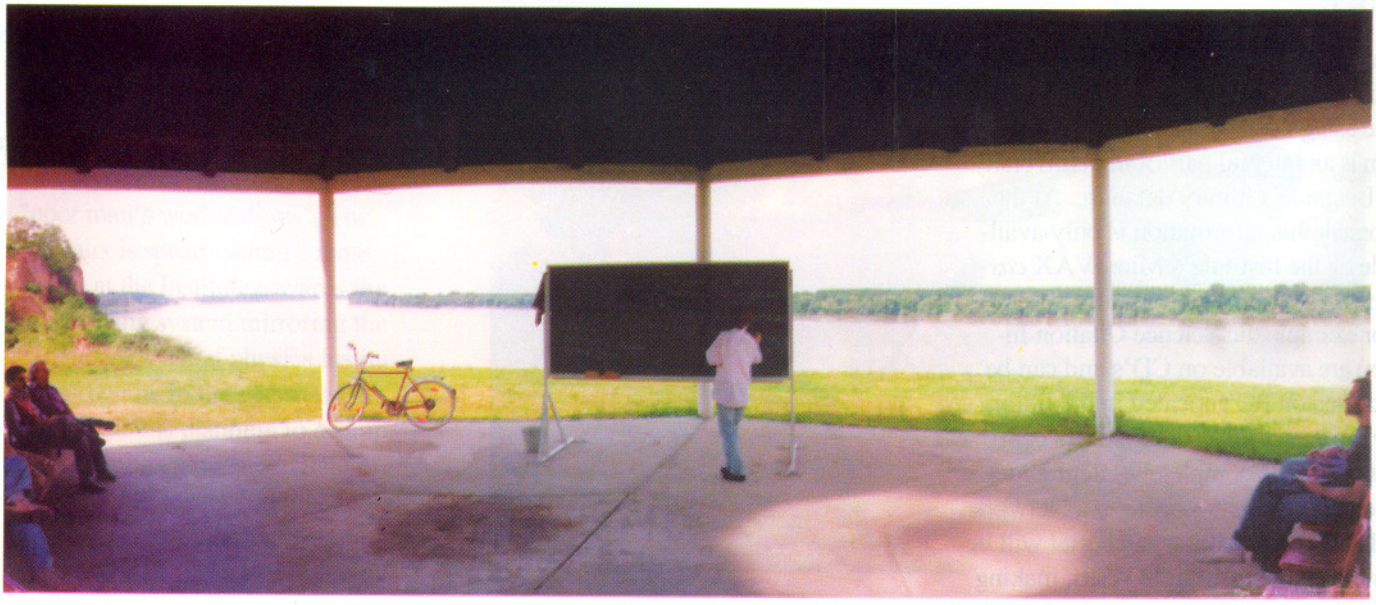
In addition four memorial meetings were organized commemorating the contributions to modern physics of Einstein, Bohr, Schroedinger and de Broglie.



Planned expansion of the main building

In the case of many of these meetings the Institute of Physics has also appeared in the role of publisher of proceedings and related material. Since 1988 the Institute publishes (in Serbian) the journal Lectures in Physical Sciences (SFIN) reviewing current topics in modern physics. In addition, three books have been published in the series Modern Investigation in Physics(also in Serbian). Six books have come out listing the abstracts of all papers published by the IP faculty from May1961 to April 1996. There is a concerted effort to extend the publishing activity of the Institute to include the publication of monographs and textbooks.

The fifth anniversary of the CAS, and the 35th anniversary of the Institute of Physics, will mark the beginning of the expansion of the IP's main building. The newly acquired space will make it possible to substantially expand the activities of the CAS, as well as other international activities of the IP.



Strings on the Danube

Library

The location of the Institute of Physics in the quiet and picturesque Belgrade suburb Zemun right on the banks of the Danube river is in most respects an advantage. However, being far from the University proper has made it necessary for the Institute library to be large and as self-sufficient as possible. The library has acquired a collection of more than 16000 books and subscribes to almost 360 international journals. At the same time many of the Institute's groups and labs have their own collections of specialized books. The Institute library is on the mailing list of a large number of physics institutions world wide who regularly send their preprints. In addition, a growing number of databases around the world offer physics preprints and journals on-line via the Internet.

There is an extensive inter-library loan program specially with the University of Belgrade Library, as well as with the libraries of the Department of Physics and of the Vinca Institute for Nuclear Sciences. Further important sources of books and journals in Belgrade are the Serbian National Library, the Mathematics Institute library, as well as the libraries of the Departments of Mathematics, Chemistry and Electrical Engineering.

Basic information about the books and journals at the Institute is available on-line using the OPAC system. This system is an integral part of the University of Belgrade's library database. At the moment this information is only available on the Institute's MicroVAX *castor*. Many important reference sources (for example the Science Citation Index) are available on CD's and can be accessed on PC's located in the library. By the end of 1996 the library's computers will be completely integrated into the Institute's Local Area Network PHYnet. All the library material will be visible on the Institute's WEB, making it easily accessible from any location.

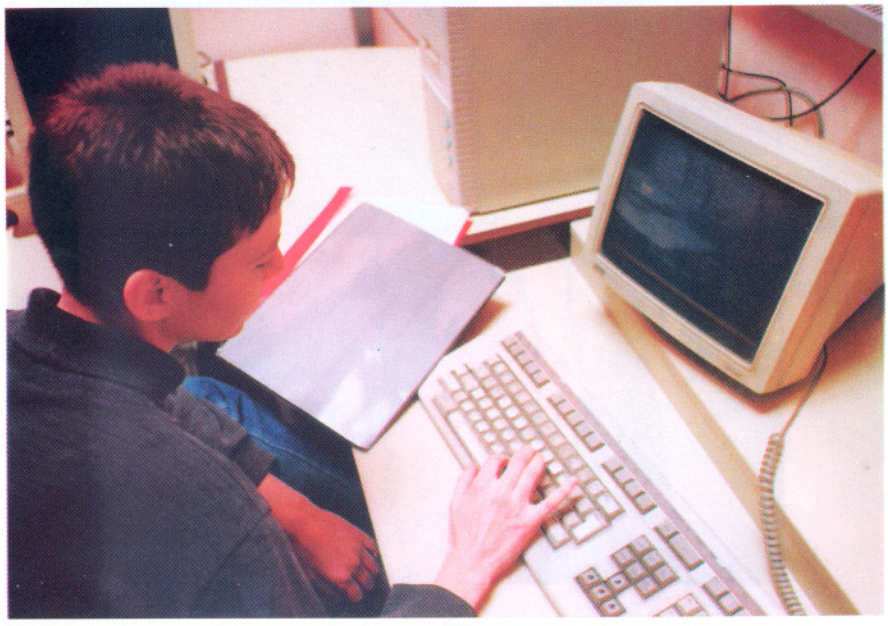
A visit to the Institute library by Slobodan Unković, Minister of Science and Technology (center)

Computing Facilities

The number and variety of computers at the Institute continue to grow rapidly. All these machines are interconnected by an Ethernet local area network PHYnet which consists of a backbone connecting 5 separate networks corresponding to the various centers. The sixth and seventh LANs will be those of the Center for Advanced Studies, and the Institute library, and will be online by the end of 1996. All the computers at the Institute of Physics are on the Internet (subdomain phy.bg.ac.yu). The principal communication machines are *castor.phy.bg.ac.yu* running VMS and *pollux.phy.bg.ac.yu* running UNIX. The Institute's central World-Wide-Web server has the URL *http://www.phy.bg.ac.yu.*

Aleksandar Belić - Monte Carlo on *jason*

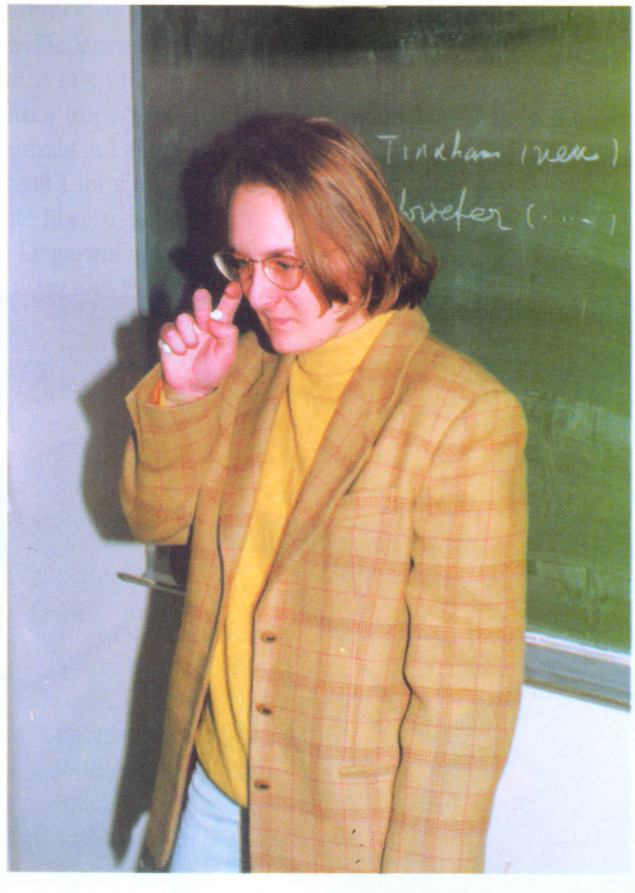
A wide range of research activities is supported by the machines at the Institute. Examples include computer control of experiments, graphical and numerical analysis of data from in-house experiments, as well as experiments at remote sites. A number of theorists are engaged in large scale numerical modeling on the Institutes workstations (IBM R6000 and DEC alpha) as well as on remote supercomputers at the University of Belgrade Computing Center and abroad. Less demanding computer needs are being met by a large number of PC's (mostly PC 486) all together about 80 of them. An increasing number of these are going over to the Linux operating system and serving the role of the "poor man's workstations". The rise of Linux is spearheading a mass movement at the Institute towards the UNIX operating system mirroring the dominance of UNIX at physics institutions world wide. In the very near future the Institute is planning to acquire a Silicon Graphics Power Challenge R8000 computer server running at 300 Mflops, as well as to upgrade and increase the number of its workstations. The next major step is to increase the speed of connection of the Institute's machines with remote machines in the world. This upgrade will take full advantage of the high speed link of Belgrade University to the Internet that is currently under construction. To do this the Institute will lay down an optical line to the University Computing Center.



Email on *castor*

Graduate Program

Although the Institute of Physics is primarily a research institution, teaching - at the graduate level - is considered to be one of its most important activities. The graduate school in physics is organized jointly with the Department of Physics at Belgrade University. Many members of the faculty teach graduate courses and serve as thesis advisers. There isn't a single graduate program, but rather a host of programs for various fields of specialization. We list here only the specializations where a majority of the teaching is done by the Institute's faculty. The courses are to be taken in two years. After completing the courses students start work on their M.Sc. thesis. The rest of their time in graduate school is devoted purely to research culminating with the writing and defense of their Ph.D. thesis.



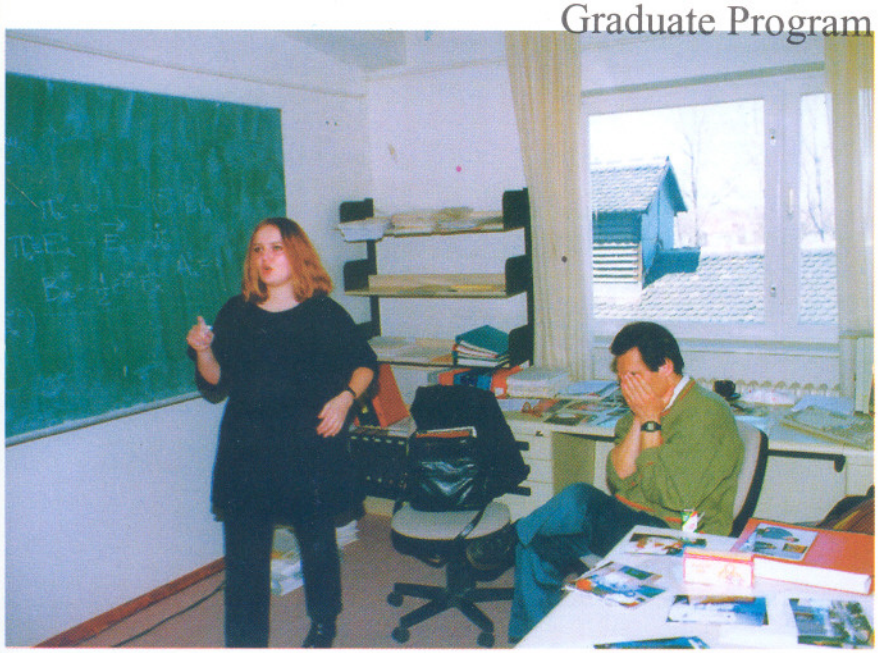
Classical, Quantum and Mathematical Physics:

Advanced Quantum Mechanics 1
Advanced Mathematical Physics
Advanced Classical Mechanics
Advanced Quantum Mechanics 2

+ a choice of four of the following Special Topics courses:

Nonequilibrium Statistical Physics
Fundamentals of Quantum Mechanics
Quantum Field Theory 1
Particle Physics
Gravitation
Quantum Field Theory 2
Nonlinear Dynamics
Algebraic Methods in Physics
Quantum Theory of Systems
Quantum Groups
Differential Geometry in Physics
Quantum Statistics of Light

(not all courses are offered each year)



Particles and Gravity Theory:

Quantum Field Theory 1
Particle Physics 1
Gravitation 1
Quantum Field Theory 2
Particle Physics 2
Gravitation 2
Quantum Field Theory 3
Unification of Interactions

(all the listed courses are obligatory)

Theoretical Atomic and Molecular Physics:

Structure of Atoms and Molecules 1
Scattering Theory 1
Structure of Atoms and Molecules 2
Scattering Theory 2

+ one of the following two semester Special Topics courses:

Electron-Atom Collisions
Collisions of Heavy Atomic Particles

+ one of the following two semester Special Topics courses:

Theory of Line Broadening
Collisions With Surfaces
Systems With Few Constituents
Quantum Optics

(not all courses are offered each year)

Condensed Matter Theory:

Phase Transitions (two semesters)

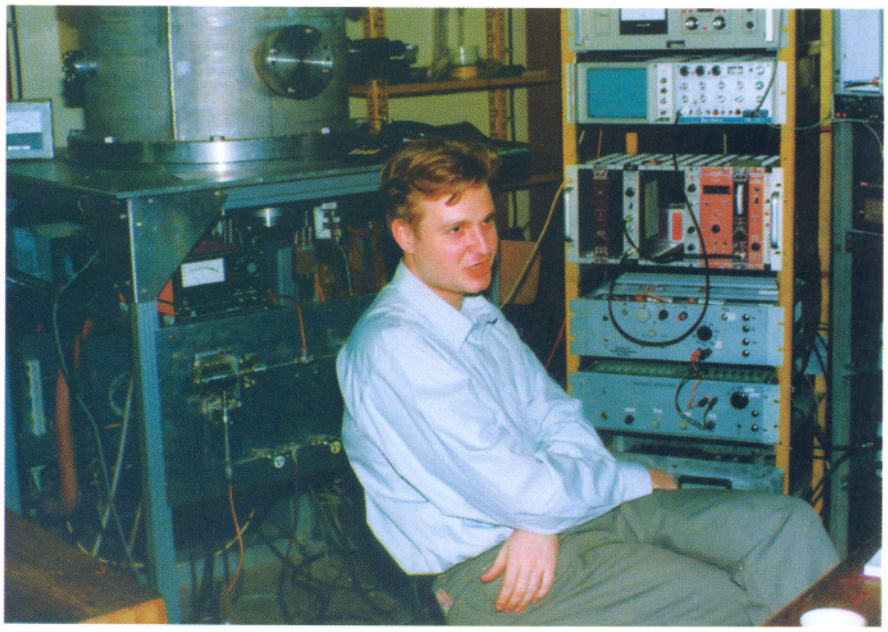
+ a choice of two of the following two semester Special Topics courses:

Physics of Superconducting Systems
Physics of Magnetic Systems
Physics of Surfaces
Physics of Ferroelectric Systems
Physics of Disordered Systems

+ a choice of two of the following one semester Special Topics courses:

Advanced Quantum Mechanics
QFT Methods in Condensed Matter
Nonlinear Effects in Condensed Matter
Numerical Methods
Low Temperature Physics

(not all courses are offered each year)



Prepared in April 1996 by
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Further information about the Institute of Physics in Belgrade
is available on the World Wide Web at the URL
http://www.phy.bg.ac.yu
Photographs: Olivera Milanović