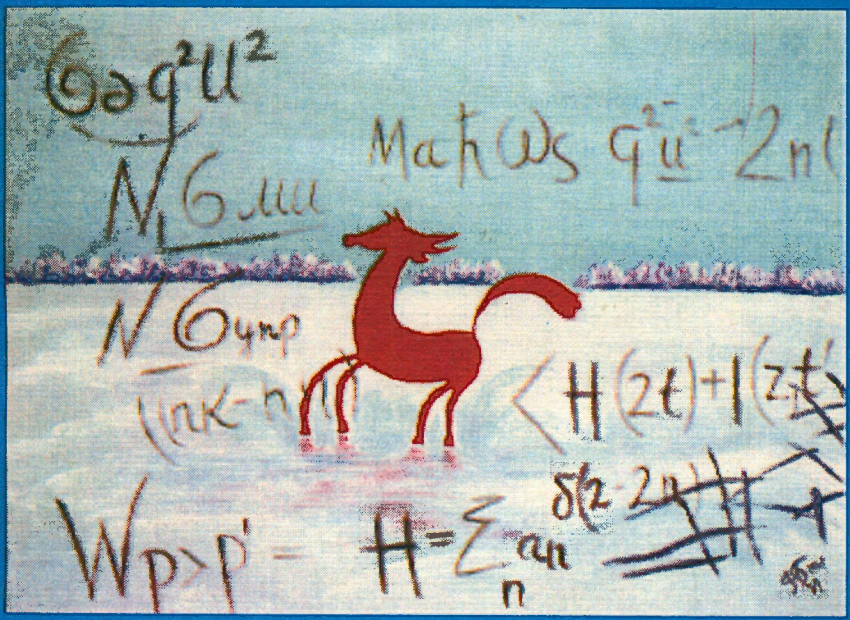

UNIVERSITY CENTRE

OF THE JOINT INSTITUTE FOR NUCLEAR RESEARCH

University Centre

of the Joint Institute for Nuclear Research

Dubna, 1995

HOW TO CONTACT UC

University Centre
Joint Institute for Nuclear Research
141980 Dubna, Moscow Region
Russia

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Under the editorship of S.P.Ivanova

HISTORY

Soon after the creation of the Joint Institute for Nuclear Research (JINR), now the largest scientific centre in Eastern Europe comprising 18 Member States, a branch of the Moscow State University (MSU) was opened in Dubna in 1961. It was organized on the basis of JINR to train graduate students of MSU in nuclear physics. Two departments of the Physics Faculty have been created at the branch of MSU: the Department of Theoretical Nuclear Physics and Department of Elementary Particle Physics. The first heads of these departments were D.I.Blokhintsev and V.I.Veksler, the prominent scientists whose energy had allowed the branch of MSU to be created. They were first to realize how forward-looking is the idea of training students directly at the largest scientific centre like JINR. At present, the existence of training departments of the higher education institutions or their branches at the scientific institutes is commonplace, but in the sixties and during the next 20 years the joint work of the branch of MSU and JINR on training young specialists in nuclear physics had been a rare exception. Further development of the branch of MSU went on under Prof. N.N.Bogoliubov, a member of Academy of Sciences, who had been director of JINR in 1966—1992.

During thirty years of its work the branch of MSU has trained about one thousand graduate and post-graduate students of MSU. Many of them are now leading scientists at JINR and other scientific institutes of Russia, former Soviet Union republics, and JINR Member States from Eastern Europe, Asia, and Cuba.

A major contribution to the creation and development of the branch of MSU was made by Profs. D.I.Blokhintsev, N.N.Bogoliubov, director of the Institute of Nuclear Physics of MSU S.N.Vernov, heads of the departments Profs. V.I.Veksler and B.M.Pontecorvo, and the professors of the departments M.G.Meshcheryakov, I.M.Frank, and F.L.Shapiro. Their portraits are given below.

D.I.Blokhintsev

N.N.Bogoliubov

B.M.Pontecorvo

S.N.Vernov

M.G.Meshcheryakov

V.I.Veksler

I.M.Frank

F.L.Shapiro

In recent years, however, it has become clear that the existing structure of the branch of MSU is no longer able to meet the increased JINR need for scientific staff of different specialties, while training abilities of the branch of MSU did have some reserve and allowed the amount of education work to be expanded.

Therefore, JINR, MSU, and Moscow Engineering Physics Institute (MEPI) have come up with the proposal on joint activities towards training in Dubna of students in more extensive variety of specialties with introduction of some new forms of teaching. With this purpose, the Training Centre of MSU and MEPI has been created at JINR and it received official status in 1991. It should be noted that the Training Centre has been created in addition to, and not instead of, the branch of MSU.

At present, the directorate of JINR headed by Prof. V.G. Kadyshevsky, a corresponding member of the Russian Academy of Sciences, takes special care of the development of JINR's educational activity. It is recorded in the decisions of the 77th Session of the JINR Scientific Council that «The

Director of JINR Prof. V.G.Kadyshevsky, Vice-Director of JINR Prof. A.N.Sissakian, and Director of the University Centre of JINR Assoc. Prof. S.P.Ivanova

Scientific Council approves new steps towards realization of the JINR Educational Programme and expansion of international contacts and the scope of subjects taught at the Training Centre».

As further development of the International University programme in Dubna, which was proposed by Prof. V.G. Kadyshevsky, the «Dubna» University for Nature, Society and Man carried out in 1994 the first enrollment of students. Its rector is Prof. O.L.Kuznetsov, President of the Russian Academy of Natural Sciences.

THE UNIVERSITY CENTRE OF JINR TODAY

The Dubna Training Centre, now the University Centre (UC), is a joint educational institute comprising students and faculty from Moscow State University (MSU), Moscow Engineering Physics Institute (MEPI), and Moscow Institute of Physics and Technology (MIPT). Students of the 4th and 5th years and graduates are invited to study at UC for two years.

The students complete here their university education. Classes include not only ordinary courses in physics, but also intensive courses on subjects defined on the basis of JINR research.

The Centre offers the following full-time programmes:

Nuclear Physics, on the basis of:
- Flerov Laboratory of Nuclear Reactions
  (Director: Prof. Yu. Oganessian)
- Frank Laboratory of Neutron Physics
  (Director: Prof. V. Aksenov)
- Department of the Atomic Nucleus Physics of MSU
- Department of Experimental Methods of Nuclear Physics of MSEPI

Particle Physics, on the basis of:
- Laboratory of High Energies
  (Director: Prof. A. Baldin)
- Laboratory of Particle Physics
  (Director: Prof. I. Savin)
- Laboratory of Nuclear Problems
  (Director: Prof. N. Russakovich)
- Department of Elementary Particle Physics of MSU
- Department of Physics of High Energy Particle Interaction of MIPT
- Departments of High Energy Physics and Experimental Nuclear Physics of MEPI

Condensed Matter Physics, on the basis of:
- Frank Laboratory of Neutron Physics
- Department of Solid State Physics of MEPI

In the above three fields, UC also offers the full-time theoretical physics programmes on the basis of the Bogoliubov Laboratory of Theoretical Physics (Director: Prof. D.V. Shirkov, member of Russian Academy of Sciences).

Technical Physics, on the basis of:
- Laboratory of Nuclear Problems
- Laboratory of Particle Physics
- Laboratory of Nuclear Reactions
- «A» (Automation and Electronics) faculty of MEPI

Radiobiology, on the basis of:
- Department of Radiation and Radiobiological Research
- Department of Radiation Safety of MEPI

The highest administrative body of UC is the UC Council, whose chairman is vice-director of JINR Prof. A.N. Sissakian. The UC Council is composed of representatives of JINR and institutions of higher education that have branches of their departments in Dubna.

Students have access to the laboratories of JINR and can work with the scientists and staff of the Institute, as well as to study under professors who are eminent in their field.

Special importance is attached to the language and computer education. Russian and English are taught here as the second language. A classroom equipped with a hardware for studying languages and a modern computer auditorium have been organized at UC.

UC is envisioned as a new type of educational institution, whose activity comprehends scientific and technical fields as well as humanities and liberal arts. UC introduces new forms of training using various teaching methods developed both in Western Europe and in Russia. It is planned to introduce courses of Economics and Law. UC has already been recognized by international organizations for its new educational style. In particular, the European Physical Society has named UC as coordinator for the Russian Federation in the European Mobility Scheme for Physics Students (EMSPS). Among the UC students there have already been the EMSPS students from Austria and Germany. Not only will this new type of

institution provide opportunities for increased international cooperation in education, but it also will broaden the scope of scientific and technical education, both in practical experience and in sciences contiguous with the arts, including languages.

UC has broad experience in contacts with leading educational institutions of the former Soviet Union and Eastern Europe. UC has permanent contacts for the exchange of students with TU Darmstadt, and a preliminary contract was concluded between them. The Joint Institute for Nuclear Research and UC have Protocols of Intent for cooperation in the field of education with the following institutions: Aalborg University (Denmark), Lund University (Sweden), Lodz University (Poland), and some others. JINR also maintains ongoing contacts with CERN in the training of students and young scientists.

The full-time educational programme of the University Centre is two years long, though it is possible to admit students for shorter periods such as the one or two-month intense courses on some selected topic. The working language for foreign students is English.

Post-graduate students are also admitted to attend lectures on selected topics and take part in scientific research at the JINR Laboratories. There is an intent to further develop UC as an international university for natural sciences. As a unique educational centre, it combines the strength and experience of a world-renown scientific community with those of respected Moscow universities. This successful combination would be enhanced by addition of a respected European or American university to further develop UC, bringing the balance between the arts and humanities on one side and the sciences on the other. With such a consortium, the potentialities for joint studies and dialog between science and humanities, as well as between peoples of the former Soviet Union, Europe, and America, are endless. In addition, UC is envisioned as a centre for training personnel for the physics institutes of the former Soviet Union republics and for wider JINR international collaboration.

The proposed arrangement of faculties and recruitment of students for such an educational institution would be fruitful in the exchange of knowledge from different perspectives of science and the arts.

UC's plans include: the exchange of information on the methods of teaching with Aalborg University and other partners, workshops on new methods and training programmes, exchange of teachers and staff members

for training/updating, and improvement of the Centre's management and administration.

The international schools and seminars on the JINR investigation fields are planned to be a regular part of UC activities (1995: a school on theoretical physics and a school on neutron physics). The main objective of this possible cooperation is to develop at JINR new educational programmes in engineering and natural sciences, as well as the business and economics courses on a university level. Furthermore, we hope to make the student and staff exchanges a regular practice, to establish joint activities in the form of continuing education and to offer foreign students an access to advanced training at JINR.

The following list of lecture courses will be given in English at the Dubna University Centre of the Joint Institute for Nuclear Research:

Theory of electroweak interaction
Some topics of quantum electrodynamics
Quantum theory of scattering
Some topics of theory of nuclei and nuclear reactions
Condensed matter physics
Modern methods of particle detection
Accelerator technique
Radiobiology

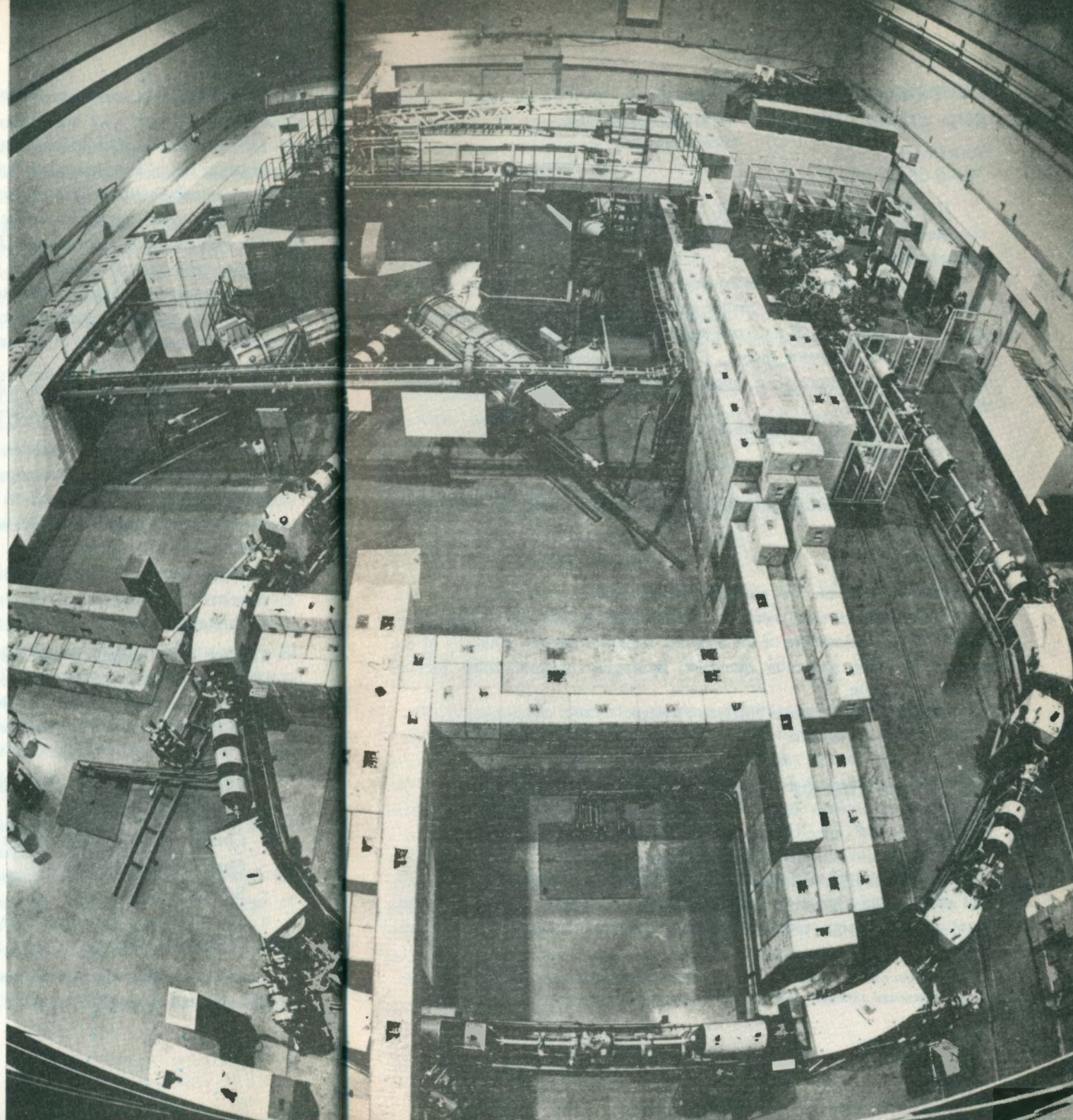
The list is not complete and can meet the proposals of Universities intending to send their students to the Dubna University Centre.

In 1995, the post-graduate student training license was obtained from the State Committee on Higher Education of Russia. The post-graduate students will be trained in the following specialties:

- Physics of nuclei and elementary particles
- Theoretical physics
- Charged particle beam physics and accelerator technique
- Computational mathematics.
- Solid state physics
- Physical experiment technique, instrument physics, and automation of physical research

Listed below are courses classified by specialties and courses given to all the UC students. The four numbers separated by hyphens are the number of hours allocated for lectures, seminars, practical exercises, and laboratory work, respectively

NUCLEAR PHYSICS



NEUTRON SPECTROSCOPY AND ATOMIC NUCLEAR STRUCTURE

Semester 8
14-0-0-0

The history of neutron discovery. Neutron as an elementary particle. Interaction of neutrons with matter and nuclei. Sources and spectrometers of neutrons. Detectors of neutrons and neutron reactions products. Neutron resonances and statistics theory. Channels of neutron resonance decay. Neutrons in the process of nucleosynthesis of the Universe. Neutron activation analysis.

Department of the Atomic Nucleus Physics
Prof. Yu.P. Popov

NUCLEAR PHYSICS METHODS OF ANALYSIS OF MATTER

Semester 9
16-6-0-2

Fundamentals of the nuclear physics methods of matter analysis. Activation analysis using neutrons, bremsstrahlung, and charged particles. Sensitivity and selectivity of the analysis, detection ranges. Analysis of the content of some particular elements: hydrogen, oxygen, noble metals, mercury, uranium.

Department of the Atomic Nucleus Physics
Prof. Yu.P. Gangrski

INVESTIGATION OF NUCLEI WITH LASER RADIATION

Semester 8
16-6-0-2

Basic properties of laser radiation. Interaction between laser radiation and matter. Basic areas of nuclear research: single atoms count, measurement of the charge radii and nucleus moments, nucleus polarization, exertion of an effect on the rate of nuclear processes. The areas of laser application in nuclear physics.

Department of the Atomic Nucleus Physics
Prof. Yu.P. Gangrski

DIELECTRIC DETECTORS OF CHARGED PARTICLES

Semester 9
10-0-0-0

Interaction between particles and matter. The nature of charged particle tracks and mechanisms of their formation in dielectrics. Methods of track identification and their geometry. Investigation of basic registration, identification, and spectrometric properties of detectors. Application of dielectric detectors in physics experiments with heavy ion beams for investigation of rare radioactive decays and spectral composition of cosmic rays. Dielectric detectors usage in radiation dosimetry and radiography. Determination of sample age. Ecological research with the aid of dielectric detectors. Nuclear filters production and utilization.

Department of the Atomic Nucleus Physics
Associate Prof. S.P. Tretyakova

NUCLEUS THEORY

Semester 8
32-0-0-0

Nucleon-nucleon interaction, its main features. Single-particle model of a nucleus. Theses of the multi-particle shell model. Investigation of the nucleus dimensions. Electromagnetic methods (fast electron scattering, *X*-ray spectra of μ-mesoatoms). Nuclear methods of the nucleus dimension investigations. Electromagnetic transitions in nuclei. Generalized model of a nucleus. Single-particle potentials of deformed nuclei. Nuclear surface oscillations. Pair correlation model. Quasiparticle-phonon model of a nucleus, its theses and results. Interacting boson model. High-spin states of nuclei. Superdeformation. Calculations of the balanced deformations of nuclei. Giant resonances in nuclei. Theses of the theory of β-decay in nuclei and its application to the nuclei structure investigations. α-decay.

Department of Physics of Atomic Nucleus
Associate Prof. S.P. Ivanova

THEORY OF NUCLEAR REACTIONS

Semester 9
36-0-0-0

S-matrix and its main properties, optical theorem. Operational formulae for the scattering and reaction cross-sections. Diffraction approach to the

low- and intermediate-energy scattering. Composite nucleus and resonance effects with neutrons. Statistical model of the composite nucleus level density. Statistical theory of nuclear reactions with heavy ions, its specific features and restrictions. Optic potential. Direct inelastic nucleon scattering from nuclei, its main regularities. Distorted wave method, related channel method. Direct nuclear separation reactions. Peculiarities of interaction of heavy ions with nuclei. Application of the optic model to the description of interaction of heavy ions with nuclei. Elastic scattering of heavy ions. Statistical description of the interaction of heavy ions with nuclei. Light particle emission in reactions with heavy ions.

Department of Physics of Atomic Nucleus
Associate Prof. S.P. Ivanova

QUANTUM INTUITION LESSONS (Direct and Reverse Problems)

Semesters 8, 9
10-14-0-0

Some of the reverse problem history. Elements of the spectral control theory: what potential perturbation can move single energy levels to the assigned positions (without affecting others). Full sets of spectral parameters. How to move in space localization of states. How to set arbitrary spectrum level or generate a new one at the assigned position. How to control the widths of resonances and the positions of allowed and forbidden zones of periodic fields. Reverse problem equations. Comparison of quantum mechanics with continuous and discrete space variables (specific features of movement of waves along the lattices of channels and mixed configurations). Schroedinger equations of higher orders (4th, 6th, ...). Multichannel, multidimensional, and multiparticle problems. Remarkable examples of tunnelling (single-particle, multi-channel, multi-particle).

Prof. B.N. Zakharyev

NEUTRON OPTICS

Semester 10
20-0-0-0

Theoretical principles of neutron optics. Modern status of experimental neutron optics. Neutron wave properties, refraction and reflection of

neutron waves, full reflection of neutrons. Ultracold neutrons. Elements of diffraction theory and neutron interferometer. Neutron optics and quantum mechanics experiments.

Dr. A.I. Frank

IONIZING RADIATION SOURCES

Semester 8
12-0-0-0

Modern trends in accelerator development. Acceleration structures, accelerator magnet and vacuum systems. Charged particle injection and extraction, beam dynamics in accelerators and accumulators. Heavy ion accelerators. Cyclotron and its primary systems. Charged particle beam transportation, accelerator control systems. Charged particle sources. Practical application of charged particle beams.

Department of Physics of Atomic Nucleus
Prof. R.Ts. Oganessian

NEUTRON SOURCES

Semester 8
16-0-0-0

Modern neutron beam sources used for physics research. Nuclear reactors (pulsed and stationary), boosters and non-breeding targets of powerful electron and proton accelerators, neutron generators, various isotope sources and nuclear explosions. Details of Grenoble ILL reactor, Dubna IBR-2 pulsed reactor, and targets at the meson factories (of British ISIS type) as the most intensive and popular modern neutron sources. Physics principles of these facilities and their schematic designs. Neutron history and early neutron sources. Some projects: nuclear micro-explosion, laser (D,T)-implosion, etc.

Department of Solid State Physics
Dr. V.L. Lomidze

FUNDAMENTALS OF NEUTRON PHYSICS

Semester 8
32-0-0-0 (test)

History of neutron discovery. Main characteristics of neutron and neutron as a tool for matter investigation. Interaction between neutron and

nuclei, cross-section resonances, Doppler effect. Potential and resonance scattering, specific features of low energy scattering. Coherent phenomena. Methods of neutron registration. Principles of neutron transfer theory. Neutron diffusion in breeding and non-breeding environments. Neutron spectra. Stationary and non-stationary neutron moderation. Neutron pulses, timing moments, the folding theorem. Principles of thermalization theory. Neutron beams. Neutron moderators, cryogenic temperatures.

Department of Solid State Physics
Dr. V.L. Lomidze

NEUTRON SOURCES

Semester 9
32-0-0-0 (test)

General description of neutron. Neutron production reactions. Isotope sources. Neutron generators. High flux reactors. Electron and proton accelerators. Periodic and aperiodic pulsed reactors. Boosters. Neutron source quality in various types of neutron research. Nuclear explosions. Nuclear sources development trends.

Department of Solid State Physics
Dr. V.L. Lomidze

MODERN METHODS OF REGISTRATION OF PRODUCTS OF NUCLEAR REACTIONS AND NUCLEAR RADIATION

Semester 8
32-0-0-0

Classification of nuclear reactions with low and intermediate energy heavy ions and their characteristics. Different types of semiconductor, gas-filled, and scintillation detectors. Spectrometers based on these detectors: time-of-flight, magnetic, correlation, 4π-geometry spectrometers, etc. Use of these spectrometers in certain experiments on investigation of the reactions with heavy ions.

Department of Physics of Atomic Nucleus
Prof. Yu.E. Penionzhkevich

ION-OPTICAL METHODS IN A MODERN NUCLEAR PHYSICS EXPERIMENT

Semester 8
20-0-0-0

Particle beams and main conditions of experiments: intermediate energy proton accelerators, heavy ion beams, radioactive beams, accumulating rings, electron beams. Status of the ion-optical methods in the particle beam experiments.

Principles of the ion optics. Equation of the particle trajectory in a beam. Main elements of the ion-optical systems and their field (dipole and quadrupole magnets, sextupole lenses). Matrices of transformation of the particle trajectory.

Ion-optical devices: magnetic spectrometer, mass-separator, mass-spectrometer, velocity selector, particle separator, fragment-separator.

Specific features of a nuclear physics experiment at the accumulating rings with electronic cooling. Methods of the particle beam cooling. Electronic cooling. Experiments with an internal target at the ring. Parameters of the main rings of LEAR, IUCF, CELSIUS, ESR and examples of the nuclear physics experiments.

Accumulation ring as a precision mass-spectrometer. Crystallization of a beam. Atomic physics experiments at the rings.

Department of Physics of Atomic Nucleus
Prof. G.M. Ter-Akopyan

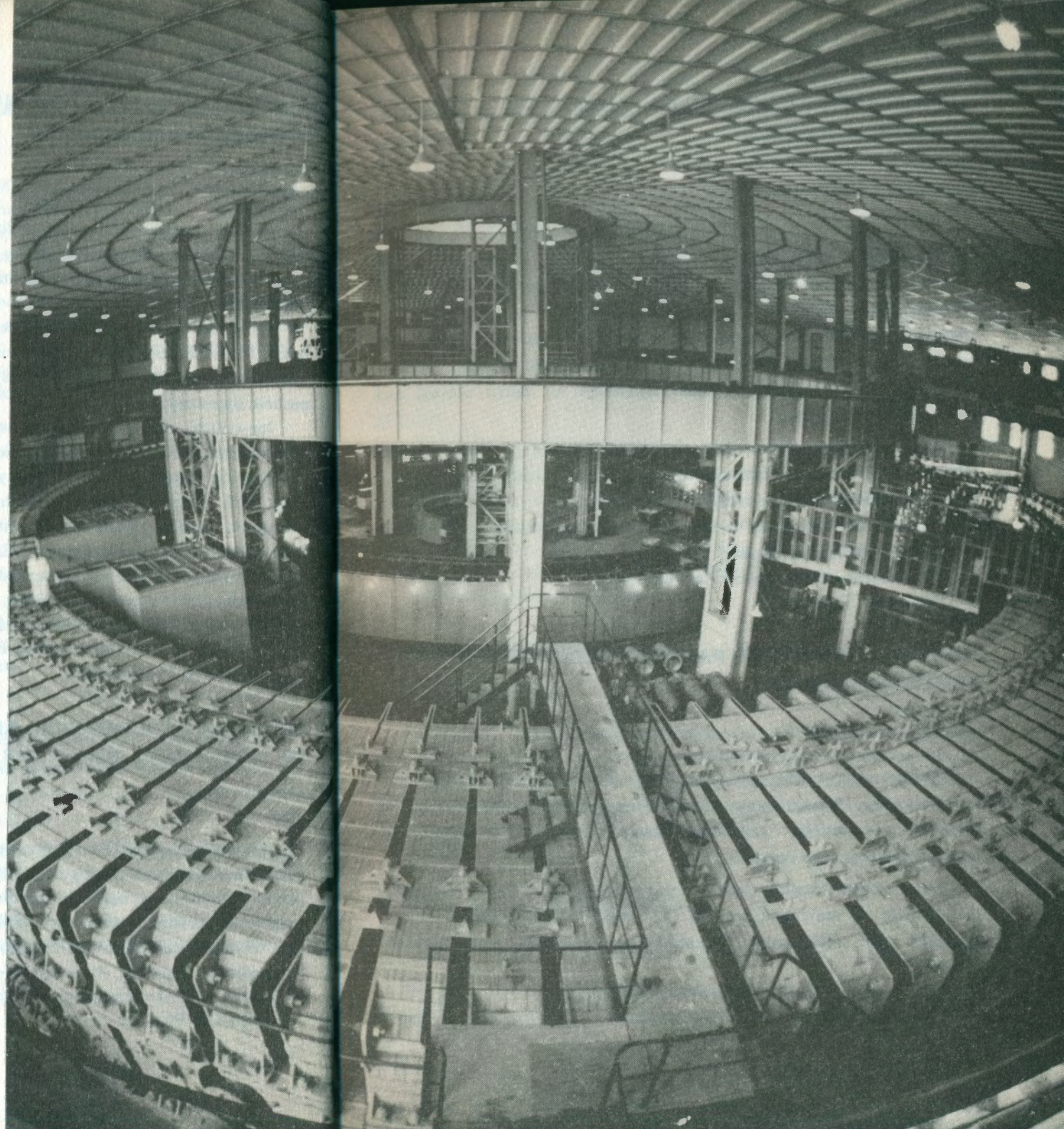
METHODS OF NUMERICAL ANALYSIS OF NON-LINEAR EQUATIONS OF PHYSICS

Semester 8,9
32-32-0-0

Newton's method for a non-linear algebraic equation. Non-linear equations. Continuous analog of Newton's method, parameter variation method, stabilization method. One-step iteration processes with assigned properties. Iteration process with minimum discrepancies. Connection with Newton's method. Some equations of non-linear physics: non-linear Schroedinger equation, Schwinger–Dayson equation, Pekar equation. Parameters of a physics model. Continuation method.

Prof. I.V. Puzynin

PARTICLE PHYSICS



INTERFERENTIAL PHENOMENA IN QUANTUM PHYSICS

Semester 10
32-0-0-0

Theoretical basis of physical processes in micro-world connected with interference of quantum system inner states. Analysis of principles and content of a unified «interferential language». Modern status and prospects for the most important applications in nuclear physics and elementary particle physics.

Department of Elementary Particle Physics
Prof. I M.I. Podgoretski I

STATISTICAL METHODS OF DATA PROCESSING IN NUCLEAR PHYSICS

Semester 8
32-0-0-0

Basic methods of mathematical statistics used in experimental physics for calculation of the measured magnitude errors. Initial problem of choosing the indirect measurement scheme to neglect systematic errors of different nature (instrument, methodical, subjective). Various aspects of statistical estimation of parameters and plausibility of theoretical hypotheses based on the maximum likelihood method. The problem of statistical error determination in the case of small samplings for initial normal and exponential distributions.

Typical nuclear physics and elementary particle physics problems related to the fluctuation of the number of registered particles. Details of the problem of deviation of the initial discrete distributions (Poisson and binomial) caused by electronic systems of particle registration. Correlation properties of nuclear processes.

Department of Elementary Particle Physics
Prof. A.A. Tyapkin, Prof. I M.I. Podgoretski I

MODERN METHODS OF PARTICLE REGISTRATION IN NUCLEAR PHYSICS

Semester 9
32-0-0-0

Various track chambers based on the gas discharge detectors of charged particles: pulse hodoscopic systems of Geiger counters, spark and stream chambers, proportional and drift chambers. Automatic pick-up of information from such detectors.

Fast electronic particle detectors providing additional information on the velocity or ionization loss of the particle (scintillation counters, threshold and differential Cerenkov gas counters, semiconductor detectors).

Department of Elementary Particle Physics
Prof. A.A. Tyapkin, Prof. Yu.K. Akimov

QUARK-GLUON STRUCTURE OF NUCLEAR MATTER

Semester 9
25-0-0-0

Theoretical prediction of the existence of quark-gluon plasma and principle indications of its existence. Experimental research to detect the quark-gluon plasma (current and planned). Experimental facilities. Spin phenomena in relativistic nuclei interaction. Exotic states.

Department of Elementary Particle Physics
Associate Prof. A.I. Malakhov

RELATIVISTIC NUCLEAR PHYSICS

Semester 8
25-0-0-0

Theoretical and experimental research in relativistic nuclear physics. Cumulative effect in nuclear interaction. Nuclear interactions in the space of 4-dimensional velocities. The principles of experimental facility construction. Basic detecting systems. Accelerators of relativistic nuclei. (synchrotron, nuclotron, LHC, RHIC) and their research programmes.

Department of Elementary Particle Physics
Associate Prof. A.I. Malakhov

QUANTUM CHROMODYNAMICS

Semester 9
28-0-0-0

SU(3) group and quarks. Non-Abelian calibration fields (gluons). Lagrangian and Feynman rules in quantum chromodynamics. Divergence problem and dimensional regularization. Renormalizational invariance. Asymptotic freedom. QCD application for description of deep inelastic processes.

Department of the Atomic Nucleus Physics
Dr. A.A. Vladimirov

ELECTROWEAK INTERACTION

Semester 9
32-18-0-0

Modern state of electroweak interaction theory and experiment. Weinberg-Salam-Glashow theory, methods of calculation of the primary electroweak interaction process cross-section. Experimental confirmation of the theory. Unsolved problems in the electroweak interactions physics.

Department of Physics of Elementary Particles
Prof. S.A. Bunyatov, Associate Prof. V.A. Dokuchayeva

CALIBRATION FIELD QUANTIZATION

Semester 10
20-0-0-0

General concept of calibration field quantization methods. Reduced quantization method. Functional integral. Secondary connection null modes and common variables. Derivation of the bound state equations.

Department of Physics of Atomic Nuclei
Prof. V.N. Pervushin

SYMMETRY IN PHYSICS

Semester 9
32-0-0-0

Principles of group theory. Examples: O(n), U(n), SU(n) groups, Lorentz and SL(2,c) groups, Poincara group. Group representations, non-reducible representations. Unitary symmetry of elementary particles.

Goldstone theory and Higgs' mechanism. Calibration symmetry in field theory. Spontaneous perturbation of calibration symmetry. Effective potential method, dynamic mechanism of symmetry perturbation. Principles of renormalization group method in field theory and some of its applications in description of elementary particle interaction processes. Anomalies.

Department of Physics of Atomic Nucleus
Prof. A.N. Sissakian, Associate Prof. I.L. Solovtsev

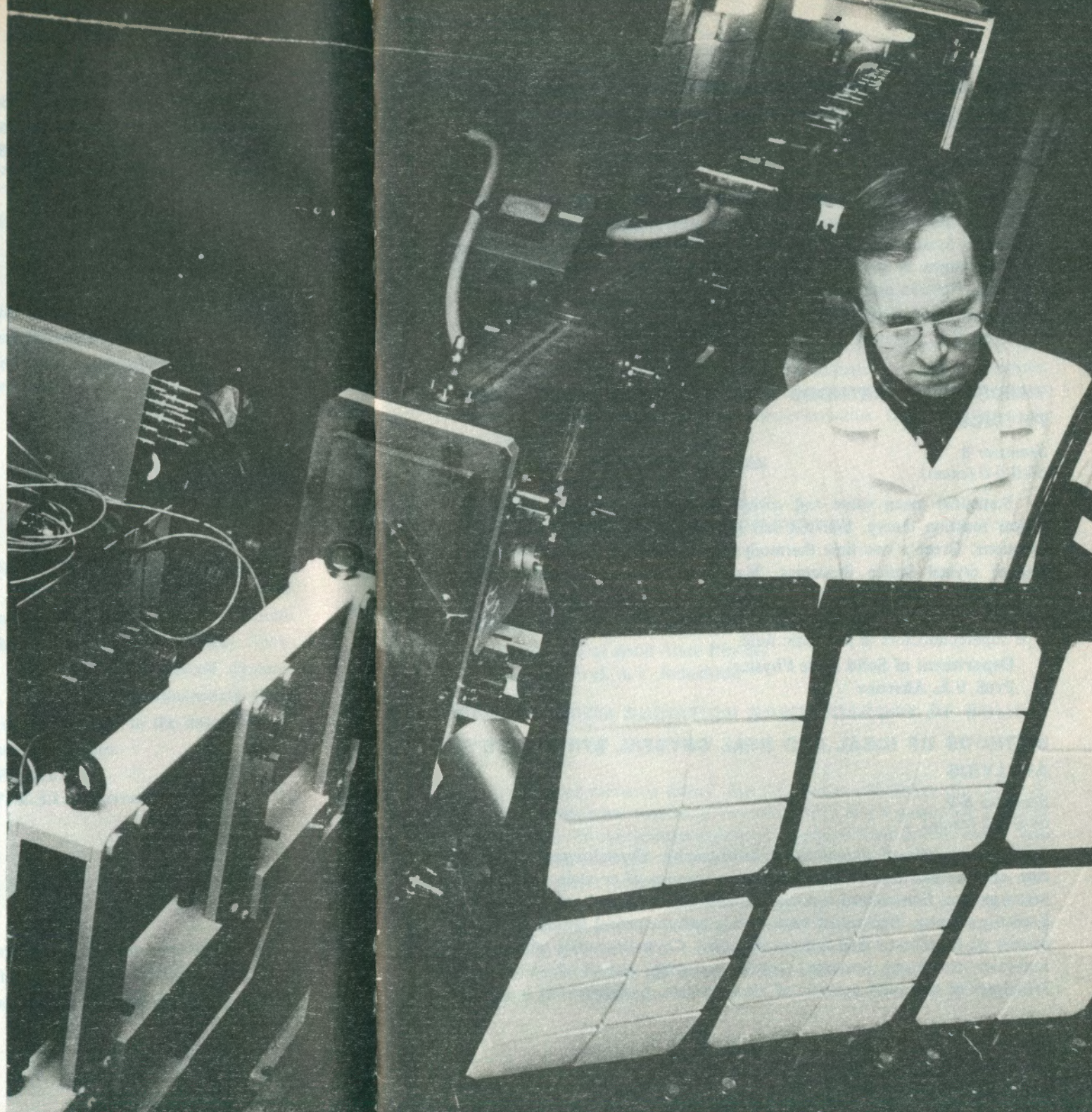
QUANTUM FIELD THEORY

Semester 9
32-0-0-0

S-matrices. Classical fields. Remaining quantities, energy-pulse tensor, field charge. Construction of the field Hamiltonian. Quantization of real scalar, complex scalar, and spinor fields. Normal and chronological multiplication of the field operators. Wick's theorem. Feynman's diagrams. Calculations of the process cross-sections and decay probability.

Department of Physics of Elementary Particles
Prof. N.B. Skachkov

CONDENSED MATTER PHYSICS



METHODS OF CONDENSED MATTER RESEARCH AT NUCLEAR REACTORS AND ACCELERATORS

Semester 8
60-0-0-0 (exam)

Charged particle accelerators. Neutron sources. Particle scattering from condensed matter. Elastic, small-angle, and inelastic neutron nuclear scattering. Synchrotron light sources. Interaction of photon with matter. Positive muons in matter. Impact of radiation on physical properties of materials. Neutron activation analysis.

Department of Solid State Physics
Prof. V.L. Aksenov

THEORETICAL METHODS OF THE CONDENSED MATTER PHYSICS

Semester 8
60-0-0-0 (exam)

Statistical mean value and correlation functions. Particle scattering. Linear reaction theory. Isolated and isothermal susceptibility. Relaxation functions. Green's two-time thermodynamic functions. Phonons in solids. Impure crystal lattice dynamics. Magnet phenomena in solids. Phase transitions and parameters of order. Solitons as quasi-particles in non-linear theories. Interacting mode theory for structural phase transitions. Second type superconductors in magnetic field.

Department of Solid State Physics
Prof. V.L. Aksenov

METHODS OF IDEAL AND REAL CRYSTAL STRUCTURE ANALYSIS

Semester 8-9
64-0-0-0 (exam)

Fundamentals of geometric crystallography. Crystallographic categories, systems and lattices. Point symmetry groups of crystals. Space symmetry groups. Generalized symmetries: anti-symmetry and color symmetry. Lattice geometry. Reciprocal vector basis and reciprocal lattice. Transformation of coordinates and indices in lattice. Crystallographic and crystallophysics coordinate systems. Crystal symmetry impact on

diffraction. Principles of structural analysis of ideal crystals. Assignment of indices to diffraction patterns. Radiation scattering from a real crystal. Scattering from crystals with extended defects.

Department of Solid State Physics
Prof. A.M. Balagurov

MATHEMATICAL PROCESSING OF RESULTS OF NUCLEAR PHYSICS INVESTIGATIONS OF CONDENSED MATTERS

Semester 9
32-0-0-0 (exam)

Random value and regression. Distribution function parameter evaluation. Maximum likelihood evaluations and their precision. Theory verification. Regression analysis. Data simulation and random number generators. Non-linear least square method and accuracy of LSM evaluations. Robust evaluation. Methods and strategy of non-linear minimization. Problem of data filtering. Discrete Fourier transformation. Deconvolution problem. Tikhonov regularization method.

Department of Solid State Physics
Associate Prof. V.B. Zlokazov

NEUTRON EXPERIMENT TECHNOLOGY

Semester 9
32-0-0-0 (exam)

Neutron beam formation. Monochromators. Detectors. Diffractometers. Inelastic scattering spectrometers. Polarized neutrons. Radiography.

Department of Solid State Physics
Associate Prof. Yu.V. Taran

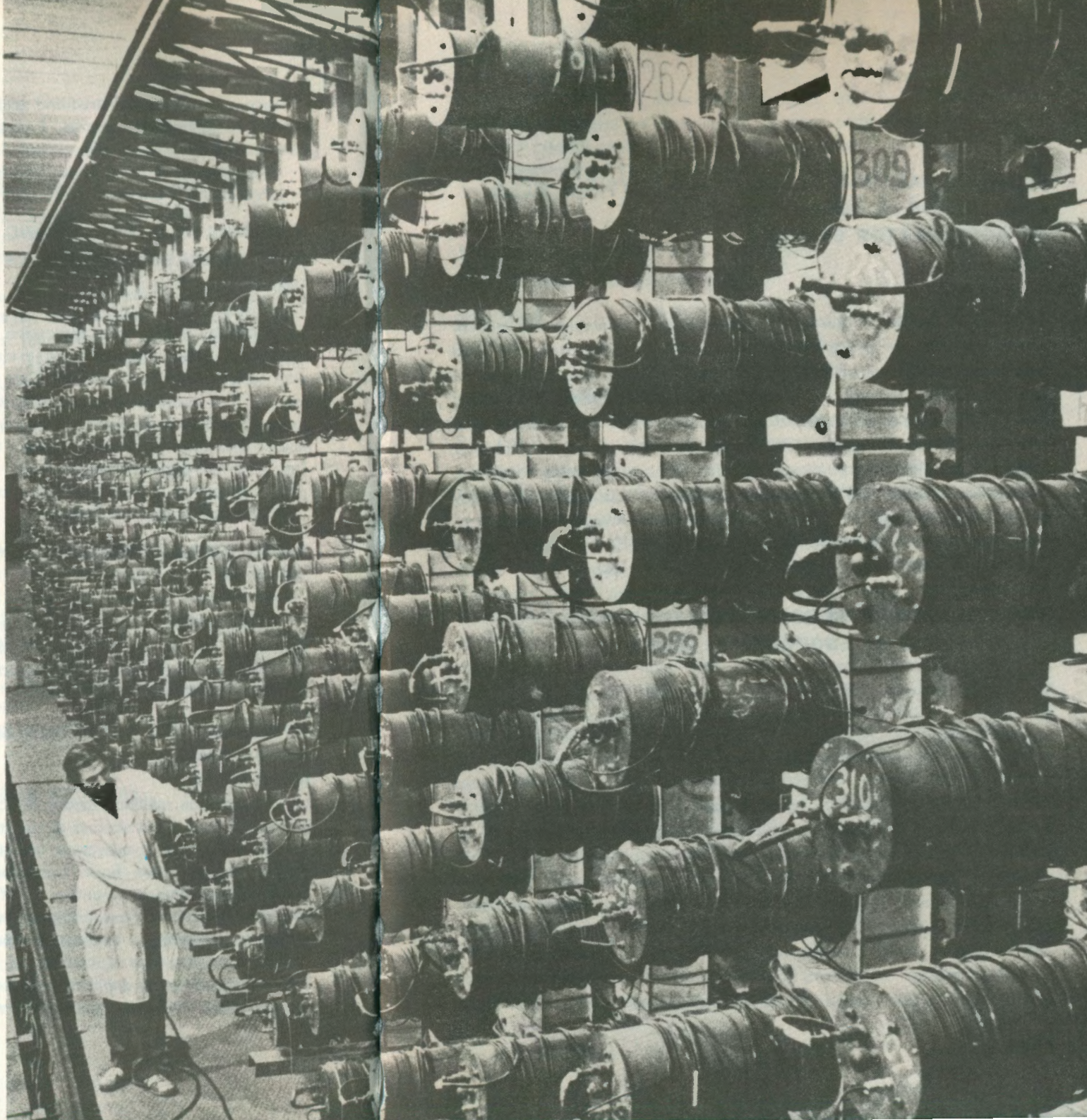
SYNCHROTRON RADIATION SPECTROSCOPY OF SOLIDS

Semester 9-10
64-0-0-0 (test)

Synchrotron radiation theory. Specific features of syncrotron radiation. Difference from other sources of radiation. 1,2,3 and 4 generation facilities for generation of synchrotron radiation, trends in their development. Synchrotron radiation beam formation methods, experiment equipment. Synchrotron radiation spectroscopy of solids, reflection and transmission methods. Vacuum-ultraviolet spectroscopy, processes of crystal luminescence, possibility of creation of solid state lasers. Theory and practice of *X*-ray fluorescence as a method of micro-impurity research in solids. Synchrotron radiation application to biology, medicine, micro-lithography.

Associate Prof. S.I. Tyutyunnikov

TECHNICAL PHYSICS



CHARGED PARTICLE ACCELERATOR PHYSICS AND TRENDS IN DEVELOPMENT OF ACCELERATOR CENTRES

Semester 8
32-0-0-0

Three branches of accelerator development. Principles of modern accelerator complex construction. The concept of orbit. Soft and hard focusing. Physics sense of the Transition Matrix. Twiss' matrix. Dispersion function. Orbits packing coefficient. The concept of resonances. Particle phase. Synchronism. Principles of auto-phasing. Space charge effects and methods of their calculation. The concept of coherent and non-coherent motion. Liouville theorem. Vlasov equation without derivation. Principles of stochastic electron and laser cooling. Colliders. Cyclic collider factories. Ways to achieve large luminosity. Non-linear colliders requirements.

Department of Technical Physics
Dr. I.N. Ivanov

ACCELERATOR BEAM PARAMETER CONTROL WITH THE AID OF LOOPBACK SYSTEMS

Semester 8
32-0-0-0

Longitudinal and transverse instability and its typical frequencies. Slow waves (waves of negative energy), conditions of their existence in the system. Beam-chamber connection impedance and its physics sense. Particle motion in frequency representation. The concept of impedance. Relation between the frequency shift (increment) and impedance and its reactive properties, using transversal instability as an example. The purpose of charged particle motion loopback control systems; a system schematic diagram. Frequency properties of the system and what determines them. Physics effects determining loopback system operation. Landau attenuation and its physics sense. Elements of loopback (pickup, electronics, kicker). Circuits of pickups and kickers (for transversal motion). Frequency representation of the beam deviation from the orbit, schematic layout of signal

processing system, its elements. Principles of longitudinal oscillation damping. Examples of accelerator systems with successfully realized loopback control systems of the beam parameters.

Department of Technical Physics
Dr. I.N. Ivanov

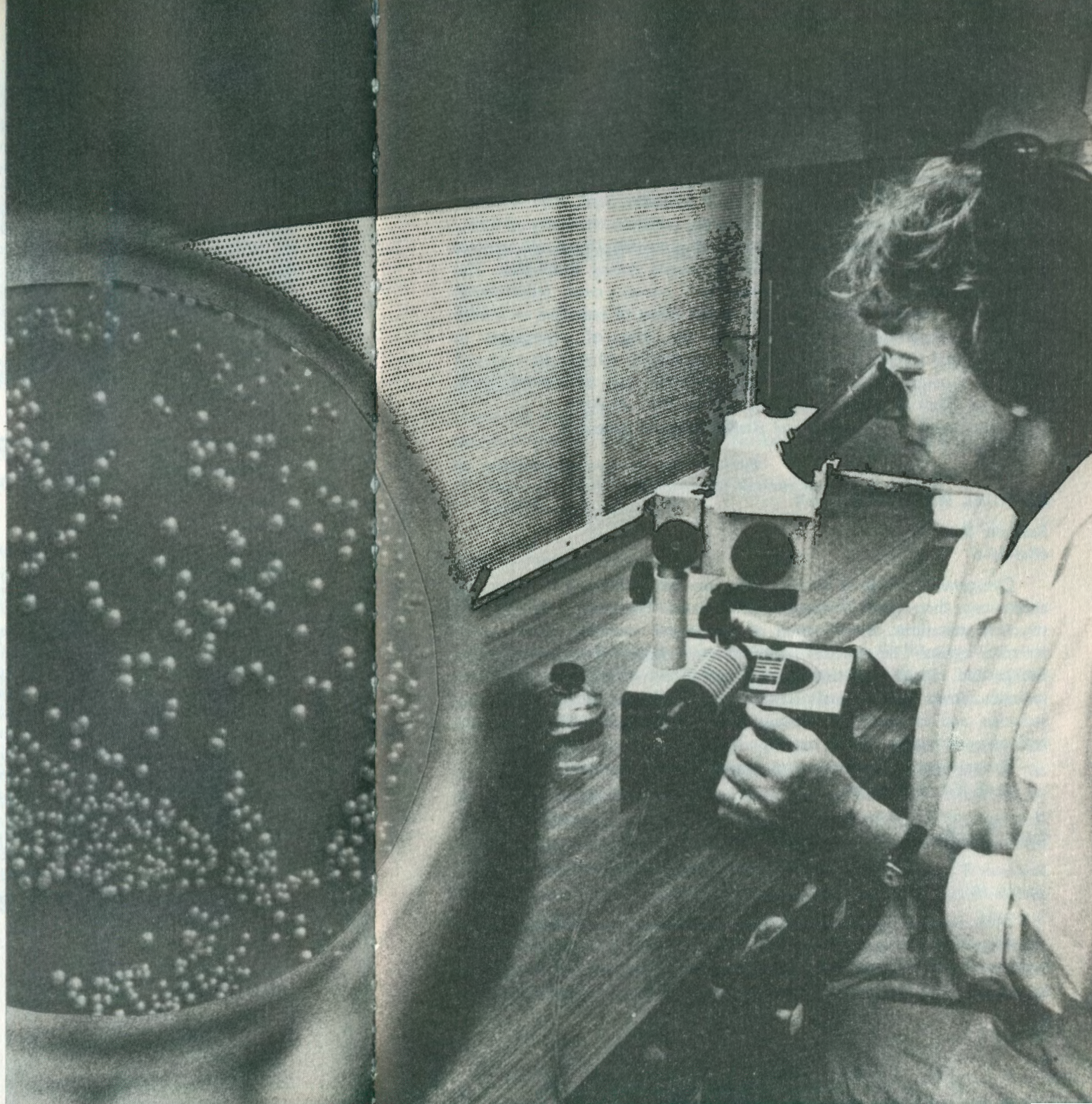
MODULAR ELECTRONIC SYSTEMS FOR SCIENTIFIC RESEARCH

Semester 8
32-0-0-0

A review of modular systems. The input/output systems of modern computers: PDP-11 and VAX (Unibus), LSI-11, μVAX (Qbus). Input/output buses of IBM PC (ISA, EISA), Microchannel (MCA) PS/2. IEC-625 apparatus interface, RS-232C series channel, CENTRONIX parallel channel. System of CAMAC standards. CAMAC crate and EUR 4600 units. Nomenclature and circuitry of the CAMAC units. Multi-crate systems with parallel connection (EUR 4600). Multi-crate systems with series connection (EUR 6100). Crates incorporating several controllers (EUR 6500). Transfer of data arrays in CAMAC crates (EUR 4100-suppl.). Software for operating the CAMAC units (ESONE/SR/01, ESONE/IML/01). System of VME standards. VME crate and bus (IEC 821 & 297). Nomenclature of the VME units. VSB bus for arrangement of sub-systems in VME crate (IEC 822). VICbus for intercrate formations (IEC 26.11458), VXI-extension of VME bus. OS9 operating system and programming systems in VME standard. FASTBUS standard for applications to the high-energy physics. Interruptions and bus seizure procedures in FASTBUS segment. Arrangement of FASTBUS multi-crate systems.

Department of Technical Physics
Dr. I.N. Churin

RADIOBIOLOGY



GENERAL RADIOBIOLOGY

Semester 8
48-6-20-6

Interaction of radiation with matter, types of radiation, ionization effect. Distribution of ions. The concept of radiation dose, dose measurement units, LET. Chemical effect of radiation: radiation chemistry of water, irradiation of biological substance outside of organism. Direct and indirect effect of ionizing radiation. The role of oxygen during irradiation. The effect of radiation on a cell: «dose-effect» curves, mean lethal dose, extrapolation number. Classic theories of the effect of radiation on a cell. Discovery of postradiation reparation, the role of reparation in radiobiological effects. Basic radiobiological models. Modification of cell radiation damage. Oxygen effect, radioprotectors and radiosensibilisers. Biological effect of various types of radiation, RBE problem.

Department of Radiobiology
Prof. V.I. Korogodin

SPECIAL RADIOBIOLOGY

Semester 9
48-6-20-6

Cytogenetic effects of ionizing radiation: cell split delay, chromosome aberrations, their types, formation mechanisms. The concept of spot and structure mutations. Modification of cytogenetic radiation damage with chemical agents. The effect of radiation on an organism. Natural radiation background. Small radiation doses. The effect of medium and large radiation doses on mammals and humans. Radiation sickness. Ionizing radiation and immunity. Radioadaptation and radiostimulation. Ionizing radiation and cancer. Use of radiation in therapy.

Department of Radiobiology
Prof. V.I. Korogodin

DNA DAMAGE AND REPARATION

Semester 8
24-0-4-10

DNA damage caused by chemical DNA-tropic agents. Radiolysis of DNA irradiated *in-vitro* and *in-vivo*. Types of damage, dose dependences. Methods of DNA damage determination. Procaryotes DNA damage reparation: basic ferments, types of reparation. SOS-reparation, methods of SOS-systems study. Yeast postradiation reparation: gene monitoring, reparation mutants. Gene recombination mechanism. Mammal cell radiation damage reparation. DNA reparation and radiotaxons. Connection between DNA reparation, mutation, cancer, and aging of organism.

Department of Radiobiology
Prof. Ye.A. Krasavin, Dr. N.A. Koltovaya

TOPICAL ISSUES OF RADIOBIOLOGY (Seminar)

Semester 8
0-0-0-28

Types of cell reaction to radiation. Mitotical and interphase death. Specific character of DNA molecular damage caused by radiation with different LET. Complex DNA damage: its role in lethal and mutation effects of irradiation. The problem of relative biological effectiveness of radiation with different LET. Peculiarities of cytogenetic damage induced by inonizing radiation of various types.

Department of Radiobiology
Prof. Ye.A. Krasavin

BIOPHYSICS PRACTICUM

Semester 8
0-72-0-0

Drosophila: fundamentals of biology and genetics. Primary test-effects and methods of their account: dominant and recessive lethal genes, visual mutations, microdeletions, reciprocal translocations. Principles of classic genetic and cytologic analysis of radiation-induced locus mutations. Spot-test for gene effects in somatic cells of drosophila. Molecular and biological

methods of investigation of radiation-induced mutations of the higher eucaryote cells.

Mammal cells in a culture: methods of cultivation and cloning. Cytogenetic analysis: the methods of culture preparation, chromosome aberration classification. Test systems for radiation-induced mutation research.

Yeast cells: methods of clone production and preservation of the genetically clean culture. Lethal and mutation effect of radiation. Selection and identification of biochemical mutants. Principles of hybrid analysis. Tetrade analysis and mapping methods. Yeast cell transcriptions. Extraction of recombination plasmoids.

Bacteria: methods of clone production and preservation of the genetically clean culture. Lethal effects of radiation. Methods of account of direct and reverse mutations. Ames' test-stamms. SOS chromo-test and SOS-LUX test. Transformations of bacteria.

Department of Radiobiology
Dr. R.D. Govorun

TOPICAL ISSUES OF RADIATION GENETICS (Seminar)

Semester 9
0-0-0-28

Pro and lower-eucaryote mutation mechanisms. Mutation effect of radiation with different LET. DNA reparation and radiation-induced mutations. Complex DNA damage and the process of mutation. Mutation effects of ionizing radiation of various types.

Department of Radiobiology
Prof. Ye.A. Krasavin

MATHEMATICAL MODELS IN RADIOBIOLOGY

Semester 9
28-0-0-6

Mathematical modelling: empirical formulae and biophysics models. Mathematical formalization of the fit principle. Biological stochastics and its account in modelling radiobiological effects. Probability model. Reparation models. Microdosimetric approach and its application to

radiobiology. Dual effect theory. Hunter-Schultz model. Molecular and biophysics models.

Department of Radiobiology
Dr. P.N. Lobachevski

RADIATION DOSIMETRY AND RADIATION DETECTION INSTRUMENTS

Semester 8
32-4-2-0

Interaction of radiation with matter. Fundamental concepts and measurement units of dosimetry. Physics foundation of dosimetry. Bragg-Gray theory, ionization method in dosimetry. Scintillation and luminescence methods of radiation detection. Photographic and chemical methods in dosimetry. Dosimetry of a mixed radiation field, LET-metry. Principles of ionizing radiation metrology.

Department of Radiobiology
Associate Prof. V.A. Aleynikov

RADIATION PROTECTION AND RADIATION ECOLOGY

Semester 9
32-0-0-0

Biological effects of ionizing radiation. The concept of acceptable risk. Physics values and units in radiation protection. Interaction of radiation with matter. Parameters of the ionizing radiation sources. Background irradiation of a human. Principles of irradiation norm-setting. The radiation safety standards. Protection from ionizing radiation. Anomalous and emergency radiation situations. Phases of accident, levels of intervention and protection measures. Fundamentals of radiation condition monitoring.

Department of Radiobiology
Associate Prof. V.A. Aleynikov

RADIATION GENETICS

Semester 9
48-40-30-10

Historic discovery by G. Meller on drosophila. Observable and lethal mutations. Inheritable structural changes in chromosomes, the «position

effect». The concept of pre-mutation damage. Point and structure mutations of a gene. Genetic effect of radiation on bacteria. Dose curves for mutations. Direct and reverse mutations. Role of DNA reparation in the induced mutation process. Mutations in the reparation mutants. SOS-reparation and mutations. Mutation process in yeast: spontaneous and induced mutations. Mutation effect of radiation on the cells of mammals. Chromosome aberrations and the cell cycle. Mechanism of the chromosome aberration formation. Point and structure mutations in the cells of highest eucaryotes.

Department of Radiobiology
Prof. I.D. Aleksandrov, Prof. Ye.A. Krasavin, Dr. R.D. Govorun

MOLECULAR BIOLOGY AND GENETICS

Semester 9
48-32-0-2

Sources, soon-to-be, and present status. The concept of gene: genetic, biochemical, and molecular aspects. DNA: structure and replication. Restriction analysis and strategy of molecular mapping. Genetic code and its properties. Molecular basis of the point mutations. «Central dogma» of the molecular biology. Transcription. Translation. Specialized transfer of information. Expression of bacterial genes and its regulations. Eucaryote genes and their expression. Organization of the procaryote genom. Eucaryote genom: paradox of the C quantity, unique and repeating sequences. Replications, recombinations, and DNC reparation: topology and ferments. Applied aspects: recombination molecules and cloning principles; gene banks.

Department of Radiobiology
Prof. I.D. Aleksandrov

MICRODOSIMETRY

Semester 9
32-0-0-0

Statistic nature of energy transfer in the interaction of radiation with matter. Basic units of microdosimetry, distribution functions of microdosimetric values. Connection between a single event spectrum and dose-dependent distributions, connection between the distribution moments

and dose. Relationship between functions in the extreme case of small doses. Correlation between semi-invariants of the dose-dependent distribution and initial moments of the single event spectrum. Geometric factor role. Experimental methods of microdosimetry. Microdosimetric methods.

Department of Radiobiology
Associate Prof. V.A.Aleynikov

COURSES GIVEN TO ALL THE UC STUDIENTS

AUTOMATION OF PHYSICS EXPERIMENT AND DATA PROCESSING

Semester 9
24-6-8-0

Organization of measurements, including multidimensional ones. Measurements systems and centres. Methods of data acquisition and spectrometric information processing (instrument response function for various types of radiation and detectors, methodical and mathematical basis of complicated spectra processing, automation of spectrometric information processing). The problem and methods of data compression. Electronics standards: CAMAC, FASTBUS, VME, etc. Computer networks. Local networks, JINET and ETHERNET at JINR as an example.

Department of Elementary Particle Physics
Prof. V.M. Tsupko-Sitnikov, Associate Prof. A.V. Solomatin

NUCLEAR ELECTRONICS

Semester 8
32-0-0-0

Elements, instruments, and methods of modern nuclear electronics in nuclear physics and elementary particle physics. Amplification, count, analog and digital signal processing, and registration of signals from nuclear radiation detectors. Specific character of the main detectors of radiaton (signal level, noise, means of amplification) and their connection with the registration instruments. Elements and methods of amplitude analysis in precision spectrometry. Coincidence method and registration of coincidence.

Department of Elementary Particle Physics
Prof. V.M. Tsupko-Sitnikov

NUMERICAL METHODS

Semester 8
32-0-0-0

Correct and incorrect problems, examples of incorrect problems. Regularizing functional, stabilizer, regularization parameter. Solution of degenerated and poorly defined systems of algebraic equations. Solution of the first type integral equations with the regularization method. Fourier series summing. Inverse task of the scattering theory. Continuous analogue of the Newton method in Banach space. Solution of non-linear tasks of mathematical physics using continuous analogue of the Newton method.

Department of Elementary Particle Physics
Prof. E.P. Zhidkov

COMPUTATION METHODS

Semester 8
32-0-0-0

Linear algebra computation methods. Cauchy problem for the system of conventional differential equations. Border problems. Methods of non-linear equation solution.

Dr. V.I. Korobov

COMPUTING STRUCTURES OF NUCLEAR RESEARCH CENTRES

Semester 9
20-4-0-0

Computing centre of the Laboratory of Computing Techniques and Automation, JINR: VAX-cluster, graphics facility of the Laboratory, ES computers, CDC-6500, Convex. Computing facilities of other JINR laboratories: SUN workstations, MicroVAX, VAXstation, DEC Alpha. JINR local computer networks: JINET, EtherNet. Communication protocols and computing environments: VAX/VMS, Unix, MSDOS, PC-Unix, DECNET, PCSA, PC-NFS, Novell, IPX, TCP/IP UUCP, X.25. Connection with global networks. KOKOS project. Software tools for data processing and simulation. PAW, X-WIN. CAD systems at workstations for mechanical and electronic design. RISC-processors and Transputers.

Dr. I.N. Churin

COMPUTER METHODS OF THE CONDENSED MATTER EXPERIMENT DATA PROCESSING

Semester 10
32-0-0-0 (test)

Methods of non-linear minimization. Newton, Gauss-Newton, gradient-like, stochastic methods. Conditional minimization. Filtering. Data accuracy and reliability. Use of certain applied computer programs for neutron distribution analysis.

Department of Solid State Physics
Associate Prof. V.B.Zlokazov

UNIX OPERATING SYSTEM

Semester 8
32-32-0-0

Introduction to UNIX. Basic concepts. UNIX file system. Commands of UNIX. Text editors. Electronic mail. DECO command shell (Commander). Programming in SHELL language of UNIX system. Technology of passage of problems in UNIX. Networking.

Dr. V.V. Korenkov

NUMERICAL METHODS

Semester 7
32-0-0-0

Lagrange and Newton interpolation formulae. Error estimation. Interpolation with multiple nodal points, error. Interpolation quadrature formulae. Newton–Cotes formulae. Trapezoid and Simpson formulae, their error.

Quadrature Gauss formulae, their error. Spline approximation, cubic splines, their error.

Methods of solving the linear algebraic equation systems.

Solution of mathematical physics problems on the grid sequence. Spline-collocation method.

Continuous analog of Newton method and its use in solving non-linear problems.

Prof. Ye.P. Zhidkov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THE TOWN OF DUBNA

Dubna, whose population is approximately 70,000, is situated about 100 km North of Moscow on the banks of the Volga, a major river of the European part of Russia. It is a town of science and high technologies: Joint Institute for Nuclear Research, nuclear equipment industry, Institute of Applied Acoustics, and a plant producing small airplanes make up most of Dubna. There is a station of satellite communication which participates in the International Telecommunication Satellite system, and the seismological control station outside the town. At a small aerodrome in the neighbourhood of Dubna, Russian national aerobatic team holds its training sessions several times a year. There is Russia's greatest private horsefarm in the neighbourhood of Dubna.

Dubna is a quiet town surrounded by fields, rivers, and forests. There are a lot of places within an easy bicycle ride where you can enjoy stillness and natural landscapes. In the winter there are a lot of possible routes in the vicinity of Dubna for lovers of Nordic skiing, with the ski tracks starting within the town.

Those keen on sailing will sure be pleased to know that there is a yacht club in Dubna.

There are many pine-trees, birches, maples, shrubs, and much grass in Dubna. In late spring one can enjoy the aroma of blossoming lilac and bird cherry in many places of the town. In late September and early October Dubna casts a spell over a visitor by abundance of bright yellow foliage on the trees and ground.

There is a good railway communication between Dubna and Moscow. It takes less than two hours and a half to get to Dubna from the Savyolovsky railway station of Moscow by a non-stop train. It is also possible to travel this way by bus. From the Sheremetyevo-2 international airport of Moscow, it takes about two hours to get to Dubna by car.

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On the cover: Reproduction of the painting by D.I.Blokhintsev

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