International Centre for Theoretical Physics

News from ICTP

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Dirac Medals 1988 to E.S. Fradkin and D. Gross

The 1988 Dirac Medal of the International Centre for Theoretical Physics (ICTP), Trieste (Italy), have been awarded to Professors Efim Samoilovich Fradkin (Lebedev Physical Institute, Moscow, USSR) and David Gross (Princeton University, Princeton, New Jersey, USA).

Efim Samoilovich Fradkin is honoured for his many fruitful contributions to the development of quantum field theory and statistics. Among these are his early work on functional methods including his formal solution to the Schwinger-Dyson equations for the Green's functions of interacting systems. This result has become a standard part of modern quantum field theory. Independently of Takahashi he discovered the generalized Ward identities for electrodynamics. These identities and their generalizations for non Abelian gauge theories are basic to the understanding of local symmetries. In his work on the Schwinger-Dyson equations, Fradkin drew attention to the zero-charge problem, a potential inconsistency in Abelian gauge theories whose later resolution in the non-Abelian theories led to the discovery of asymptotic freedom. At the same time as Schwinger and Nakano, Fradkin constructed a Euclidean formulation of quantum field theory, a development which was to have far-reaching implications for the development of statistical physics and string theory. His contributions to the quantization of relativistic systems with constraints are widely recognized. This work culminated in the Batalin-Fradkin-Wilkovisky quantization method which is used both in quantum field theory and in the theory of extended objects such as strings and membranes.

David Gross is honoured for his fundamental contributions to the understanding of nuclear forces at short distances and to the theory of superstrings. Together with F. Wilczek and, independently, H.D. Politzer and G.H. 't Hooft, he discovered the mechanism of asymptotic freedom in non Abelian gauge theories. This discovery, which accounts for the phenomenon of scaling in deep inelastic interactions, was central to the development of quantum chromodynamics as a viable model for the nuclear force. His invention, together with Harvey, Martinec and Rohm, of the heterotic superstring model enlarges the theoretical understanding of string theory and has provided a great stimulus to research in this subject. By its bold generalization from the picture of the relativistic string as a geometrical object embedded in spacetime, the heterotic model, seen as a two-dimensional conformal field theory whose left and right-moving modes are qualitatively different, is able to account for chirality in particle physics. This opened the way for a new understanding of the nature of spacetime and the unification of elementary forces.

The Dirac Medals of the ICTP were instituted in 1985 in view of the late Professor Paul A. M. Dirac's association with this Centre and are awarded yearly to senior physicists on Dirac's birthday, 8th August.

Professor Yakov Zeldovich, from the Space Research Institute, Moscow, USSR, and Professor Edward Witten from Princeton University, USA won the Medals in 1985, while Professor Yoichiro Nambu from the Enrico Fermi Institute for Nuclear Studies (University of Chicago, USA) and Professor Alexander Polyakov from the Landau Institute of Theoretical Physics, Moscow, USSR, were the recipients of the 1986 Medals. In 1987, the Medals were awarded to Professors Bruno Zumino (University of California, Berkeley, California, USA) and Bryce S. DeWitt (University of Texas, Austin, Texas, USA).

The selection Committee for 1988 includes Professors S. Lundqvist, R. Marshak, J. Schwinger, L. Van Hove, S. Weinberg and Abdus Salam. The Dirac Medals are not awarded to Nobel Laureates or Wolf Foundation Prize winners.

Contents

Heisenberg Prize to Dr. J.N. Onuchic

The 1988 Prize of the International Centre for Theoretical Physics (ICTP, Trieste, Italy) - named this time after the late Werner Heisenberg, Nobel Laureate for physics 1932 - was awarded to Dr. J.N. Onuchic from the University of São Paulo, Brazil, in recognition of his contributions to biophysics.

Dr. Onuchic works on the theory of electron transfer reactions with

applications to biology and chemical systems. For calculating the rates of these reactions, he has developed new theoretical models and techniques which permit a better understanding of fundamental questions in the dynamics of reactions in condensed matter such as adiabaticity criteria, quantum friction and quantum resonances. These models were very useful to address the question of mode-specificity in biophysical reactions and to show the importance of quantum effects in the primary events of bacteria photosynthesis.

The Awarding Ceremony of the Heisenberg Prize: (from left to right) Prof. G.C. Ghirardi, Director of the Department of Theoretical Physics of the University of Trieste and consultant to the ICTP, Prof. J.J. Giambiagi (Argentina), Member of the ICTP Scientific Council, Professor Abdus Salam, Director of the ICTP, and the awardee Dr. J.N. Onuchic (Brazil).

More recently, using some ideas from photosynthesis, Dr. Onuchic and his colleagues have proposed a device in molecular electronics, the "Shift Register Memory", which integrates designed electronic onto a silicon microelectronic substrate.

The Prize, a diploma, a medal and a US$ 1,000-cheque were presented to Dr. Onuchic by Professor Abdus Salam, Nobel Laureate 1979 and Director of the ICTP, in Trieste on Monday, 19 September 1988.

Frontier Crystals

by

*Fabio Pagan**

"In the sixties, solid state physics was essentially studying new effects, building new theoretical models. Now, in the eighties, physicists try to invent new structures the properties of which are tailor-designed. Previously we wanted to understand the nature of the physical world; now we rather want to modify matter, to build according to the necessities and to our wishes".

Andrea Frova, from the University of Rome, chairman of the conference on "Superlattices, microstructures and microdevices" which filled for five days the 300-seat lecture hall of the International Centre for Theoretical Physics of Trieste, synthetizes in these words the electronic revolution which in thirty years has brought us from the first rudimentary transistors to the sophisticated microprocessors of the computers of today and to those of tomorrow.

A revolution which has involved informatics, automatization, communications and which was represented in Trieste by two Nobel Prize Laureates who belong, to some extent, to the two distinct periods of development mentioned by Professor Frova: the 63-year old Leo Esaki, a Japanese by birth but settled since nearly thirty years at the IBM Laboratories of Yorktown Heights, New York, who won the Nobel Prize in 1973 for having invented the tunnel diode (the so-called "Esaki diode"); and the 45-year-old Klaus von Klitzing, a German from the prestigious Max-Planck-Institut in Stuttgart who won the Nobel Prize in 1985 for the discovery of the "Quantum Hall Effect".

The protagonist of this electronic revolution is the semiconductor or, in other words, this silicon or germanium or (more recently) gallium arsenide crystal the electric conductivity of which is between that of metals and that of substances which do not allow the passage of electrical currents at all such as glass and ceramics. These are the semiconductors, the basic material for the realization, in addition to the transistors, of the TV sets, these famous chips which constitute the "brain" of the computers as well as the components for fibre optics communication which little by little are entering the daily electronics. It was at the beginning of the 60's that very specialized semiconductors, made of successive very thin layers of materials with various electrical properties, were imagined first and made later. Carlo Bertoni from the University of Rome 2, scientific secretary of the Trieste meeting, explains: *"Those involved in pure physics understood quickly that these systems also allow the study of fundamental phenomena which have their roots in quantum physics. This is tantamount to saying that those quantum phenomena which govern the properties of atoms and molecules can be studied and realized on a 'mesoscopic scale', i.e.*

* *This article is a translation of the original published in the newspaper "Il Piccolo" of Trieste, Italy.*

on an intermediate scale between the microscopic scale of the phenomena and the macroscopic scale of the natural world. A scale which involves distances which are ten to a hundred times greater than those of the atomic dimensions. Moreover, such systems offer unique opportunities to material engineering, allowing the design of artificial semiconductors with properties different from the traditional semiconductors. This has made it possible to renew or to improve the electronic devices. Semiconductor lasers already commercially available are an example".

But how did the young Klaus von Klitzing succeed in making this frontier physics progress? This happened in 1980 at the laboratory of strong magnetic fields at Grenoble - a laboratory of the French National Research Council (CNRS) which also hosts German "brains" and equipment.

Von Klitzing started by investigating the behaviour of electrons in a practically bidimensional space, i.e. in a semiconductor with a thickness of just a few atoms and this at a temperature close to the absolute zero, one or two degrees above the -273°C, which is the lowest limit in matter. In these conditions, electrons remain virtually "confined", trapped in the semiconductor in what is defined in quantum mechanics a potential well. And the properties of the material are completely changed so far as the passage of electric current is concerned.

This is not all. At this point, von Klitzing applied a magnetic field perpendicular to the plane of the semiconductor. In this way, electrons were withheld on their orbits around the atom fixed in a quite abnormal way which is called "total quantization" by the experts. And this phenomenon was named "Quantized Hall Effect" after the name of an American scientist of the last century who was the first to study this type of phenomena.

What are the consequences of the experiments which gave the Nobel Prize to von Klitzing? The most important one is that, in these conditions, it was discovered that the electric resistance does not depend any more on the material utilized, but that it remains the same, a truly universal constant, an "absolute" resistance which is now a new measure unit, the "Klitzing", which is much more accurate than the traditional "Ohm" used in the traditional measurement of resistances. Samples with a resistance of half a Klitzing are already available. This amuses von Klitzing very much as if he were a "halved physicist".

One should, above all, underline one aspect of this research developed by von Klitzing and by other researchers (in Italy, such phenomena had been studied in the 20's by the physicist and politician Orso Mario Corbino, the man who created the famous "group of Via Panisperna" where illustrious Italian physicists like Enrico Fermi started their research). This research is done through technologically refined experiments which are able to produce a new physics, a fundamental knowledge which, in turn, can be used for producing new industrial devices. An evidence of this is the presentation at the ICTP of papers signed by scientists from famous "sanctuaries" of high technology: Hewlett-Packard and Xerox, the Bell Laboratories of AT&T and Philips, the MIT and the Max-Planck-Institut, Cavendish Laboratories and Thompson, and then Japanese, Israeli, Soviet and Chinese centres and, of course, IBM, one of the official sponsors of the Conference.

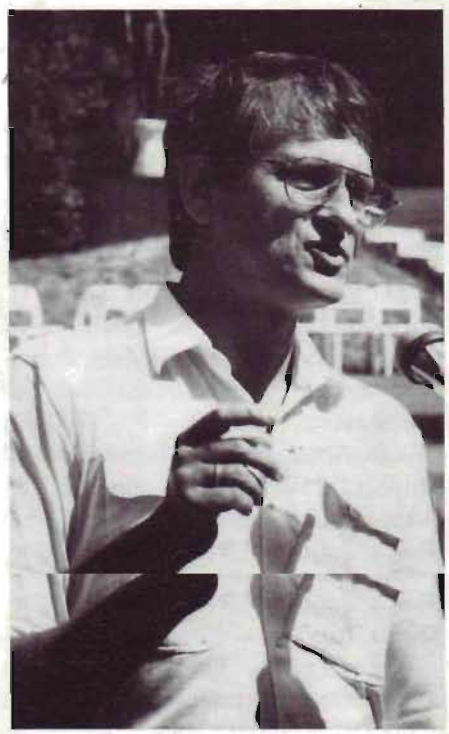
Science and Family

Interview with Professor von Klitzing

by
Fabio Pagan

Q.: Dr. von Klitzing, when you received the Nobel Prize, three years ago, you were only 42. It is often said that once he has won the Nobel Prize, a scientist does no longer have great objectives in his professional life. Is this also true for you, though you are so young?

A.: "I hope not. For the time being, I travel a lot, I continue my research and, above all, I am interested in helping scientists who are younger than me. This is also one of the reasons why I have come several times to the International Centre for Theoretical Physics where so many young people from the Third World and from industrialized countries do come for work. At the Max-Planck-Institut in Stuttgart, I am one of the ten Directors for research, in physics and in chemistry, who are involved in solid state: superconductors, semiconductors, structure of materials. In my group, we are thirty or forty from sixteen different nationalities. There is a great turnover of people, visiting professors who come for one year or two, young scientists working on their Ph.D... The atmosphere is international, very stimulating. Automatically, the directors of the institute are also professors at the university. But after the Nobel Prize, I had no time any more for teaching.



Prof. K. von Klitzing

Q.: Research on semiconductors has a rather fast fall-out on technology, on industry...

A.: "Of course, but I am interested in the basic physics which is behind these phenomena which appear at the atomic level. The big technological thrust comes from Japan: new devices for communication and the supercomputer.

Some time ago, the Japanese were specialized in copying new things from America and Europe and sell them. Nowadays, instead, they are also involved in a big fundamental research effort in their laboratories.

Q.: You have studied an always worked in Germany. However, you were born in a region which is now part of Poland.

A.: "Yes, I was born in a small village near Poznan in 1943. Then two years later, my family came to the West. Next week, however, I shall return with my father to the place where I was born, for the first time, taking advantage of a conference on semiconductors which will take place in Warsaw. Then I will travel to China, Japan... for this, when I am at home, I try to stay as much as I can with my wife and my three children. It seems to me that I never have enough time for them...".

Activities at ICTP from July to September 1988

Title: MINI-WORKSHOP ON MECHANISMS FOR HIGH TEMPERATURE SUPER-CONDUCTIVITY (20 June - 29 July 1988).

Organizers: Professors G. Baskaran (Matscience Institute of Mathematical Science, Madras, India), A.R. Bishop (Los Alamos National Laboratory, USA), E. Tosatti (International School for Advanced Studies, ISAS-SISSA, and ICTP, Trieste, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP, Trieste, Italy).

Lectures: The slave boson approach to the extended models of high temperature superconductivity. Hole correlations in the Hubbard model. Antiferromagnetism and superconductivity. Electronic transfer of local pairs and superconductivity in metal oxide compounds. Superconductivity in chain-like structures. On possible extensions of the Gutzwiller Ansatz. Electron correlation and antiferromagnetism in high-T_c superconductors. Perturbative treatment of local correlations in Cu-O planes for high-T_c superconductors. Spin correlations, excitations of spin-1/2 Heisenberg antiferromagnet on square lattice. Spin-hole models for CuO_2 layers in superconducting oxides. Exact excitation spectrum of 1-d Hubbard model. Phase diagram of d-wave superconductors in magnetic fields. Numerical simulation of high T_c superconductivity. Resonating valence bond picture of high T_c superconductors. The short-range RVB superconductor. Connection of RVB with QHE. Numerical simulations of RVB. Approach to strongly correlated systems with and without slave bosons. What do high T_c experiments tell theoreticians. Exact states and variational states of a periodic two-dimensional cluster of the Heisenberg model. Parameters of a Hubbard Hamiltonian to describe superconducting Cu oxides. Charge fluctuation pairing in the extended Hubbard model. High energy spectroscopies of high T_c superconductors. Two or three dimensionality of high T_c superconductors.

Microconference on mechanisms for High-T_c superconductivity: About the possibility of superfluid transition in weakly non-ideal Fermi-gas with repulsive interaction between particles. Possible superconductivity on the junction surface of dielectric La_2CuO_4. On the RVB theory of high T_c superconductivity. U(1) gauge theory as a collective field of Hubbard model. Superconductivity due to correlation effects. Effect of quantum fluctuations on the Gutzwiller-approximation solution of the Hubbard model. On the Gutzwiller-approximation solution of the Hubbard model. Twinning plane superconductivity in high T_c superconductors. Transfer matrix method for solving spin-1/2 1-D Heisenberg model. Quasi particles in the 1-II Hubbard model. Critical temperature of layered high T_c superconductors. Josephson junctions in $yBa_2Cu_3O_7$ single crystals. The calculation of thermodynamic characteristics of YBCO in the model of strong electron-phonon coupling. Optical calculations for La_2CuO_4 based superconductors. Possible mechanism for high T_c superconductivity: A multicomponent plasma model. Superconductivity in the nearly half-filled Hubbard model with strong on-site correlation. Simple spin hole model for magnetic correlations in copper oxide superconductors. Microscopic origin of effective attractive interaction in a Hubbard type Hamiltonian for the Cu-O plane. Common excitonic mechanism for CuO_2 and BiO_3 based perovskites. Possible occurrence of band interplay in high T_c superconductors. Superconductivity and impurities in layered systems.

The workshop was attended by 74 lecturers and participants (33 from developing countries).

Title: RESEARCH WORKSHOP IN CONDENSED MATTER, ATOMIC AND MOLECULAR PHYSICS (20 June - 30 September 1988).

Organizers: Professors P.N. Butcher (University of Warwick, UK), F. Garcia-Moliner (Instituto de Ciencias Materiales, Madrid, Spain), S. Lundqvist (Chalmers University of Technology, Gothenburg, Sweden), Chi Wei Lung (Institute of Metal Research, Academia Sinica, Shenyang, P.R. China), N.H. March (University of Oxford, UK), K.S. Singwi (Northwestern University, Evanston, USA), E. Tosatti (International School for Advanced Studies, ISAS-SISSA, and ICTP, Trieste, Italy), M.P. Tosi (University of Trieste and ICTP, Trieste, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP, Trieste, Italy).

Lectures: Many-body effects in inversion layers. Field theory of phase separation in first-order phase transitions. Electronic structure of high-[illegible] transitions. Electronic structure of high-T_c superconductors. Ballistic aggregation. Surface deconstruction of Au(110). Pair potentials in disordered alloys. Study of chaos in quantum dissipative systems. Electronic structure and formation of magnetic moments in compounds and alloys. A new approach in the theory of fractals. Fermi liquid picture for disordered electron system. Importance of the atomic structure of dislocations on plastic behaviour of materials. Supercritical fluids: Their behaviour and peculiarities. Magnetic penetration in Hi-T_c superconductors. Atomic structure of grain boundaries. Vibrational properties of disordered materials (including also quasicrystals

and fractal systems). Density functional theory in magnetic fields. Atomic level stresses and structure of glasses and liquids. Initial stages of heteroepitaxial interface formation: GaAs on Si and Si on GaAs. The stability of different types of polarons. Wigner crystallization of electrons on helium layers: nonlocality and substrate screening effects. Particle and wave properties of solitons. Quasicrystals: An overview. Simulations of quasicrystal growth. Electronic states in quasicrystals. Electrons and phonons in superlattices. Excitons in one-phonon resonance Raman scattering. Universal conductance fluctuations. Tunneling in quantum Hall effect. Charge transfer excitations and high-T_c superconductivity. Differential geometric aspects of the theory of ferroelectricity. Hopping relaxation and photoconductivity in disordered semiconductors. Freezing in glasses and spin glasses. Density wave theory of quantum Wigner crystallization. The concept of quantum-mechanical stress in Coulomb systems and its consequences. Remarks on collision processes. Damping of zero-sound in liquid ^{3}He. Superconductivity in high magnetic fields. Resonant tunnelling and ballistic transport in high magnetic fields. Nonlinear theory of deformable solids with quasiparticles. Local field corrections and the influence of exchange and correlation on the microscopic dielectric function of copper. Transport and phase transitions in dense partially ionized gaseous and solid state plasmas. Charge dispersion of polyelectrolytes. Random fluctuations of energy bands and nonequilibrium phenomena in semiconducting slid solutions. Ground state properties of low-dimensional magnetic systems. Bond particle model for semiconductor melts and its application to liquid structure of germanium. Computer simulation of liquid crystal surfaces. The roles of defects in phase transitions in complex oxide crystals and some applications. Quantum and statistical mechanics of non-Hamiltonian systems. Analytic solutions for the anisotropic Heisenberg model with arbitrary dimensionality. Many body effects in defect properties of binary solids. Properties and some novel phenomena determined by nonequilibrium 2D plasma. Electron correlation in conducting polymers. Mott transition: Low energy excitations and superconductivity. Pairing mechanism in high-T_c superconductors. Algebraic Bethe Ansatz with applications to multicomponent nonlinear Schrödinger model.

Working Group Seminars: Lagrangian description of some nonlinear phenomena. Partition function zeroes in statistical mechanics: Application to phase transitions. Doping superlattices. Electronic properties of doped semiconductors. Matching techniques and applications. Characteristic times for resonant tunnelling in 1D. Random network of cellular automata. Fracture in materials. Study of creep fracture by internal friction method. Retardation effects in 1-dimensional Peierls systems. Stationary solutions of spin lattice systems. Is the interior of a neutron star a type II superconductor? On the thermal quenching of the photoconductivity of a-Si:H. Interaction of hydrogen with dislocations. Theory of surface phonon polaritons in superlattices. The Lorentz gas. The simplest model of kinetics of particles and quasiparticles. Resonant tunneling and universal conductance fluctuations. Two-band model for graded $Al_xGa_{1-x}As$-GaAs superlattices. On quantum diffusion of hydrogen in transition metals. Obtaining dynamics from multifractals. New dimension in multifractals. Theory of exciton in GaAs/GaAlAs quantum wells. Size-dependent properties of small 3-D transition metal clusters. Optical properties of strained layer superlattices. Radiation enhanced diffusion of Ag in soda-lime glass. One-dimensional electron transport. Fractal dimension measured with perimeter/area relation and its relationship with fracture properties of materials. Electro-modulated interfacial optics. Nature of ion migration in superionic fluorites. Vertical and longitudinal transport in 2D systems. Quasicrystal dynamics. Observation of defects and magnetic domains by X-ray topography. Rigorous theorems in the electron theory of surfaces and interfaces. The role of the order parameter in a liquid crystalline phase transition. Nonlinear excitations in the Heisenberg chain. DX centre in GaAs. Quantum diffusion of defects. Lightly doped quantum wells: Monte Carlo simulation. Dissolution of B-doped Si(100) layers. Weakly first order (or nearly second order) phase transitions. Elastic fields of disclinations in a non-homogeneous medium. Electronic structures of strained Si/SiGe superlattices. Density functional theory and atomic shell structure. Deep levels in semiconductors under uniaxial stress. Bimetallic systems using density functional theory. Dynamic of continuous time random walk. Atomic representation: An application to the study of Auger spectra of transition metals. Fröhlic electron-phonon interaction in superlattices. On the possibility of superfluidity in Fermi gas with repulsive potential. Interband resonant polarons in the semimagnetic zero-gap semiconductor $Hg_{1-x}Mn_xTe$. Positron annihilation studies on point defects in semiconductors and ceramics. Structural characteristics and defect effects on electric transport properties of TiS_2. Gauge theory of defects and elastic precursor decay. Graded-gap semiconductors. Optical quantum size effects in chemically deposited PbSe films. Phase transition and high pressure behaviour of compound semiconductors. Indirect interaction in submonolayers and sets of noble metal adatoms on jellium. Thermopower in semiconductor quantum well structures. Structural characterization and fatigue behaviour of a Carbon-implanted Nickel. The soliton behaviour of crack propagation. Vibration property of one-dimensional quasilattice. Photoreflectance of $In_xGa_{1-x}As/InP$ multiple quantum wells. Dynamical equations describing electrons and holes in a semiconductor. Induced representations of groups in the theory of continuous phase transitions.

The workshop was attended by 284 lecturers and participants (241 from developing countries).

Title: SUMMER SCHOOL IN HIGH ENERGY PHYSICS AND COSMOLOGY (27 June - 5 August 1988).

Organizers: Professors G.F.R. Ellis (International School for Advanced

Studies, ISAS-SISSA, Trieste, Italy), G. Furlan (University of Trieste, Italy), J. Pati (University of Maryland, USA), S. Randjbar-Daemi (ICTP, Trieste, Italy), E. Sezgin (ICTP, Trieste, Italy), and Q. Shafi (University of Delaware, USA).

Lectures: Overview of astroparticle physics. Introduction to supersymmetry (SUSY, SUGRA). Overview of unified theories. Phenomenology of the standard model. Quantization of systems with constraints. Introduction to string theories. Compactification in string theories. Conformal invariance and two-dimensional field theories. Symmetry and low energy string theory. Renormalization group and the σ model approach to strings. Dynamical evolution of cosmic strings and superconducting. Complex manifolds and discrete symmetries in superstring compactification. Hidden symmetries in superstring theories. Addressing the flavour problem through supersymmetry and compositeness. Effective Lagrangian in string theories. Physics beyond the standard model. An overview of supermembrane theories. Superstrings and differential geometry. Effective nonrenormalizable theories; superstring-inspired models. Inflation through supersymmetry and compositeness. The early universe: review and key questions. Big bang nucleosynthesis: neutrino counting, quark-hadron transition, etc. Inflation does not necessarily imply W = 1. Evidence for dark matter (including lensing). Large scale structure: cosmic strings, late time phase transitions, etc. Non-baryonic dark matter: candidates and abundances. Baryonic dark matter. The age of the universe. Origin of structure: linear and non-linear processes. Large scale structure of the observed universe. Non-topological solitons as dark matter candidates. Spectrum and anisotropies of background radiation (including millimetre excess). Large scale microwave background anisotropy. Cautionary comments on the relation of particle physics and cosmology.

Conference on Phenomenology in High Energy Physics (25-29 July): Heavy flavour physics. Fermion masses and mixing. Probing the standard model in hadron colliders. Symmetry breaking: the standard model and superstrings. Status of CP violation. Non-accelerator particle physics (Kamioka, IMB and other results). Supersymmetry signals at Tevatron, SLC and LEP. Searches for rare decay modes of the K-meson. Physics at Gran Sasso. Particle physics and cosmology. Recent developments in lattice gauge theories. Dark matter candidates and their detection. Status of neutrino physics. Physics beyond the standard model. U(1) anomaly effects in polarized electroproduction. Supernova 1987a. CKM matrix elements. Superstring-inspired models.

The school was attended by 195 lecturers and participants (133 from developing countries).

Title: ADRIATICO RESEARCH CONFERENCE ON "COMPUTER SIMULATION TECHNIQUES FOR THE STUDY OF MICROSCOPIC PHENOMENA" (19 - 22 July 1988).

Organizers: Under the chairmanship of Professor S. Lundqvist (Chalmers University of Technology, Gothenburg, Sweden): Professors F. James (CERN, Geneva, Switzerland), A. Nobile (International School for Advanced Studies, ISAS-SISSA, Trieste, Italy) and C. Rebbi (Boston University, USA), with the co-sponsorship of the International School for Advanced Studies, ISAS-SISSA, Trieste, Italy.

Lectures: Survey of particle methods in simulation. Monte Carlo and molecular dynamics studies of nucleation. Unified approach to molecular dynamics and density functional theory. Scientific simulation on the Connection Machine. Improved lattice action and redundant operators. QCD with dynamical fermions. Neural networks as models of associative memories. Non-universal critical slowing down in Monte Carlo simulations. What can you learn by computing partition functions? Computer simulation of strongly interacting fermion systems. A general cluster updating method for Monte Carlo simulations. Gauge theories for high temperature superconductors. Path-integral simulations of Lennard-Jones solids and liquids. A scaling Ansatz for the Swendsen-Wang dynamics. Finite size effects in nucleation. Monte Carlo study of Ising model on quasicrystals. World prospects and activity on high performance computing. Monte Carlo algorithms for many-fermion systems. Computer simulation of the wetting transition. QCD-PAX, the Japanese lattice gauge project. Molecular dynamics simulation of a chemical reaction. Simulation on parallel processor based on multi microprocessor network. Monte Carlo renormalization group studies of spin models. Quantum Monte Carlo simulation of the two-dimensional spin 1/2 XXZ model. Computer simulation of conformational properties on n-butane liquid. Computer simulations of excitations in spin chains. Monomers, dymers, polymers and fermion determinants. Computer simulation of the ground-state properties of many-fermion systems.

The conference was attended by 47 lecturers and participants (16 from developing countries).

Title: ADRIATICO RESEARCH CONFERENCE ON "TOWARDS THE THEORETICAL UNDERSTANDING OF HIGH T_C SUPERCONDUCTORS" (26 - 29 July 1988).

Organizers: Under the chairmanship of Professor S. Lundqvist (Chalmers University of Technology, Gothenburg, Sweden): Professors E. Tosatti (International School for Advanced Studies, ISAS-SISSA, and ICTP, Trieste, Italy); M.P. Tosi (University of Trieste and ICTP, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP, Trieste, Italy), with the co-sponsorship of IBM and International School for Advanced Studies, ISAS-SISSA, Trieste, Italy.

Lectures: Recent progress in high T_c superconductors. Superconductivity and magnetism in high T_c oxides. Treatment of strong electron correlations in high T_c materials. Anomalous electronic properties of high T_c superconductors. Experimental insight into the mechanism of high T_c superconductivity. ODLRO in various proposed models of high T_c superconductors. Binding of holes with the effective single band Hamiltonian for CuO_2 layers. Spin polaron pairings and high T_c superconductivity. Spin waves

and superconductivity. A two-band superconductor with a narrow band near the Fermi level. Electronic properties of strongly correlated systems. RVB theory: an overview. RVB vs. BCS. RVB state in 1 and 2 dimensions. RVB: A new state for mixed valence systems? Holes in Cu-O planes: Exact diagonalization and renormalization group results. The electronic structure of high T_c materials. Electronic properties and the nature of the superconductivity state in the high T_c materials. Critical currents in high T_c superconductors. Charge fluctuation in $YBa_2Cu_3O_7$ from XPS and Auger spectroscopies. Symmetry of the $3d^9$ Ligand hole induced by doping in $YBa_2Cu_3O_{7-\delta}$. Photo-induced infrared absorption in 1-2-3 system. Spin correlations in superconducting $La_{2-x}Sr_xCuO_4$. Spin correlations and their interaction with charge carriers in $La_{2-x}Sr_xCuO_4$. Comparison of Hall number, hole concentration in high T_c superconductors. Transport and magnetic properties of $(La_{1-x}Sr_x)_2CuO_4$ systems. NMR studies of high T_c superconductors. Elastic modulus, internal friction and oxygen ordering in Y-Ba-Cu-O. Elastic properties of high T_c materials; C_p (spec. heat) near T_c. Fermi liquid behaviour and its breakdown in the 2-dimensional Hubbard model. Magnetic mechanism of the superconductivity. Numerical simulations of high T_c superconductivity. Hole attraction in more band extended Hubbard model. Antiferromagnetism and RVB in the 2-dimensional Heisenberg model. Pairing-bag in superconducting oxides. Magnetic frustration model for superconducting oxides. Charge fluctuation pairing in the extended Hubbard model. Kondo lattice Hamiltonian for high T_c superconductors. Strong electron-phonon coupling and polaron formation in metal oxides. Magnetic polarons and superconductivity in Hubbard model with intersite interaction. Macroscopic magnetic properties of YBaCuO crystals.

Short communications: Recent research related to the mechanism of high T_c superconductivity: ^{17}O NMR, angle-resolved photoemission and isotope effect. Electronic transfer of local pairs on superconductivity in metal-oxide superconductors. Elastic strains and enhanced critical temperature in copper oxide superconductors. On phonon mechanism of high T_c superconductivity. Does high temperature superconductivity appear in two phases? Non-collinear antiferromagnetic structure in La_2CuO_4. The Fermi surfaces of La(Sr)CO and YBCO. Superconducting and minor phases in Bi-Sr-Ca-Cu-O systems. Distorted flux lines behaviour in type II superconducting spherical shell: Application to high T_c superconductivity. New effect of critical temperature in non rare earth ceramic superconductors. The electron kinematic interaction and high T_c superconductivity in transition metal compounds. Distribution of superconducting phases in the $Bi_2Sr_2CuO_6$- $CaCuO_2$ system. Optical anisotropy of single crystal YBCO in infrared and visible region. Effect of equilibrating temperature on the critical temperature of ceramic YBCO. Reformation of pairing theory due to quantum size effect. Effect of local symmetry on electron-phonon interaction in perovskites.

The conference was attended by 94 lecturers and participants (22 from developing countries).

Title: SUMMER SCHOOL ON DYNAMICAL SYSTEMS (1 August - 9 September 1988).

Organizers: Professors J. Palis (Instituto de Matemática Pura e Aplicada, IMPA, Rio de Janeiro, Brazil) and E.C. Zeeman (University of Warwick, Coventry, UK).

Lectures: Topology. Qualitative ordinary differential equations. One complex variable. Elementary probability and ergodic theory. Computing and experiments. Introduction to dynamical systems. Introduction to rational maps and complex flows. Introduction to singularity theory and applications. Introduction to smooth ergodic theory. Introduction to computational dynamics. Representation of ergodic flows. Diophantine conditions and KAM estimates for the Siegel theorem. Extended Sarkovski order for almost period points. Asymptotic solutions of a PDE from mathematical biology. Minimising cones and planar dynamical systems. On the topological conjugacy classes of Anosov endomorphisms on tori. Fixed points, Conley and Fuller indices in the theory of flows. A generalization of Grobman-Martman theorem for plane vector field, through Newton polyhedra. Foliation of codimension 1: Level of leaves in the C^0 class. Versal deformation of quasihomogeneous singularities. An application of stochastic operators in ergodic theory. Finding isolated zero points of polynomial mappings by homotopy and Sard's theorem. About the number of limit cycles of a polynomial vector.

The school was attended by 130 lecturers and participants (92 from developing countries).

Title: FIFTH TRIESTE SEMICONDUCTOR SYMPOSIUM (IUPAP): FOURTH INTERNATIONAL CONFERENCE ON SUPER-LATTICES, MICROSTRUCTURES AND MICRODEVICES (8 - 12 August 1988).

Organizers: Professors C.M. Bertoni (II Università di Roma, Italy), G.H. Döhler (Universität Erlangen-Nürnberg, Federal Republic of Germany), A. Frova (Università "La Sapienza", Rome, Italy) and E. Tosatti (International School for Advanced Studies, ISAS-SISSA, and ICTP, Trieste, Italy), under the auspices of the Italian Ministry for Scientific Research and with the sponsorship of the Italian National Research Council (CNR), IBM Italy and the International Union of Pure and Applied Physics (IUPAP).

Lectures: Amorphous semiconductor superlattices. Perpendicular transport in a-Si/aSiGe superlattices. Theoretical estimate of the stable configuration for $Ga_{0.5}In_{0.5}As$ ordered alloy and superlattice. Impact of MBE-growth rate on optical properties of GaAs quantum wells. Phonons in superlattices. Calculated phonon spectra in semiconductor superlattices. Photon energy dependence of the bulk and interface phonon frequencies. Phonons in amorphous superlattices. Theory of

electronic and optical properties of quantum wells. Theory of band offsets at semiconductor heterojunctions: an ab-initio linear response approach. Strained layer superlattice. Study of the optical properties of (100) and (111) oriented GaInAs/GaAs strained layer superlattices. CdTe-CdMnTe superlattices. Widely tunable exciton radiative recombination rate in ZnSe based superlattice structures. Theory of excitons in (111)-oriented quantum wells. Saddle point excitons in GaAs/GaAlAs superlattices: magneto-optical effects. Stark and Zeeman effects in excitons of GaAs/GaAlAs quantum wells. Ultrafast studies of carrier relaxation in semiconductors and their microstructures. Femtosecond studies of real-space transfer in AlGaAs/GaAs heterostructures. Carrier dynamics in $(GaAs)_m(AlAs)_n$ superlattices. Linear and nonlinear radiative recombination mechanisms in indirect GaAs/AlAs superlattices. Band and deep emission and their recombination processes in a heavily Si doped GaAs/AlGaAs quantum well. Coherent vs. incoherent resonant tunneling and implications for fast devices. Resonant and nonresonant tunneling in GaAs-AlAs MQW structures. Intrinsic bistability in the resonant tunneling diode. Optical detection of vertical transport in short-period GaAs-AlGaAs superlattices. Resonant tunneling of various strained $Si/Ge_xSi_{1-x}/Si$ heterostructures. Photoluminescence determination of charge accumulation and the characteristic tunneling time in a double-barrier resonant tunneling structure. Charge build-up and intrinsic bistability in resonant tunneling devices. Picosecond intersubband spectroscopy. Plasmon excitations in 2 DEG with large in-plane wave-vector. Wannier-Stark ladders in semiconductor superlattices. Modulation spectroscopy in superlattices. Electromodulation spectroscopy of confined systems. Theory of electroabsorption of quantum wires and dots. Quantum interference devices. Quantum point contacts and coherent electron focussing in a 2D electron gas. Resistance of multiprobe, microstructures: fluctuation, non-locality, and mode conversion. 1D transport in GaAs-AlGaAs heterojunctions. Effect of dynamical screening on FIR absorption of quasi-1D-microstructures (QIDMS). Intersubband resonance in quasi 1S inversion channels. DC and far infrared experiments on 1D-multi quantum well wire structures. Magneto-optics of 2D-electrons under conditions of integral and fractional quantum Hall effect. The quantum Hall resistance in quantum wires. Quenching of the Hall effect in a one-dimensional wire. Optical nonlinearities of semiconductor superlattices and microstructures - Key to high-speed switching and photonic applications. Ultrafast modulation of quantum states by virtual charge polarization in biased quantum well structures. Memory phenomena in novel floating-gate GaAs/AlGaAs structures with graded-gap injector. Surface field induced transverse and vertical tunnel junctions. Quantized states in δ-doped Si-layers. Optical investigations of PbTe n-i-p-i structures. Quantum-confined excitonic interband transitions in GaAs sawtooth doping superlattices.

The conference was attended by 291 lecturers and participants (38 from developing countries).

Title: THE APPLICATION OF LASERS IN SURFACE SCIENCE (23 - 27 August 1988).

Organizers: Under the chairmanship of Professor S. Lundqvist (Chalmers University of Technology, Gothenburg, Sweden): Professors P. Andresen (Max-Planck-Institut für Strömungsforschung, Göttingen, Federal Republic of Germany), H.-J. Freund (Ruhr-Universität Bochum, Federal Republic of Germany) and E.W. Plummer (University of Pennsylvania, Philadelphia, USA), with the co-sponsorship of the International School for Advanced Studies (ISAS-SISSA, Trieste, Italy).

Lectures: Applications of lasers in surfaces science. General perspective of the theoretical advances and challenges of the application of lasers in surfaces science. Chaos in surface physics. Lifetimes of excited adsorbate levels at metal surfaces. Lasers in surface spectroscopy. State selective detection of desorbing molecules. Desorption of ablation from molecular van der Waals systems with IR and UV lasers. Rotational dynamics of desorption and direct inelastic scattering: NO/Pt(111). Laser induced desorption of NO from Pt(111): Dynamics of excitation and desorption. UV-photodesorption of NO from Pd(111). UV laser photodesorption of NO from the surface of condensed films: translational and internal energy distributions. Photon stimulated desorption: What has been learned. Desorption induced by electronic transitions: Laser spectroscopy. Experimental and theoretical studies of desorption induced by electronic transitions. Energy distributions of molecules thermally desorbed from a surface. UV surface photodynamics: Charge transfer and fragmentation competition. Differentiating primary and secondary processes in electron- and photon-stimulated desorption using laser detection of desorbed neutral atoms. Femtosecond laser mass-spectrometry of molecules on surfaces. Laser-induced thermal, dynamic and field desorption of molecules. Atomic and molecular beam studies. Vibrational excitation caused by electronic effects in O_2-Ag(111) scattering. The structures of monolayers of polar molecules physisorbed on single crystal surfaces of graphite and on xenon plated graphite. Theory of recombinatively desorption. Evidence for a molecular precursor state in D_2 desorption from Pd(100). Two photon photoemission. Femtosecond image-potential dynamics in metals. Time resolved photoemission spectroscopy of laser excited silicon using synchrotron radiation. The characterization of normally unoccupied surface electronic states by angle-resolved two photon photoemission. Time resolved study of surface recombination at Si(111) 2x1 surfaces. Observation of surface intervalley scattering on GaAs(110). Energy transfer at surfaces. Time-resolved measurements of vibrational relaxation rates (metal clusters). Laser studies of energy transfer at surfaces. Spectroscopy and diffusion of molecules on surfaces using laser induced desorption. Infrared surface spectroscopy: Tunable lasers and other radiation sources in the infrared. Laser induced reactions in two dimensions. An

experimental study of the kinetics of OH and H_2O formation on Pt in the H_2+O_2 reaction. Dynamics of CuF formation in the dry etching reaction of fluorine with a copper single crystal surface. Laser reactions on semiconductor surfaces. Surface nonlinear optical processes. Theory of second harmonic generation at simple metal surfaces. Spectroscopy of electronic transitions at a solid/solid interface by resonant three-wave mixing: CaF_2/Si(111). Surface structure of cubic ionic crystals studied by optical SHG. Probing the electronic and structural properties of thin metallic overlayers by SHG. Infinite barrier model calculations of SHG at a metal surface. Dynamic screening at a surface of a NFE metal. Three-photon mixing at smooth Nobel metal surfaces: beyond jellium. Time-resolved study of laser-induced disorder of Si surfaces. Fast-time resolved studies of pulsed laser heating of metals. Second harmonic generation probe of structure and energy transfer dynamics on a metal surface. Tensor symmetries and adsorbate structure in second order nonlinear optical processes at surfaces. Tensor symmetries and adsorbate structure in second order nonlinear optical processes at surfaces. Infrared-visible sum spectroscopy as a molecular probe at interfaces. Resonant SHG from Ag(110): Metallic interband electronic contributions. Studies of kinetics of surface reactions using lasers. Molecular cluster calculations for the analysis of laser induced emission of electrons and ions from the (111) surface of BaF_2. Mechanisms of nonthermal photon-induced processes on solid surfaces. [illegible] induced processes on solid surfaces. Lasers in electro-chemistry.

The meeting was attended by 83 lecturers and participants (3 from developing countries).

Title: WORKING PARTY ON ELECTRON TRANSPORT IN SMALL SYSTEMS (29 August - 9 September 1988).

Organizer: Professor M. Büttiker (IBM Thomas J. Watson Research Center, Yorktown Heights, USA).

Lectures: Phase-sensitive properties of mesoscopic systems. The Aharonov-Bohm effect in condensed matter physics - A new challenge for quantum mechanics. Adiabatic and non-adiabatic quantum effects in mesoscopic systems. Experiments on single electron charging in tunnel junctions. Single electron effects and the dissipative phase transition in Josephson junctions and Josephson junction arrays. Mesoscopic fluctuations and level repulsion. Nonlinearity and photogalvanic effects in mesoscopic systems. Correlations and fluctuations of wave transmission through disordered multiple scattering media. Experiments on single electron charging in tunnel junctions. Experimental studies of charge quantization using tunneling capacitors. Resistance of ballistic point contacts. What is universal about universal conductance fluctuations? What is measured when you measure a resistance? - The Landauer formula revisited. Resistance fluctuations in a four probe geometry with infinite leads. Semiclassical and quantum effects in tunnel junctions. Isolated rings of mesoscopic dimensions: Quantum coherence and persistent currents. Point contact spectroscopy. Statistics of mesoscopic fluctuations. Mesoscopic fluctuations of Landau diamagnetism. Point contact spectroscopy. Traversal time for tunneling. Experimental observation of the dynamical image potential in extremely low $GaAs/Al_xGa_{1-x}As/GaAs$ tunnel barriers. Reduction of quantum noise by magnetic field: An orthogonal to unitary Wigner statistics transition. Single-electron tunneling and charging effects observed with point-contact tunnel junctions. Magnetoconductance of small electric [illegible] Magnetoconductance of small electric networks. Remarks on recent measurements of the I-V characteristic of small-capacitance Josephson junctions. Mechanism for 1/f noise in strongly disordered systems. 1/f noise in disordered conductor - A case of universal conductance fluctuation. 1/f-noise: Theory and experiment: Zero bias tunneling spectroscopy in small 2-D samples. Linear magnetoresistance. Hopping conduction in 1-D samples. Oscillatory quantum elastic resistances of small contacts: Holes, constrictions, tube precursors. Quantum point contacts and coherent electron focusing. Theory of quantum conductance of a narrow constriction. Coherence of electrons emitted through small constrictions and the experimental prospects. Oscillations in the Sharvin point contact resistance. Hot electrons and semiconducting properties of thin carbon filaments on insulator surfaces. Reflectionless ballistic transport. Statistics of mesoscopic fluctuations. Dephasing by inelastic scattering. Introduction to resonant tunneling in semiconductors. Physics of resonant tunneling through quantum well structures and resonant tunneling transistors. Inelastic and resonant tunneling. Coherent transport in an electron wave-guide. Resistance of multiprobe microstructures: Fluctuations, non-locality and mode conversion. Perpendicular transport in superlattices. Current topics in resonant tunneling. Edge states in diamagnetism and transport. Electric transport in quasi-one-dimensional channels. Nonequilibrium and hot electron transport across band discontinuities. Microscopic approach to resistance fluctuations based on invariant imbedding: 1-channel case. Influence of magnetic scattering as the phase coherence in disordered metallic structures. Electromigration and local transport fields in metallic microstructures. A macroscopic approach to resistance fluctuations and universal conductance fluctuations: N-channel case.

The working party was attended by 58 lecturers and participants (10 from developing countries).

Title: ADRIATICO RESEARCH [illegible]

Title: ADRIATICO RESEARCH CONFERENCE ON COHERENT SOURCES FOR FRONTIER SPECTROSCOPY (30 August - 2 September 1988).

Organizers: Under the chairmanship of Professor S. Lundqvist (Chalmers University of Technology, Gothenburg, Sweden): Professors J.C. Bergquist (National Institute of Standards and Technology, Boulder, USA), G. Denardo (University of Trieste and ICTP, Italy), K.M. Evenson (National Institute of Standards and Technology, Boulder, USA) and M. Inguscio (Università di Napoli, Italy), with the co-sponsorship of the International School for Advanced Studies (ISAS-

SISSA, Trieste, Italy).

Lectures: Light sources below quantum noise and applications. Beyond the shot-noise limit: Generation and applications of squeezed states of light. Soliton laser. Optically stabilized diode lasers. Diode-pumped crystal lasers and frequency extension by nonlinear optics. Color center lasers. Difference-frequency and color-center laser spectroscopy of van der Waals complexes. Difference frequency laser spectrometer using Li I O3 and observation of H_3^+ hot bands. IR and far infrared spectroscopy of molecular ions and clusters. Tunable far infrared laser spectroscopy. Far-infrared heterodyne spectroscopy. Application of infrared laser sources to the spectroscopy of molecular and cluster beams. Infrared-radiofrequency double resonance spectroscopy of CH_3F using a color center laser. Generation of ultra-stable cw optical sources. Nonclassical radiation from one-atom oscillators. Experiments with laser-cooled trapped ions. Spectroscopy of heavy trapped ions. Laser control of atomic motion. Laser cooling of atomic helium. Application of laser cooling to atomic frequency standards. Vacuum ultraviolet laser sources and spectroscopy. Vacuum UV coherent spectroscopy. Generation of radiation in the extreme UV by upconversion in a gas discharge. Development of free-electron lasers for the extreme ultraviolet. High resolution spectroscopy of atomic hydrogen Rydberg states. High resolution spectroscopy of atomic hydrogen. High resolution spectroscopy of atomic discharges.
resolution spectroscopy of atomic discharges.

The conference was attended by 51 lecturers and participants (5 from developing countries).

Title: WORKSHOP ON DYNAMICAL SYSTEMS (5 - 23 September 1988).

Organizers: Professors J. Palis (Instituto de Matemática Pura e Aplicada, IMPA, Rio de Janeiro, Brazil) and E.C. Zeeman (University of Warwick, Coventry, UK), with co-sponsorship of the Instituto de Matemática Pura e Aplicada, IMPA, Rio de Janeiro, Brazil.

Lectures: Causality, locality and time irreversibility in general dynamics. Algorithms, dynamics and topology. Minimal sets of complex foliations in complex projective plane. Dirichelet problem and Julia sets. Homoclinic bifurcations. Classification of dynamical systems. Lifting invariant measures. Existence and non-existence of invariant tori for Hamiltonian vector fields. Centralisers and differentiable conjugacies. Computer experiments and Julia sets of entire maps. Algebra and dynamical systems. Variations on Morse theory. Dulac's problem. Geometric and topological ideas in dynamical systems. Dynamical systems, aspects of computation theory. A finiteness theorem in one-dimensional dynamics. Geometry and dynamics of holomorphic flows. Best arithmetical conditions in small divisors. The structure of positive entropy surface diffeomorphisms. Reduction of the singularities of holomorphic foliations - existence of separatrices. Conjugacy of normally tangent diffeomorphisms. On the unfolding of certain codimension 3 singularities of planar vector fields. Dynamics under anisotropic perturbations. The speed interval of circle endomorphisms. Dimension for repellors in expanding cylinder maps. A common fixed point for commuting diffeomorphisms of surfaces. Stability conditions for discontinuous vector diffeomorphisms of surfaces. Stability conditions for discontinuous vector fields. Discontinuity of Hausdorff dimension and limit capacity on arcs of diffeomorphisms. Elementary existence proofs for periodic orbits of Hamiltonian systems. Geometry of the modular orbifold related to the Riemann hypothesis. Large deviation, entropy and dimension. Slow diffusion is Hamiltonian systems near elliptic equilibrium points. Quasi transversal saddle node. Open questions on the dynamics of complex polynomials. On quasi-periodic bifurcations. Morse-Smale diffeomorphisms in dimension 2. Deformation of holomorphic foliations having a first integral. Genericity of hyperbolic homogeneous fields in R^3. Surgery on complex polynomials. Bifurcations of planar vector fields. The finite cyclicity property. Global stability of one parameter families of vector fields. Sur les singularités diritiques. Zeros, basic sets, topological entropy in unimodal maps. Controllability properties of families of vector fields. Rotation sets for toral maps. Homoclinic points and moduli. Entropy and length for 2-dimensional diffeomorphisms. Onset of stochasticity for some one-dimensional systems. Morse theory, area and heat. Quadratic mappings of the plane. Chaos of interval maps with topological entropy 0. Global bifurcation diagrams for nerve impulse equations. Homoclinic bifurcations: Persistence of tangencies. C^k-integrability of analytic Hamiltonian systems. Bifurcating singular horseshoes. C^r configurations and positive C^r quadratic differential forms. Continuity properties of invariant subsets and measures of 1-dimensional maps. Extended Shannon entropy and global dimension. Dimensions of Cantor sets. Continuity of exponents under random perturbations. Convergence of renormalisation and the global rigidity conjecture. Plane billiards: Positive Lyapunov exponents. Topological study of logarithmic foliations. Global stability of codimension N saddle-nodes, flips and codimension 2 reflexions.
stability of codimension N saddle-nodes, flips and codimension 2 reflexions.
Average linking numbers of closed orbits of hyperbolic flows. Periodic orbits near equilibria in Hamiltonian systems. Attractors.

The workshop was attended by 122 lecturers and participants (70 from developing countries).

Future Activities at ICTP

1988	
College on Medical Physics	10 October - 4 November
First Autumn Workshop on Mathematical Ecology	31 October - 18 November
College on Neurophysics: "Development and Organization of the Brain"	7 November - 2 December
Workshop on Global Geophysical Informatics with Applications to Research in Earthquake Predictions and Reduction of Seismic Risk	15 November - 16 December
College on Global Geometric and Topological Methods in Analysis	21 November - 16 December

1989	
Fourth Workshop on Total Energy and Force Methods	4 - 6 January
Workshop on Theoretical Fluid Mechanics and Applications	9 - 27 January
Course on Basic Telecommunications Science	9 January - 3 February
College on Atomic and Molecular Physics: Photon Assisted Collisions in Atoms and Molecules	30 January - 24 February
College on Theoretical and Experimental Radiopropagation Physics	6 - 24 February
Workshop on Space Physics: Materials in Microgravity	27 February - 17 March
Workshop on Remote Sensing Techniques with Applications to Agriculture, Water and Weather Resources	27 February - 21 March
Experimental Workshop on High Temperature Superconductors	30 March - 14 April
Spring School and Workshop on Superstrings	3 - 14 April
Workshop on Radon Monitoring on Radioprotection, Environmental Radioactivity and Earth Sciences	3 - 14 April
Topical Meeting on Hyperbolic Geometry and Ergodic Theory	17 - 28 April
Spring College on Materials Science on "Ceramics and Composite Materials"	17 April - 26 May
Conference on Oxygen Effects in High T_c Superconductors	18 - 21 April
Fourth Workshop on Perspectives in Nuclear Physics at Intermediate Energies	8 - 12 May
Spring School on Plasma Physics	15 May - 9 June
Working Party on Modelling Thermomechanical Behaviour of Materials	29 May - 16 June
Working Party on Fracture Physics	29 May - 16 June
Second ICFA School on Instrumentation in Elementary Particle Physics	12 - 23 June
Research Workshop in Condensed Matter, Atomic and Molecular Physics	19 June - 29 September
Interface between Quantum Field Theory and Condensed Matter Physics (Adriatico Conference)	20 - 23 June
Conference on Supermembranes	26 - 30 June
Summer School in High Energy Physics and Cosmology	26 June - 18 August
Quasicrystals (Adriatico Conference)	4 - 7 July
Strongly Correlated Electron Systems (Adriatico Conference)	18 - 21 July
Topical Meeting on Variational Problems in Analysis	28 August - 8 September
Computations in Physics and and Physics in Computation (Adriatico Conference)	5 - 8 September
Workshop on Nonconventional Energy Sources	11 - 29 September
Workshop on Physics in Environment Conscious Design	25 - 29 September
25th Anniversary Conference on "Frontiers in Physics, High Technology and Mathematics"	2 - 6 October
Workshop on Soil Physics	9 - 27 October
College on Microprocessors	9 October - 3 November
College on Differential Geometry	30 October - 1 December
Workshop on Telematics	6 - 24 November
Workshop on "Atmospheric Radiation and Cloud Physics"	27 November -15 December
College on Electron Microscopy	27 November - 22 December

For information and applications to courses, kindly write to the Scientific Programme Office.

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EDITORIAL NOTE - *News from ICTP* is not an official document of the International Centre for Theoretical Physics. Its purpose is to keep scientists informed on past and future activities at the Centre and initiatives in their home countries. Suggestions and criticisms should be addressed to Dr. A.M. Hamende, Scientific Information Officer.

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