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Prof. Élcio Abdalla from the Universidade de São Paulo, Brazil, receiving the V.F. Weisskopf Prize from Professor Abdus Salam, Director of the International Centre for Theoretical Physics and President of the Third World Academy of Sciences.

Inside:

V.F. Weisskopf Prize Ceremony

Professor Abdus Salam, Director, International Centre for Theoretical Physics (ICTP), and President, Third World Academy of Sciences (TWAS),
World Academy of Sciences (TWAS),
presented the V.F. Weisskopf Prize 1992 to Prof. Élcio Abdalla from the Universidade de São Paulo, Brazil. The ceremony took place in the Main Building Lecture Hall of the ICTP, Trieste, on 2 October, 1992.

The 1992 ICTP Prize in honour of Professor V.F. Weisskopf, in the field of High Energy Physics, has been awarded to Prof. Élcio Abdalla from the Universidade de São Paulo, Brazil, in recognition of his contributions in the field of High Energy Physics.

He has proved that the CP^n model has a quantum anomaly and showed its cancellation in supersymmetric case. He has also constructed the supersymmetric extension of the Wess-Zumino term. More recently he dealt with correlation function in noncritical superstrings, computing the correlators in super
computing the correlators in super
Liouville theory. The general problem of two dimensional gravity has also been treated.

He has written a book on two dimensional quantum field theory which was intended to emphasize the relations of this field with more realistic models, as well as to explicit the difficulties in this area, specially concerning non perturbative aspects.

Professor Abdalla obtained his Ph.D. in 1977 at the Institute of Physics of the University of São Paulo with a thesis on "Quantum Electrodynamics". He is a Full Professor at the same University and also Senior Associate at the International Centre for Theoretical Physics (ICTP). He is the author of many scientific articles and two books.

The 1992 ICTP Prize honours Professor V.F. Weisskopf. He was born
Professor V.F. Weisskopf. He was born
in Vienna in 1908 and was educated at the Universities of Vienna and Göttingen. He held numerous positions in various European universities before moving to USA, where he worked at the Los Alamos Laboratories and was Professor of Physics at M.I.T. from 1946 to 1960. From 1961 to 1965, he was Director General of the European Organisation for Nuclear Research. He was President of the American Physical Society and is member of various Academies and Societies. He has received many awards and several honorary degrees. Professor Weisskopf is the author of a large number of important scientific papers on field theory and electrodynamics, nuclear and

high energy particle physics. Three of these contributions changed the course of physics. They are, firstly, a theory of atomic level width and its fundamental relation to life-time, secondly, the discovery that the self-energy divergence of the electron is logarithmic in Dirac theory and, thirdly, the theory of nuclear scattering phenomena known as the cloudy crystal ball model. In addition to this important original work, Weisskopf is remembered for his textbook (with J. Blatt) on nuclear physics and for his many articles on special topics for a non-specialized audience.

Prof. Abdalla read out his article about "Two Dimensional Quantum Field Theory" and "Development of Science in Brazil, and Future Prospects". ____ ♦

Two Dimensional Quantum Field Theory

The development of Relativistic Quantum Field Theory started in 1932 as a natural extension of Quantum Mechanics to the relativistic domain. The computation of spectral line width by Weisskopf and Wigner was a direct contact with the experiment. The work of Feynman in the late forties provided a powerful tool for the calculation of processes in quantum electrodynamics. Second quantization led, however, to new conceptual and technical difficulties. Quantum fields had to be regarded as operator-valued distributions, their local products being ill-defined as a result of ultraviolet divergencies, which plagued the higher order computations in perturbation theory. The Weisskopf's computation of the electron self energy is an example. This problem was partially mastered via the techniques of renormalization, and later on completely understood.

In the early fifties, there appeared a series of papers concerned with the extraction of general non-perturbative properties of quantum field theory from a perturbative setup. Of particular importance for this latter development of quantum field theory were the papers of Lehmann, Symanzik and Zimmermann (and also of Wightman, Haag, and others). The so-called LSZ formalism established the relation between fields and particles, and the reduction formula. From the study of the analytic properties of Feynman diagrams, one derived dispersion relations, which could be used to obtain non-perturbative information.

These developments were followed by a new axiomatic approach to Quantum Field Theory (QFT), which became known as constructive QFT. Some of the (non-perturbative) results of the *LSZ* formalism, which had been based on perturbative studies, could thereby be derived from general principles.

Meanwhile, all dynamical calculations in QFT were restricted to perturbation theory. In particular, this rendered calculations involving strong interactions unreliable, and made information about the bound state spectrum only accessible within approximative non-perturbative — and often non-unitary — schemes. As a result, *QFT* had fallen into stagnation, and even discredit, in the late fifties.

These difficulties provided, in particular, the motivation for a new approach to the strong interactions, which became known as S-matrix theory, which was to play a dominant role in the sixties. The predictive power of this theory turned out to be very small, since it was entirely based on kinematical principles and analyticity supplemented by the bootstrap idea. An underlying dynamical framework was lacking. Nevertheless, analyticity in the complex angular momentum plane led to the important concept of duality.

An explicit realization of these concepts by a remarkable formula proposed by Veneziano led to a new, parallel development in the sixties summarized under the name of dual models. However, in the S-matrix (or dual model) approach the high energy behavior was incorrect. Moreover, further analysis required the introduction of a somewhat mysterious new concept, the *pomeron*. The ever increasing number of necessary parameters, and the resulting loss of predictive power, eventually led physicists to abandon them, and to turn again to QFT.

In the meantime, QFT had scored some remarkable successes in the realm of the weak interactions. Moreover, symmetry principles such as those advocated by Gell-Mann and Ne'eman had proven powerful in predictions concerning strongly interacting particles, without the recourse to dynamical calculations.

This situation led to a revival of QFT in the late sixties and in the seventies, when much attention was given to the non-perturbative aspects. Quantum chromodynamics (QCD) had been proposed as the fundamental theory of the strong interactions, but reliable calculations confronting QCD with experimental tests were lacking. The high energy behavior of QFT was investigated by means of the renormalization group and Callan-Symanzik equations. A momentum dependent ("running") coupling constant turns out to characterize the strength of the interaction: it may be sufficiently small for either high or small momenta, to legitimate perturbation theory in one of these regions. In the case of non-Abelian gauge theories, perturbation theory turned out to be a good approximation at high energy (asymptotic freedom). Classical solitons of field theory and topological methods have also played a central role in the (non-perturbative) semiclassical analysis of QFT.

First models in two dimensions

Although the above studies have been important for revealing a non-trivial and highly interesting structure, exact non-perturbative results are only available for specific models, all in two-dimensional space-time. A complete (non-perturbative) solution of a QFT model means exact knowledge of all its correlation functions. Quantum field theories with such properties have been restricted to 1+1 dimensions.

Two dimensional quantum field theory provides a very powerful laboratory for gaining a non-perturbative understanding of quantum field theory. The kinematical simplifications resulting from two dimensional space time have allowed for the complete solution of a variety of models involving interacting fields. The non-trivial nature of these solutions provides a deeper insight into the structure of quantum field theory, and has found useful applications in several areas of research, such as string theories and systems in statistical mechanics at criticality.

The first such model, describing the current-current interaction of massless fermions was discussed by Thirring in 1958, as an example of a completely soluble quantum field theoretic model obeying the general principles of a QFT. The complete quantum solution was given by Klaiber, and was shown to satisfy all Wightman axioms. Up to that time the only models known to obey these axioms had been those describing generalized free fields.

Following the above work, Schwinger obtained an exact solution of Quantum Electrodynamics in 1+1 dimensions $(QED)_2$. A number of interesting properties, such as the nontrivial vacuum structure of this model, were however only later revealed after one has explored the consequences of the long range Coulomb force for the charge sectors of the theory. This long range force was interpreted as being responsible for the confinement of quarks, that is, their occurrence in the form of permanently bound states of $\bar{q}q$ pairs. The problem of confinement and the related phenomenon of screening of charge quantum numbers in d=2 has been extensively studied, and has served as a basis for sharpening the concepts involved also in higher dimensions.

The surprisingly rich structure of two dimensional quantum electrodynamics was found to describe several important features of non-Abelian gauge theories, under investigation in the seventies. As a matter of fact, in the late sixties one learned that the short distance singularities of quantum field theory play a key role in the dynamical structure of the theory. The experimental results on lepton-proton scattering at large the theory. The experimental results on lepton-proton scattering at large momentum transfer, required that a realistic theory of the strong interaction by asymptotically free. This made QCD the unique candidate for the theory describing strong interactions. The properties of vacuum structure and confinement attributed to QCD_4 were found to be partially realized in two-dimensional QED, which made the theory a very interesting "laboratory".

Nontrivial models for realistic theories

Several further developments in d = 2 QFT, of growing importance, followed. Classically exactly integrable models, and the quantization of solitons were extensively studied in two dimensions. Such integrable models were generally characterized by the existence of an infinite number of conservation laws. In the cases where these conservation laws survived quantization, the S-matrices and their associated monodromy matrices could be computed exactly. Besides being the first examples of exact S-matrices realizing the ideas of "minimal analyticity" of the sixties, these exact results also play an important role in checking approximation schemes.

In the particular case of the sine-Gordon theory, exact results have also been obtained beyond the S-matrix level. The S-matrix of fundamental fields was generalized to describe scattering of bound states and solitons as well. Moreover one finds an unexpected U(1) symmetry, reflecting the fact that the solitons in the sine-Gordon theory correspond to the fermions of the massive Thirring model.

In the framework of two-dimensional models, the possibility of writing fermions in terms of bosons (bosonization) has been a powerful method for obtaining non-perturbative information. Significant progress in the direction of non-Abelian bosonization was provided by the work of Polyakov, Wiegman, and Witten. Hence in d = 2 dimensions, fermionic theories were found to exhibit a remarkable "universality" in the bosonic formulation, where the non-linear sigma model and "topological" terms seemed to play a fundamental role.

Non-linear sigma models have a long history. A particularly important role has been played by the class of two-dimensional integrable non-linear sigma models, which have a geometrical origin. dimensional integrable non-linear sigma models, which have a geometrical origin. They have been shown to share several properties with Yang-Mills theories in four dimensions: classical conformal invariance, geometrical identities, non-trivial classical solutions. The non-linear sigma models for symmetric spaces, and the Yang-Mills theories for either the self dual sector, or with extended supersymmetry, share similar integrability properties. Quantum non-linear sigma models exhibit features also believed to characterize realistic theories, such as confining long range force, and dynamical mass generation. These properties make them appealing as toy models for the strong interactions. However, their geometrical origin makes them also very interesting mathematical objects to be studied in their own right.

Two dimensional space-time has also proven to be an excellent laboratory for the study of gauge-anomalies and the consistency of anomalous chiral gauge theories. The exact solubility of two-dimensional chiral QED has played here an important role in opening up a whole new line of developments in the area of chiral gauge theories. In view of the fact that the top quark has not yet been found, the successful quantization of such seemingly inconsistent theories without recourse to an algebraic cancellation of the gauge-anomalies on group-theoretical grounds, is of much interest. An unexpected deep underlying differential geometric significance of such anomalies has thereby been revealed.

The above model studies have provided an extraordinary amount of information about quantum field theory. Their success has motivated further developments leading to a direct application of two dimensional models to physical phenomena. To summarize, two dimensional models have been an extraordinary laboratory to test ideas in quantum field theory. Thus, the Thirring model provided a realization of an exactly soluble quantum field theory, while the Schwinger and the non-linear sigma models were found to exhibit properties of four dimensional non-Abelian gauge theories. However, two dimensional QFT also plays a direct role in the description of physical reality, having applications in string theories, as well as statistical mechanics. In particular, the methods developed in two-dimensional QFT have been used to particular, the methods developed in two-dimensional QFT have been used to extract results concerning the critical behavior of models in statistical mechanics, using conformal invariance alone.

Infinite dimensional symmetries

More recently, it was shown that in two dimensional quantum field theories, Poincaré and scale invariance, alone, imply invariance under an infinite dimensional symmetry group. As a result, non-trivial correlators can be exactly computed. They are found to be in general related to solutions of hypergeometric differential equations. The parameters labeling these equations, which are regarded as the critical indices, have been classified and characterize the correlators uniquely. The conformal algebras are realized in terms of the so-called primary fields and their descendants. In Minkowski space, this construction leads naturally to the use of Artin Braids, which relate this problem to the algebraic construction of exact S-matrices, since the star-triangle relations obtained from the infinite local conservation laws, have the same structure as the permutation relations of knot theory.

The above ideas may be generalized to include the interaction with conformally invariant gravity. In the light cone gauge the theory simplifies dramatically, due to a new SL(2,R) symmetry. The critical indices of the theory may be computed from a very simple equation relating them to the critical indices of the theory in flat space. The results have also been generalized to the supersymmetric case.

String theory

One of the most promising applications of two dimensional models to the description of fundamental interactions is that of string theory, which has an interesting history. It was conceived in the beginning as an alternative approach to quantum field theory based on the concept of duality; hence also dual theory. The discovery by Veneziano of an amplitude describing most of the desired features of such a theory was the cornerstone of a complex story to follow. It was realized that this theory could be understood as the movement of an extended one dimensional object in space time; hence the name "string theory". Later fermions dimensional object in space time; hence the name "string theory". Later fermions have been incorporated into the theory, leading to the discovery of supersymmetry.

The old string model, as well as the Neveu-Schwarz-Ramond model, could be described in terms of a two dimensional QFT, with a local Lagrangian. The discovery of space-time supersymmetry by means of the Gliozzi-Scherk-Olive construction, permitted one to envisage possible applications to grand unified theories, since supersymmetry was a requirement to solve the hierarchy problem in unified theories; this use of string theories had been proposed earlier, from the interpretation of the spin 2 (lowest) state of closed string theory, as the graviton, and strings would in such a case be a theory of quantum gravity. This unification dream was later implemented at the theoretical level after a historical sequence of works on the cancellation of anomalies, which opened the possibility of grand unification in terms of a new superstring theory treating left and right movers differently, the heterotic string.

As it turns out sigma models also play an important role in string theory, where the D-dimensional target manifold is compactified to four dimensional space-time. The action associated with the compactified dimensions is described by a sigma model. The requirement of conformal invariance at the quantum level leads directly to the Einstein equation of general relativity, and predicts its quantum corrections.

Two dimensional QFT and physical reality

It must be clear that our ultimate objective is to understand the dynamics of reality. Many successes of quantum field theory merely rely on a "kinematical understanding", such as the (very important) idea of dynamical symmetry breaking, and the construction of representations of the gauge group in the matter sector. The actual non-perturbative dynamics of quantum field theory in four dimensions remains largely unknown. Hence, an application of the experience gained from the study of two dimensional QFT, to higher dimensions is highly welcome, and scores success. It is rewarding that the machinery of two dimensional *QFT* provides many of the expected results, sometimes just "taken for granted" in provides many of the expected results, sometimes just "taken for granted" in higher dimensions. We have however also witnessed some surprising features which are non-perturbative in nature, and cannot be understood in a perturbative context.

Some important results concerning generalizations to higher dimensions have been obtained. Bosonization of fermions is also possible in three dimensional space-time if we include a Chern-Simons density in the Lagrangian. The ideas developed in the context of two dimensional quantum field theory thus appear to represent a step in the correct direction. Moreover, recent progress made in the study of random surfaces, shows that the ideas of string theory have a wider range of validity; indeed, there are hints showing a phase transition in string theory as a function of the space time dimensionality, such that the theory can accommodate the grand unification ideas, statistical models, and strong interactions, in a common framework.

At last, one should mention that applications of two dimensional quantum field theory have made a deeper understanding of Liouville theory, allowing one to consider the problem of non critical string theory with possible application on the problem of strong interactions at low energies, one of the most important in elementary particles, as well as further one hundred years old problems in mathematics.

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Development of science in Brazil, and future prospects

There are a few points preventing the full development of science in Brazil to the level of developed countries, most of them connected with political reasons. The lack of proper financial support can be traced back to two main causes.

The first concerns the huge social differences inside Brazilian society. A big amount of resources is drained to maintain a semi-feudal system of privileges, in favor of a small subset of the population. As amazing as it might appear, resources originally intended for science and education (or even health) can end up in the hands of wealthy landlords supporting a certain class of politicians.

The second cause barring substantial support of science and education is a The second cause barring substantial support of science and education is a strongly burocratized system in the federal government, which can retain resources for a long time, waiting until they are washed out by the strong inflation. Sometimes this fact is used almost officially by the federal authorities: the official name is "under-contingency".

In the above scheme, non-scientific leadership unavoidably get strength to fulfil their purposes, and young scientists have to participate too early in political decisions, awakening the scientific basis in the country.

Moreover, the minuscule support of general education prevents the access of more than 80% of the population to an average education. Data from the presidency of the University of São Paulo show that only 20% of our courses in high education fulfil the minimum criteria of excellency.

Despite the above conditions, some islands of excellency have grown up in Brazil, mainly in the Southwest, where modern thinking found good grounds for development. There the State University is the best in South America, and support for research projects which fulfil criteria of excellency has been undertaken by the FAPESP foundation, which receives 1% of the state of São Paulo budget, guaranteed by the state constitution, and awarded by the state government. Moreover, which is very important, this is done without the idiosincrasy of the federal government, due to a strictly scientific scheme of judgement. Thus in the last 20 years a high level group of scientists has been able to do research at international level, especially in physics, chemistry and some areas of medicine.

Special thanks are due to the International Centre for Theoretical Physics which is undertaking an important effort for the development of science in our countries, by means of material support, as well as an example of scientific leadership.

I would like also to say some final remarks concerning the development of science in Brazil, where 20% of the gross national product is lost after the production process, mainly due to the lack of proper education (training) and technology, and the prospects of future development, as well as the role played by some islands of excellency in the Brazilian scientific community, and of the International Centre for Theoretical Physics with its several programs towards developing countries. ◆

IV International Conference on "Applications of Physics in Medicine and Biology: Advanced Detectors for Medical Imaging" (Giorgio Alberi Memorial)

The IV International Conference on "Applications of Physics in Medicine and Biology" was held on 21–28 September 1992 at the Adriatico Lecture Hall of the ICTP, Trieste, Italy. It was organized by the International Centre for Theoretical Physics (ICTP), by the Trieste Section of the National Institute of Nuclear Physics (INFN) and by the local Organizing Committee of Medical Physics Conferences.

Professor Abdus Salam, Director of the ICTP and President of TWAS, inaugurated the one-week conference. In his opening speech he said, *"It is a great pleasure for me to open this Conference, the fourth in this series of international meetings initiated with the collaboration of Dr. Giorgio Alberi, who was an enthusiastic physicist from the University of Trieste, well appreciated by those of us who were fortunate enough to know him and in whose memory we continue these conferences.*

As you all know, this Centre was established in 1964. At the beginning we only had programmes in nuclear, particle and solid state physics. With the help of Professor Sergio Mascarenhas, John Cameron and Horacio Farch, the activities in the life sciences have continued since 1982 when the biophysics and medical physics colleges began their work. This year we are already celebrating their 10th anniversary.

I would like to thank Professors Anna Benini and Roberto Cesareo for their valuable contribution to the previous colleges of medical physics. Finally, I wish you a successful meeting and even more successful programmes in the future".

The topic of the Conference was "Advanced detectors for medical imaging". This subject is a very important one. Frontier research in several fields of physics and state-of-the-art technology are applied to the instrumentation needed for medical examinations.

The purpose of the Conference was to provide the participants with a basic knowledge of the technology behind the most recent detectors used in medical physics and to encourage a thorough discussion of their application to medical imaging.

More than 50% of the equipment expenses which hospitals sustain is devoted to the installation of radiological rooms. Scientific research and technological development are the priming factors of an industry which is extremely sophisticated and at the cutting-edge of technology.

The optimisation of a medical

Ms. Giulietta Alberi, widow of Giorgio Alberi, presenting the Giorgio Alberi Prize to Dr. Korder.

examination is of great importance for two main reasons: finding the best working conditions so as to obtain the maximum diagnostic efficiency and exposing the patient to the minimum possible risk.

In this field of applied research a modest technological improvement can lead to substantial health and social benefits.

Detectors are of course, an essential part of the instrumentation. In this Conference, renowned experts from all over the world discussed the latest technological developments and presented various types of detectors for medical imaging.

Research in the field of medical imaging is being carried out in the Trieste University as well, mainly at the Physics Department and at the Institute of Radiology, in collaboration with the Trieste Section of the INFN. This group of researchers is developing a novel semiconductor detector and plans to use a beam of synchrotron radiation as an X-ray source. The beam will come from a bending magnet of the Elettra synchrotron machine, under construction here in Basovizza, on the Carso plateau. This ongoing research has a truly interdisciplinary nature, and can be pursued only as a joint venture between the University, the INFN and the Synchrotron.

Taking advantage of the locally planned synchrotron radiation source, a working session of this Conference was devoted to "Detectors for X-rays from synchrotron radiation sources".

An important aspect of the Conference was the awarding of the Giorgio Alberi Prize. This ceremony Conference was the awarding of the Giorgio Alberi Prize. This ceremony took place on Friday 25th September at the end of the academic events. It was attended by Mrs. Giulietta Alberi, Prof. P. Baxa, Prof. L. Dalla Palma, Prof. E. Castelli, Prof. S. Mascarenhas and Prof. L. Bertocchi, and the local organizer, Prof. J. Chela-Flores, acted as Chairperson. The Prize was awarded by Prof. S. Mascarenhas, President of the Third World Association of Medical Physics, to Dr. D. Korder, A. Stanovnik and M. Staric of J. Stefan Institute and Physics Department, University of Ljubljana, Slovenia. ◆

Pakistanis in USA Launch Major Effort for Third-World Development

Prof. Abdus Salam Receives Mazhar Medal in Applied Science

Parallel Medal in Salam's Name also Initiated for Pure Sciences

In an extremely impressive banquet, attended by many hundred academic, business and diplomatic representatives from many countries, the President of the Polytechnic University of New York, Dr. George Bugliarello, conferred the "Prof. Mazhar-Ali Applied Science Medal" on Nobel Laureate Professor Muhammad Abdus Salam, on 6 September 1992.

Minister Ch. Naeem Hussain Chattha brought the message of good wishes and felicitations from Prime Minister Mian Nawaz Sharif while the former MNA Mr. Afaq Shahid carried congratulations from the former Prime Minister Mohtrama Benazir Bhutto.

Currently the Director of the United Nations Centre for Theoretical Physics in Trieste, Italy, Prof. Salam — in addition to his research in pure science — has rendered unparallelled services for promotion of Science & Technology in the Third World. He has received honorary doctor-of-science degrees from universities in every continent. universities in every continent.

The Mazhar Medal was initiated in 1991 by Americans of Pakistani origin to honor Prof. Dr. Mazhar Ali Khan Malik whose theories on econo-industrial planning, engineering education, machinery maintenance, food forecasting and agro-industrial integration are capable of eliminating poverty from the Third World in a short period. Published around the world, the theories are applied in America and internationally. Excerpts on the theories are also translated into Russian, German, French, Persian and Arabic. A Ph.D. from New York University, Dr. Malik is a fellow of Industrial Engineering, is nominated to American Men of Science and listed in Who's Who in the World.

New York's Polytechnic University has evolved from the merger of the New York University's School of Engineering and Polytechnic Institute of Brooklyn. An author of 11 books on technology transfer, Dr. Bugliarello commands the same international stature in engineering education as did Dr. Henry Kissinger in diplomacy.

In the banquet, Dr. Shafi Ahmad Bezar, President, Pakistan League of America, also announced a second medal, "Prof. Salam Science Medal". From 1993, two medals will be given to experts for work on developing countries: the Mazhar Medal for contribution in applied science (engineering, economics etc.), and the Salam Medal for contribution in pure science (physics, chemistry, science (physics, chemistry, mathematics etc.). Fare to and from New York will also be given.

It is hoped that this venture of immigrants in America will induce the experts and governments of the Third World to work on eliminating poverty. The press in developing countries is also requested to urge them.

Courtesy of Pakistan League of America, 325 Broadway (2nd Floor), New York, NY 10017, USA. ◆

Nobel Prize in Physics and Chemistry

Professor Georges Charpak of France was awarded the Nobel Prize in Physics for an invention that helps explore the innermost parts of matter, and Professor Rudolph A. Marcus, an American, received the Chemistry Prize for research that has helped explain such phenomena as the use of light by plants.

Professor Charpak was born 1 August 1924 in Poland, but he is a French citizen. He got his Ph.D. in 1955 at Collège de France, Paris. He has been working at CERN, Geneva, Switzerland, since 1959. Joliot-Curie Professor at Ecole Supérieure de Physique et Chimie de la Ville de Paris since 1984, Prof. Charpak is Honorary Doctor at the University of Geneva and became a member of the French Academy of Sciences in 1985. In 1989 he received the "High Energy and Particle Physics Prize" from the European Physical Society (EPS).

The discovery for which he was given the award was the multi-wire proportional chamber, a device for detecting the thousands of particles produced in atom smashers like those at CERN. He invented the device in 1968 and linked it directly to computers. This enabled the data collection speed to be increased by a factor of 1,000 and the path of the particle to be measured more precisely. Since then, this type of detector and its successors have been used in virtually every experiment in particle physics.

Professor Rudolph A. Marcus was born in Montreal, Canada in 1923, but he is a naturalised American. He received his B.Sc. in 1943 and Ph.D. in 1946 at McGill University, Montreal. In 1951 he became Professor at the Polytechnic Institute of Brooklyn, New York. In 1964 he became Professor of Chemistry at the University of Illinois and in 1978 he received the Arthur Amos Noyes Chair of Chemistry at the California Institute of Technology, which he still holds. Over the years Prof. Rudolph Marcus has received many scientific distinctions, including the Wolf Prize of Chemistry in 1984.

His Prize was for theoretical work on a simple chemical process that underlies many important phenomena — the transfer of an electron between two molecules. In such processes no chemical bonds are broken, but changes take place in the molecular structure, which this theories explain. *"The theory has proved useful in the interpretation of many chemical phenomena, even though it was initially controversial"*. ♦

A Break-through in the Technique for Exploring the Innermost Parts of Matter

Courtesy of
The Royal Swedish Academy of Sciences.

This year's Nobel Prize in physics is awarded to Georges Charpak, France, for his invention and development of detectors in high energy physics. Since his invention and development of detectors in high energy physics. Since 1959 Charpak is working at CERN, the European laboratory for particle physics situated in the canton of Geneva in Switzerland. Charpak invented the multiwire proportional chamber at CERN. The pioneering work was published in 1968. Largely due to his work, particle physicists have been able to focus their interest on very rare particle interactions, which often reveal the secrets of the inner parts of matter. Sometimes only one particle interaction in a billion is the one searched for. The experimental difficulty lies in choosing the very few but exceptionally interesting particle interactions out of the many observed. Photographic methods, once so very successful in exploring particle processes, are not good enough for this. In the new wire chamber Charpak used modern electronics and for this. In the new wire chamber Charpak used modern electronics and realised the importance of connecting the detector directly to a computer. The invention made it possible to increase the data collection speed with a factor of a thousand compared to previous methods for registering charged particle trajectories. At the same time the high spatial resolution was very often considerably improved. His fundamental idea has since been developed and for more than two decades Charpak has been at the forefront of this development.

The development of detectors very often goes hand in hand with progress in fundamental research. Various types of particle detectors based on Charpak's original invention have been of decisive importance for many discoveries in particle physics during the last two decades. Several of these have been awarded the Nobel Prize in physics. Charpak has actively contributed to the use of this new type of detector in various applications in, for example, medicine and biology.

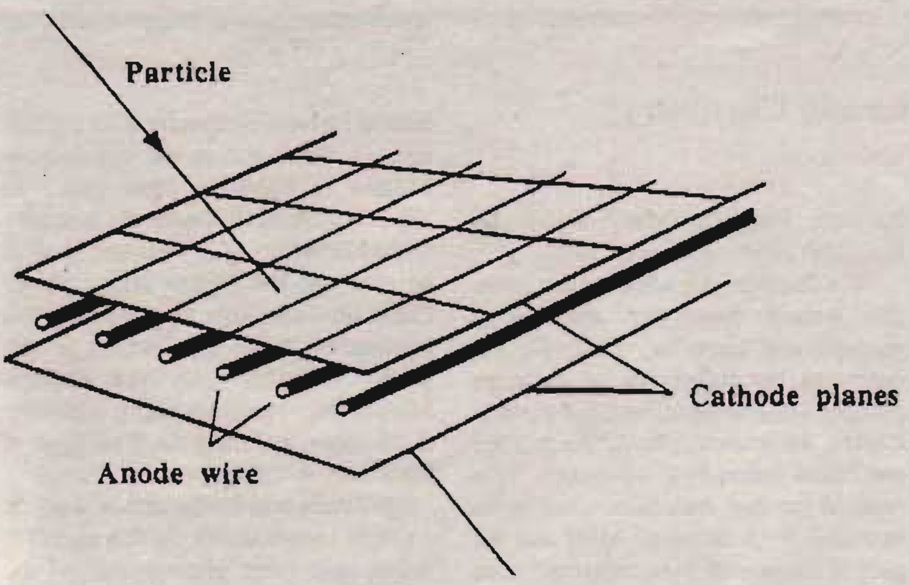
Background information

The study of reactions between

Background information

The study of reactions between elementary particles provides knowledge of their properties and of the forces that act between them. The reactions are often very complex — sometimes several hundred particles can be created in a single reaction — and to interpret them the scientists very often need to register every single particle trajectory. Up to about 1970 this registration was often done with photographic methods. The pictures were analysed with the help of special measuring devices, a slow and laborious process.

Charpak's invention consists of using an earlier development, the proportional counter, in a particularly unconventional



The principle of the multiwire proportional chamber.

The distance between the anode wires is about 2 mm and the distance between the cathode planes is about 2 cm. A charged particle ionises the gas between the cathode planes and the charges, — the electrons and ions — move towards the anode and the cathodes respectively. Several chambers are placed at different distances from each other to make it possible to determine the particle trajectory precisely.

way. The classical proportional counter, like the Geiger-Müller tube, consists of a thin wire in the middle of a tube with a diameter of about a centimetre. Between the wire and the wall of the tube a high voltage of a few kilovolts is applied. A charged particle passing though the gas-filled tube will ionise the gas. In this process electrons, which have negative electric charge, are liberated from the neutral atoms of the gas, which then become positively charged. In the electric field the electrons move towards the central wire, the anode. Near the wire the electric field is very strong and results in a rapid acceleration of the electrons. They then have enough energy to ionise
in a rapid acceleration of the electrons.
They then have enough energy to ionise
the gas and more electrons are liberated, which in their turn are accelerated and so on. This results in an avalanche of electrons and positive ions and it is the movement of the electrons and the ions that gives rise to an electric signal on the wire. The position of the charged particle that started the ionisation in the gas can however only be determined with a precision of about a centimetre, the size of the tube.

To cover large surfaces with layers of these classical proportional tubes is impractical and the desired spatial precision cannot be reached. The break-through occurred with Charpak's invention of the multiwire proportional chamber. It consists of a large number of thin, parallel wires arranged in a plane between two cathode planes a few centimetres away. The thin anode wires have a diameter of about a tenth of a millimetre and are placed about one or a few millimetres apart. In 1968 Charpak, contrary to the general belief, realised that each wire would behave as a proportional counter and result in a spatial precision of about a millimetre or less. Each wire could stand a very high rate of particles, several hundred thousand per second, at that time an exceptionally high rate.

Each wire has an amplifier. The use of such a large number of amplifiers is
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of such a large number of amplifiers is
feasible thanks to the developments in electronics which make it possible to construct compact amplifiers with very small power requirements. An additional very important advantage is the ability to register the signals with computers and handle large amounts of data.

In this pioneering work from 1968 Charpak also points to possible developments of the multiwire proportional chamber. One such application makes use of the time it takes for the primary ionisation to drift to the anode wire. A measurement of the drift time results in an improved spatial precision. This application is called a drift chamber and a spatial resolution better than a tenth of a millimetre has been obtained.

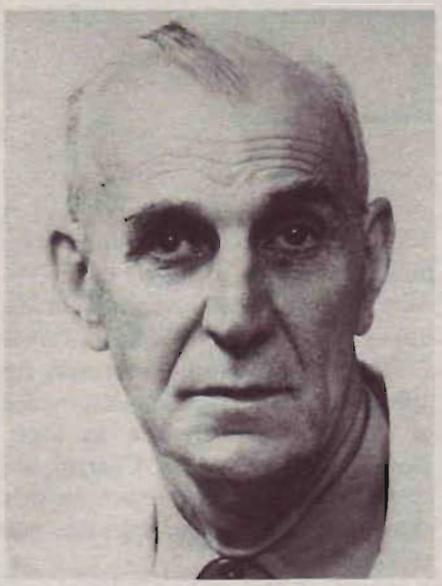
History

Very often discoveries in physics are related to detector development. For the development of the cloud chamber, which registers tracks of charged particles in a gas, the 1927 Nobel Prize was awarded to C.T.R. Wilson. The cloud chamber was used in the discovery of the first antiparticle, the position, for which C.D. Anderson (of Swedish descent) was awarded the 1936 Nobel Prize. The 1948 Nobel Prize in physics went to P.M.S. Blackett for his development of the cloud chamber technique and its use in the study of the atom nucleus and the cosmic radiation. In studies of the cosmic radiation during the 1940's and 1950's special photographic emulsions were used to register the tracks of charged particles. C.F. Powell was awarded the 1950 Nobel Prize in physics for the development of the emulsion technique and the discovery of the pi meson.

The invention of the bubble chamber, for which D.A. Glaser received the 1960 Nobel Prize in physics, was of great importance for the evolution of particle physics in the 1960's. In the bubble chamber, which is filled with an overheated liquid, charged particles give rise to small bubbles where the liquid is boiling along the track. These strings of bubbles are photographed. However, pictures can only be taken about once per second. During the 1960's a large number of new elementary particles were discovered thanks to the bubble chamber technique and L.W. Alvarez was
discovered thanks to the bubble chamber
technique and L.W. Alvarez was
awarded the 1968 Nobel Prize in physics for the development of this technique.

Charpak's discovery in 1968 started a massive development of different types of wire chambers. Today practically every experiment in particle physics uses some type of track detector that has been developed from Charpak's original invention. Charpak himself has been in the centre of this development from which thousands of scientists, both at CERN and elsewhere, have profited. When the charm quark was discovered in 1974, resulting in the award of the 1976 Nobel Prize in physics to B. Richter and

continued on Page 10



Alfred Kastler (France), 1966
"for the discovery and development of optical methods for studying Hertzian resonances in atoms".
Dates of visits:
1969, April 14 – 16
1970, August 19 – 22
1972, January 9 – 13
1973, January 16 – April 13
1974, November
1978, September 21 – 23
1979, March 3 – 4.

Thirty-five Nobel Laureates have visited the ICTP since 1964. The citations for the Prize and dates of their visits are given for five of them in this issue. More will be published in future ICTP newsletters.

John Robert Schrieffer (USA), 1972
"for the theory of superconductivity called the BCS theory".
Dates of visits:
1968, June 10 – 22
1974, March 10 – 20
1983, June 19 – July 2
1984, June 24 – July 1
1985, June 6 – July 11
1987, June 28 – July 6
1989, September 24 – November 11
1990, August 11 – 14.

Steven Weinberg (USA), 1979
"for contributions to the theory of the unified weak and electromagnetic interaction between elementary particles, including inter alia the prediction of the weak neutral current".
Dates of visits:
1968, June 21 – 29
1989, October 31 – November 3.

Charles Hard Townes (USA), 1964
"for fundamental work in the field of quantum electronics which has led to the construction of oscillators and amplifiers based on the maser-laser principle".
Date of visit:
1968, June 16 – 30.

Werner Karl Heisenberg (Germany), 1932
"for his establishment of quantum mechanics whose application has led, among other things, to the discovery of the allotropic forms of hydrogen".
Dates of visits:
1965, June 1 – 3
1968, June 16 – 20
1972, September 18 – 25.

Visits to ICTP

Ministry of Science and Technology of Pakistan

Dr. Parvez Ahmad Butt (Secretary, Ministry of Science and Technology, Government of Pakistan) visited the Centre on 22 September 1992. He had a meeting with Professor Abdus Salam, Director, International Centre for Theoretical Physics (ICTP) and President of TWAS, and Prof. L. Bertocchi, Deputy Director, ICTP, to discuss matters of research related to technical co-operation and further collaboration between Pakistan and TWAS and ICTP. Dr. Parvez Ahmad also visited the Library of the ICTP.

Royal Swedish Academy of Sciences

Professor T. Laurent, President of the Royal Swedish Academy of Sciences, and Prof. O.G. Tandberg, Foreign Secretary of the same Academy, visited ICTP and ICGEB on 23 and 24 September 1992. On 23 September they visited the International Centre for Genetic Engineering and Biotechnology (ICGEB) and were briefed by Professor Falaschi, Director General of the Centre. After that they visited the laboratories of the ICGEB. On 24th September, the delegation met Professor Abdus Salam, Director, ICTP, and President, TWAS, and discussed the scientific activities of the ICTP, ICS and TWAS. They met Prof. L. Bertocchi, Deputy Director, Prof. Forti, Project Director, ICS, and Prof. Denardo, Head of the Office of External Activities of the ICTP, and were
Prof. Denardo, Head of the Office of External Activities of the ICTP, and were
acquainted with the activities of the ICTP, ICS and TWAS.

During the afternoon they visited the Library, Laser Laboratory and Microprocessor Laboratory of the ICTP.

Mathematical Centre, Ahuja, Nigeria

Professor C. Olanyan, Chairman of the Governing Council of the Mathematical Centre, Ahuja, Nigeria, visited the Centre from 28 September to 1st October. He met Professor Abdus Salam in his office and discussed the scientific activities of the ICTP and TWAS. Professor Olanyan further discussed the possibility of co-operation and collaboration between the Mathematical Centre, Ahuja, Nigeria, and the ICTP and TWAS. He met African scientists and students present at the Centre.

After that he visited the laboratories of the ICTP and ICGEB.

Iowa State University

Professor M. Jischke, President of Iowa State University, visited the ICTP on 5th October 1992. He met Professor Abdus Salam, Director, ICTP, and President, TWAS, and discussed the possibility of strengthening future scientific exchanges between the Iowa State University and ICTP. He also met Prof. L. Bertocchi and high officials of the ICTP and ICS. Prof. Jischke visited the Laser Laboratory and the Library of the ICTP. ♦

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S.C.C. Ting, several multiwire proportional chambers were used. The wire chamber was also used in the discovery of the intermediate bosons at CERN in 1983. For this discovery the 1984 Nobel Prize in physics was awarded to C. Rubbia and S. Van der Meer. Detectors developed by Charpak are being used more and more outside physics, e.g. in medicine for the detection of X-rays. ♦

First Scientific Conference on The Future of Science and Mathematics Teaching and the Needs of Arab Society

Beirut, 20 – 30 October, 1993

Invitation and call for papers

Sponsored by:
Arab Development Institute (ADI)
UNESCO Education Bureau in the Arab States (UNEDBAS)
American University of Beirut (AUB)

The main objective is to get together scientists, researchers and specialists to discuss and analyse the following topics:

1. The current situation of teaching Science and Mathematics in the Arab World (development of aims, early modernization projects, decision mechanism, results, etc.).
(development of aims, early modernization projects, decision mechanism, results, etc.).
2. Teaching Science and Mathematics and the needs of the society (science and society, teaching and development, conformity of aims etc.).
3. New trends in the development of teaching Mathematics and Science (initiation of modernization and its nature, new trends, modernization and its nature, modernization criteria etc.).
4. The future of teaching Science and Mathematics (future needs, future of international changes, features of Arab changes etc.).

Kindly observe that the deadline for submitting abstracts of papers is January 15, 1993.

Participants shall bear air travel expenses and accommodation costs. However, a limited number of fellowships covering ravel and/or accommodation is provided to a limited number of invited speakers.

Dr. Mohamad Debs, Conference Coordinator, Head of Science and Technology Department, Arab Development Institute, P.O. Box 14, 5300 Beirut, Lebanon.

Activities at ICTP in September/October

Title: WORKSHOP ON COMMUTATIVE ALGEBRA, 14 – 25 September.

Organizers: Professors Ngo Viet Trung (Academy of Sciences of Viet Nam, Hanoi), A. Simis (Universidade Federal da Bahia, S. Salvador, Brazil) and G. Valla (University of Genoa, Italy).

Lectures: Gröbner bases. Cohen-Macaulay approximations. Embeddings of affine varieties. On Macaulay's definition of perfect ideals. Some application of completing unimodular polynomial vectors. Theorems of Artin-Nagata type on residual intersection and algebraic linkage. On vector bundles on projective varieties. Determinantal rings. Linkage and deformation. COCOA for the working algebraist. Monomial conjecture and Gorenstein rings. Results and problems on the resolution of certain graded algebras. Coherence, regularity and homological dimensions of fixed rings. Theoretical aspect of MACAULAY — a computer system for doing Commutative Algebra and Algebraic Geometry. Canonical modules and Cohen-Macaulay types of modular lattices. Generic maps revised: results and open questions. Critical binomials of monomial curves. On the cofiniteness of local cohomology modules. Elimination, resultant and ideals of determinantal type. Macaulayfication of quasi-projective varieties. Normality of ladder determinantal ideals. On the depth of the associated graded ring of an m-primary ideal of a Cohen-Macaulay ring. Finite free resolutions with a multiplicative structure. Multiplicities of blow-ups of straightening closed ideals in graded ordinal Hodge algebras. On the equations defining monomial curves. The Dilworth number of a Stanley-Reisner ring of dim 1. Computational Methods in Commutative Algebra. On the Gorenstein property of multigraded Rees algebras. Finiteness properties of local cohomology modules. Beyond Cohen-Macaulay approximation. Structure of complete differential local rings. On the structure of the canonical modules and the Gorenstein property of Rees and form rings of powers of ideals. Cohomological annihilators and hypersurface sections. On face rings. The h-vector of a graded Gorenstein algebra: unimodality and related problems. Hodge algebras and standard bases. Multiplicity of ideals of maximal analytic spread and intersection theory. The special fiber of the ideal of a monomial curve in P^3. Equations of monomial varieties and Rees ring of a monomial quasi-homogeneous projective surface. Certain loci associated to a canonical curve. Associated graded algebras of a Gorenstein algebra. On the equations which are needed to define a projective scheme. Integral valued polynomials. On the Gorenstein property of blow-up rings of analytic deviation 1 ideals. Discriminants and resultants. Generic maps: results and open questions. Hilbert-function of bigraded algebras. Reduction numbers and Rees algebras of powers of an ideal. γ-hyperellipticity and weights of Weierstrass points. Projective modules over monoid rings and related topics. Certain monomial curves are set-theoretic complete intersections. On epimorphism theorems. Buchsbaum criterion for Segre products. A computational proof for the Quillen-Sushin theorem.

The Workshop was attended by 141 lecturers and participants (74 from developing countries).

Title: FOURTH INTERNATIONAL CONFERENCE ON APPLICATIONS OF PHYSICS IN MEDICINE AND BIOLOGY: ADVANCED DETECTORS FOR MEDICAL IMAGING, 21 – 25 September.

Organizing Committee: Professors P. Baxa (University of Trieste, Italy), A.M. Benini (International Atomic Energy Agency, Vienna, Austria), L. Bertocchi (ICTP), J.R. Cameron (University of Wisconsin, Madison, USA), E. Castelli (University of Trieste, Italy), J. Chela-Flores (Instituto Internacional de Estudios Avanzados, Caracas, Venezuela, and ICTP), F. de Guarrini (Unità Sanitaria Locale, Trieste, Italy), A. Del Guella (University of Ferrara, Italy), M. Giorgi (University of Pisa, Italy), R. Longo (Ospedale di Cattinara, Trieste, Italy), I. Ortalli (University of Parma, Italy) and A. Stefanini (University of Pisa, Italy).

Scientific Advisory Committee: A.B. Brill (University of Massachusetts Medical Center, Worcester, USA), L. Dalla Palma (University of Trieste, Italy), G. Fullerton (University of Texas Health Science Center, San Antonio, USA), C.A. Mistretta (University of Wisconsin, Madison, USA), N. Molho (University of Milan, Italy), G. Moschini (University of Padua, Italy), M. Regler (Österreichische Akademie des Wissenschaften, Vienna, Austria), F. Sauli (CERN, Geneva, Switzerland) and A. Todd-Pokropek (University College, London, UK).

Sponsors: Associazione italiana di fisica biomedica (AIFB), European Federation of Organizations for Medical Physics (EFOMP), Società italiana di fisica (SIF), Third World Association of Medical Physics (TWAMP) and Università degli Studi di Trieste.

Lectures: Fundamentals of semiconductor detectors and their use in medical imaging. Fundamental and future trends of detectors for EPR. X-ray projector for digital radiology: the state-of-the-art of new X-ray sources. Application of multiwire proportional

Honors

• Professor James Eells, former Director of the Mathematics Group at ICTP, has been made Honorary Fellow of Leeds University (UK) and has received the Senior Berwick Prize of the London Mathematical Society.

We congratulate him. Professor Eells directed the Mathematics Group of the ICTP from 1986 to 1992 with great competence and efficiency. He has been associated with the ICTP since 1975.

• The scientists and Staff of the ICTP congratulate Professor Roald Sagdeev, Member of the ICTP Scientific Council, for receiving the Tate Medal of the American Physics Society for achievements in international science, on October 19, 1992. ♦

chambers (MWPC) and microstrip gaseous detectors in medical imaging. Thin-film flat panel imagers — a coming revolution in megavoltage and diagnostic X-ray imaging. Comparative use of gaseous detectors and semiconductors in medical imaging. Neural networks in medical physics. SQUID-detectors: a unique tool for functional studies in the brain. X-ray imaging with photostimulable storage phosphors and future trends. High rate X-ray gaseous detectors. Silicon detectors in digital radiology with synchrotron radiation. Biological application of X-ray microscopy. The medical programme at the European synchrotron radiation facility. Detectors for synchrotron based coronary angiography. A multinanode gas detector for noninvasive coronary angiography. Improvement of detector performance by preprocessing techniques: scatter correction. 2D and 3D imaging with integrated detectors using VLSI technology. High pressure gas avalanche chambers for medical radiology. The electrönification of classical radiography. Large area solid state X-ray imagers. 2D and 3D graphical methods — applications in medical imaging. Application and development of CdTe and CdZnTe in medical imaging. Fundamental and future trends for detectors for MR imaging and spectroscopy. Advanced piezo- and piroelectric ceramic detectors.

Contributed papers and posters.

Working sessions.

Awarding of the Giorgio Alberi Prize.

The Conference was attended bv 198

The Conference was attended by 198 lecturers and participants (124 from developing countries).

Title: College on methods and experimental techniques in biophysics, 28 September – 23 October.

Organizers: Professors H.A. Farach (University of South Carolina, Columbia, USA), S. Mascarenhas (Universidade de São Paulo, São Carlos, Brazil), J.N. Onuchic (University of California, San Diego, USA) and J. Chela-Flores (Instituto Internacional de Estudios Avanzados, Caracas, Venezuela, and ICTP).

Lectures: The first 10 years of biophysics at ICTP. Protein folding. Protein crystallography. Optical techniques: Raman, IR, dichroism. Magnetic techniques. The photosynthetic bacterial reaction center: structure and dynamics. Molecular dynamics on water at different temperatures. Electron transfer. Bioelectrets and water. Water structure around macromolecules. Unified view from atoms to fluids. Magnetic techniques and biological molecules in photosynthesis. Proton transfer; protein-water interactions. Protein dynamics. 2D-NMR in protein structure. Monte Carlo methods in biology. Electron transfer. Mirror symmetry breaking, origin of biochirality and prebiotic evolution. Subviral pathogens of plants and animals: the viroids and viroid-like satellite RNAs. Genetics, evolution and
the origin of life. Fundamental symmetry aspects of molecular chirality. Subviral
the origin of life. Fundamental symmetry aspects of molecular chirality. Subviral pathogens of plants and animals: the prions.

Poster session and discussion.

Round table on instrumentation and techniques in the Third World.

The College was attended by 74 lecturers and participants (60 from developing countries).

Title: Second College on microprocessor-based real-time control — Principles and applications in physics, 5 – 30 October.

Organizer: Professor C. Verkerk (CERN, Geneva, Switzerland), in co-operation with the International Centre for High Technology and New Materials (ICTM, Trieste, Italy) and with the sponsorship of Direzione Generale per la Cooperazione allo Sviluppo (Ministry of Foreign Affairs, Rome, Italy) and the United Nations University (Tokyo, Japan).

Lectures: Course overview. Recall of 6809, Rosy. C language — basics. Practical OS-9. Operating system principles. ICTP-Colombo Board. Software design. Fully piplined and programmable level 1 trigger. Introduction to Multiboard. Introduction to projects. UNIX and LynXOS. Practical networks. Distributed computing. Principles of telephony. Case study — small switching systems. Discussion of ICTP Board exercises solutions. Advanced features of C
language. PC-based systems. Case study — design and implementation of a
language. PC-based systems. Case study — design and implementation of a general purpose PC based data acquistion system. Case study — distributed real time systems. Case study — an inexpensive implementation for Real-Time Control. Wrap-up.

Presentations by participants.

Laboratory exercises.

The College was attended by 64 lecturers and participants (55 from developing countries).

Title: Second Trieste Conference on recent developments in the phenomenology of particle physics, 19 – 23 October.

Organizers: Professors A. Ali

College on methods and experimental techniques in biophysics, 28 September – 23 October.

(DESY, Hamburg, Germany), G. Altarelli (CERN, Geneva, Switzerland), J. Ellis (CERN, Geneva, Switzerland), F. Hussain (ICTP), N. Paver (Istituto Nazionale di Fisica Nucleare and University of Trieste, Italy) and R. Peccei (University of California, Los Angeles, USA).

Lectures: Neutrino masses and mixing. Detection of pp neutrinos from the Sun in the GALLEX experiment. Neutrinos, astrophysics and cosmology. Heavy quark symmetries: recent progress. Future of heavy quark physics. PCAC tests in neutrino interactions at low Q^2. Finite-temperature effective potentials and the nature of the electroweak phase transition. Hints within the standard model on m_t and m_H. Heavy meson decays in HQET. Heavy flavours at LEP. Predictions from minimal SUSY and unification. Semileptonic B decays to positive parity charmed states and the heavy quark symmetry. Chiral SU(2) X SU(2) liquids: a theory of heavy nuclei and neutron stars. Search for new physics at LEP. The search for the SM neutral Higgs boson: results at LEP and prospects for LEP 200P. QCD at LEP. Electroweak physics at LEP. Inclusive rare B-meson decays. Heavy meson decays in the infinite quark mass limit. Particle physics phenomenology from lattice QCD. Precision electroweak physics within and beyond the Standard Model. What does QCD phenomenology of hadron jets tell us about confinement? Deep inelastic scattering of polarised leptons on polarised nucleons — the SMC experiment. Scientific activity at Gran Sasso Laboratory. Experimental determination of f_{Ds}. Rare K decays and CP violation. Radiative K decays in chiral perturbation theory. Quark model with QCD vacuum structure. Theoretical aspects of HERA physics. New formulation of the unitary and analytic VMD model of nucleon electromagnetic structure and its experimentally verifiable aspects. Experimental aspects of HERA physics. Planck scale effects on low energy particle physics.

The Conference was attended by 90 lecturers and participants (40 from developing countries).

Title: CONFERENCE ON CHEMICAL EVOLUTION AND THE ORIGIN OF LIFE, 26 – 30 October.

Organizers: Professors C. Ponnamperuma (University of Maryland, College Park, USA) and J. Chela-Flores (Instituto Internacional de Estudios Avanzados, Caracas, Venezuela, and ICTP), with the co-sponsorship of the International Centre for Science and High Technology (ICS, Trieste, Italy), the Commission of the European Communities (Bruxelles, Belgium) and UNESCO (Paris, France).

Lectures: Earliest records of life on earth. Phosphate in models for molecular evolution. Biological markers in precambrian sediments — Indian subcontinent. Could comets be carriers of intact homochiral biomolecules from interstellar space? The need to study the origin of life. On Dyson's models of the origin of life. Prebiotic chemistry. Evolution in an RNA world. From amino acids to chemically active peptides. Chromoproteinoids and their ability to form boundary structures. Ionizing radiation and water in chemical processing in space and on early Earth. Chemical effects of ionizing radiation and sonic energy in the context of chemical evolution. The role of neoteny and sociogenesis in the evolution of cell structure. Chemical origin and early evolution of biological energy

Conference on chemical evolution and the origin of life, 26 – 30 October.

conversion. Small pathogenic RNAs of plants: living fossils of the RNA world? The weak force and the origin of life. Viruses and viroids at the origin of organized life. True and false chirality. Experiments in search of the origin of biomolecular asymmetry. Topological origin of chiral asymmetry in biology. Bifurcation with symmetry breaking as the cause of biological big bang. The origin of chirality, the role of phase transitions and their induction in amino acids. Chirality: hypothesis and new experiments. Theoretical considerations: spontaneous regulating mechanisms that may have led to the origin of life. An attempted experiment. Search for phase transitions changing molecular chirality. Chiral interaction and biomolecular evolution. Chiral forces and molecular dissymmetry. Differences in radiolysis behaviour of D, L amino acid in primary stage and thermodynamic state. Experimental studies on the possibility of chirality dependent time reversal. Physicochemical basis for the origin of the genetic code. The search for extraterrestrial intelligence. Summary: origin of life 1992. Discussion of new experiments on the origin of amino acid chirality.

The Conference was attended by 69 lecturers and participants (37 from developing countries).

Title: SCHOOL ON PHYSICAL METHODS FOR THE STUDY OF THE UPPER AND LOWER ATMOSPHERE SYSTEM, 26 October – 6 November.

Organizers: Professors M.L. Chanin (CNRS Service d'aéronomie, Paris, France) and S.M. Radicella (Programa Nacional de Radiopropagación, PRONARP, Buenos Aires, Argentina, and ICTP).

In cooperation with the International Institute for Earth, Environmental and Marine Sciences and Technologies (IIEM, Trieste, Italy), and with the financial support from the World Meteorological Organization (WMO), Scientific Committee on Solar Terrestrial Physics of ICSU (SCOSTEP), the International Union of Radio Science (URSI), the French Centre National d'Etudes Spatiales and the Italian Istituto Nazionale di Geofisica.

Lectures: Time series analysis of atmospheric data. Quality control of atmospheric ozone data. Atmospheric coupling mechanisms. Middle and upper atmosphere satellite, rocket and balloon measurements techniques. Middle and upper atmosphere optical ground measurements techniques. Ionospheric measurements techniques. Ionospheric models and its use in telecommunications. Magnetospheric measurements techniques. Ionosphere-magnetosphere coupling.

Workshop Activities: Time variability at different time scales of precipitation, surface temperature and stratospheric ozone. Coordinate analysis of satellite and ground based data for lower and upper atmosphere coupling studies. Use of ionospheric data basis and models for telecommunications.

The School was attended by 89 lecturers and participants (72 from developing countries). ♦

Second College on microprocessor-based real-time control — Principles and applications in physics, 5 – 30 October.

Calendar of Activities at ICTP

1992

Second Autumn Workshop on mathematical ecology .... 2 – 20 November

Workshop on three-dimensional modelling of seismic waves generation, propagation and their inversion .... 30 November – 11 December

1993

Sixth International Workshop on computational condensed matter physics .... 11 – 13 January

Experimental Workshop on high temperature superconductors and related materials (advanced activities), San Carlos de Bariloche, Argentina .... 11 – 29 January

Fourth Training College on physics and technology of lasers and optical fibres .... 18 January – 5 February

Second Workshop on functional-analytic methods in complex analysis and applications to partial differential equations .... 25 – 29 January

Third ICTP-URSI College on theoretical and experimental radiopropagation physics .... 1 – 26 February

Winter college on optics .... 8 – 26 February

Workshop on scientific aspects of the rural communications in developing countries .... 1 – 5 March

Adriatico Research Conference on quantum interferometry .... 2 – 5 March

Conference on "Highlights of particle and condensed matter physics" .... 8 – 12 March

Workshop on representation theory of Lie groups .... 15 March – 2 April

Spring School and Workshop on string theory, gauge theory and quantum gravity .... 19 – 29 April

Meeting on "Intracellular channels, organelles and cell function" .... 21 – 23 April

Sixth Workshop on perspectives in nuclear physics at intermediate energies .... 3 – 7 May

Sixth Workshop on perspectives in nuclear physics at intermediate energies .... 3 – 7 May

Workshop on qualitative aspects and applications of nonlinear evolution equations .... 3 – 14 May

Course on ocean-atmosphere interactions in the Tropics .... 10 – 29 May

College on computational physics .... 17 May – 11 June

Spring College on plasma physics .... 17 May – 11 June

Summer School in high energy physics and cosmology .... 14 June – 30 July

including

Third School on non-accelerator particle astrophysics .... 28 June – 9 July

Miniworkshop on strongly correlated electron systems .... 21 June – 9 July

Research Workshop in condensed matter, atomic and molecular physics .... 21 June – 3 September

Adriatico Research Co nference on strong correlation phenomena at low carrier densities .... 22 – 25 June

continued on following page

Calendar of Activities at ICTP in 1992, contd.

Adriatico Research Conference on scattering from surfaces .... 6 – 9 July

Workshop on the liquid state of matter: opportunities from new radiation sources .... 19 – 30 July

Miniworkshop on non-linearity: chaos in mesoscopic systems .... 26 July – 6 August

Adriatico Research Conference on mesoscopic systems and chaos, a novel approach .... 3 – 6 August

Conference on variational problems in differential geometry and partial differential equations .... 16 – 20 August

Adriatico Research Conference on vortex fluctuations in high T_c superconductors .... 17 – 20 August

Working Party on mechanical properties of interfaces .... 23 August – 3 September

Workshop on materials science and physics of non-conventional energy sources .... 30 August – 17 September

Course on geometric phases .... 6 – 17 September

College on soil physics .... 6 – 24 September

Second Workshop on composite media and homogenization .... 20 September – 1 October

Workshop on telematics .... 27 September – 22 October

Workshop on radioecology: mechanisms of transfer of radionuclides to the environment .... 11 – 29 October

Conference on the origin of life .... 25 – 29 October

Second School on the use of synchrotron radiation in science and technology:

"John Fuggle Memorial" .... 25 October – 19 November

Trieste Conference in high energy physics .... 8 – 12 November

Second Workshop on non-linear dynamics and earthquake prediction .... 22 November – 10 December

ICTP-UNU-Microprocessor Laboratory: Third Course

on basic VLSI design techniques .... 22 November – 17 December

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

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