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Dr. Deepak Dhar from the Tata Institute of Fundamental Research, India, receiving the J.R. Schrieffer Prize from Professor Luciano Bertocchi, Deputy Director, International Centre for Theoretical Physics (ICTP).

Inside:

J.R. Schrieffer Prize Ceremony

Professor Luciano Bertocchi, Deputy Director, International Centre for Theoretical Physics (ICTP), presented the J.R. Schrieffer Prize 1993 to Dr. Deepak Dhar from the Tata Institute of Fundamental Research, India. The ceremony took place in the Main Building Lecture Hall of the ICTP, Trieste, on 10 August 1993.

The 1993 ICTP Prize in honor of Nobel Laureate Professor J. Robert Schrieffer, in the field of Solid State, Atomic and Molecular Physics, has been awarded to Dr. Deepak Dhar from the Tata Institute of Fundamental Research, Bombay, India, "for his outstanding work on a class of complex systems involving self-organized criticality and phase transition".

Dr. Deepak Dhar is an Associate Professor working at the Tata Institute of Fundamental Research. His high scientific achievements have been recognized by his election to Fellow of the Indian Academy of Sciences as well as conferment of the Shanti Swarup Bhatnagar Award in Physical Sciences (the highest science award in India) in 1991.

Dr. Deepak Dhar has made an outstanding contribution to our understanding of a class of complex physical problems involving geometrical, numerical, dynamical and statistical mechanical randomness. This includes his work on directed percolation lattice animal statistics and combinatorics, random walks on fractals, spin glasses, self-organized criticality of automata models, and equilibrium phase transitions. His exact solution of the abelian sandpile model of self-organized criticality and of the directed-site animals enumeration in three dimensions marks a notable advance in our understanding of this class of complex systems.

Dr. Deepak Dhar obtained his Ph.D. in 1978 at the California Institute of Technology, Pasadena, California, USA. He did his Master of Science in 1972 at the Indian Institute of Technology, Kanpur, India. He started his career as a Visiting Fellow (1978-80), Fellow (1980-86), Reader (1986-90) and Associate Professor (1990 till to date) in the Theoretical Physics Group at the Tata Institute of Fundamental Research, Bombay, India. He held the position of Research Associate of CNRS (France),

Université P. and M. Curie, Paris (1984-85). He is a Fellow of the Indian Academy of Sciences, Senior Honorary Fellow of the Jawaharlal Nehru Centre for Advanced Scientific Research, and Associate Member of the International Centre for Theoretical Physics (ICTP).

The 1993 ICTP Prize honors Professor John Robert Schrieffer. He was born in Oak Park, Illinois, in 1931. He obtained his undergraduate degree in physics from the Massachusetts Institute of Technology in 1953 and a Ph.D. from the University of Illinois in 1957, where his dissertation was on the theory of superconductivity.

In January 1992 he was appointed University Professor, State University System of Florida, with primary appointment at Florida State University and at the University of Florida, USA. He is Chief Scientist of the National High Magnetic Field Laboratory, located at FSU. From 1982 to 1991 he was Chancellor's Professor at the University of California, Santa Barbara, and served as Director of the Institute for Theoretical Physics from 1984 to 1989. Previously he was Mary Amanda Wood Professor of Physics at the University of Pennsylvania and on the Faculties of the Universities of Illinois and Chicago.

In 1986 he received the Oliver E. Buckley Condensed Matter Physics Prize and the Comstock Prize of the National Academy of Science. Professor John Robert Schrieffer received the Nobel Prize in Physics in 1972 with his co-laureates, John Bardeen and Leo Cooper, for their development of the BCS theory of superconductivity, which related the superconducting state of the bound pair actions of electrons at low temperature in the conductor. His later work was in the areas of particle physics, metal impurities, spin, fluctuations and chemisorption. Other awards include the John Ericsson Medal and the Alumni Achievement Award of the University of Illinois.

He is a Member of the National Academy of Science, serving on its Council for the period 1990-1993. He is also a Member of the American Academy of Science, the American Philosophical Society, and the academies of science of Denmark and

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The Genesis of Unified Gauge Theories

by Tom Kibble

Courtesy of Cern Courier, June 1993.

From 8-12 March, at a 'Salamfest' at the International Centre for Theoretical Physics in Trieste, Italy, friends, colleagues, admirers and former students paid tribute to the Institute's founder and director Abdus Salam, and his contributions to science. Presentations centred around the development of today's Standard Model of particle physics and attempts to go beyond it, and the parallels between the physics of condensed matter and elementary particles.

During the week, Salam was awarded the honorary degree of Doctor of Science by the Rector of St. Petersburg University, Academician S. Merkuriev.

While in recent years Salam has mainly been identified with the Centre which he established in 1964, many of his important contributions to physics came when he resided permanently at London's Imperial College. At the Trieste Salamfest, Tom Kibble, formerly Head of Physics at Imperial and a longtime colleague of Salam, described Salam's role at Imperial in the quest for a unification of electromagnetism and the weak force. In 1979 Salam, Sheldon Glashow and Steven Weinberg shared the Nobel Physics Prize for the new synthesis, one of the major achievements of 20th-century physics.

The theoretical physics group at London's Imperial College in 1959 had three permanent faculty: Abdus Salam, his erstwhile thesis supervisor Paul Matthews, and John C. Taylor. I joined as a lecturer the following year.

In those early days we had lots of visitors, both long- and short-term — Murray Gell-Mann, Ken Johnson, John Ward, Lowell Brown, Gordon Feldman and Steven Weinberg.

About a year after I arrived we were transferred from the Mathematics to the Physics Department under the formidable Patrick (P.M.S.) Blackett. Having been brought up in the Cavendish Laboratory tradition under Lord Rutherford, Blackett was rather scornful of theoretical physicists, but he knew a good thing when he saw one and had persuaded Salam to join the rapidly expanding Physics Department.

In 1960 field theory was widely regarded as very *passé*. It had had its triumphs: renormalization theory had made sense of divergences, and quantum electrodynamics had been magnificently vindicated.

But field theory didn't seem to work for anything else, particularly not for the strong interactions, and was definitely out of fashion. There were, however, a few places in the world where field theory was still studied unashamedly. Imperial College was one. Harvard was certainly another; many of our visitors over the next few years were Julian Schwinger's students.

At Imperial there were two dominant theory themes: symmetries and gauge theories. Both had their origins in the concept of isospin.

The isospin symmetry between protons and neutrons had shown how two apparently disparate particles might be regarded as different states of a single fundamental entity, the nucleon. The symmetry was generalized to include Yukawa's mesons in an important paper by Nick Kemmer in 1938, which is incidentally perhaps one of the first papers to suggest the need for a neutral current.

Kemmer was very influential in British theoretical physics in the immediate post-war period. He was Paul Matthews' supervisor in Cambridge and when I was a student in Edinburgh he was my Head of Department, having succeeded Max Born in 1953.

In the forties and fifties, as new particles proliferated, it was natural to try to bring some order into this chaos by enlarging the symmetry group beyond the SU(2) of isospin, especially after the discovery of the new quantum number, strangeness.

Salam had students working on every

conceivable symmetry group. One of those students was Yuval Ne'eman, who had the good fortune and/or prescience to work on SU(3). From that work, and of course from the independent work of Murray Gell-Mann, stemmed the Eightfold Way, with its triumphant vindication in the discovery of the omega-minus in 1964.

Salam himself made many important contributions to these symmetries, but I believe this was not his first love. His real goal was to find the ultimate theory to describe the weak, electromagnetic and strong interactions, and even gravity — what we would now call a Theory of Everything.

From an early stage, certainly well before I joined Imperial, Salam was convinced that the ultimate theory would be a gauge theory.

The starting point was the epoch-making paper of Yang and Mills in 1954. There may be others who deserve some of the credit — Weyl, Klein, Shaw, Utiyama — but Yang and Mills articulated very clearly the 'gauge principle' — sometimes paraphrased as 'Nature abhors a rigid symmetry'.

Yang and Mills argued that a rigid, global isospin symmetry is incompatible with relativistic field theory. Their point was that once isospin symmetry has been accepted, it is arbitrary which component is identified with the proton and which with the neutron. But it then seems odd that making this choice should automatically fix the convention throughout all space for ever. So they looked at what needed to be done to make isospin a local symmetry.

The gauge principle provided a natural basis for electromagnetic interactions, and after the work of Yang and Mills people began to look for gauge theories of the strong and weak interactions.

The first goal was strong interactions; that is what Yang and Mills themselves were after. But it was hard to make progress because calculations were difficult. With such a strong coupling, perturbation theory would not work, and the asymptotic freedom of quarks was unknown.

So the weak interactions emerged as a better bet. There were certainly tantalizing hints of a structure very similar to electrodynamics. While Fermi's classic recipe with four particles interacting at a point was obviously non-renormalizable, it was probably a shorthand way of writing an effective interaction due to the exchange of a heavy boson.

Progress was held up while people searched for the correct space-time symmetry of the weak interaction. The breakthrough came with another suggestion of Yang's, working this time with T.D. Lee, that mirror symmetry (parity) is not conserved in weak interactions. After the fall of parity in 1957, Salam was one of the first to point out the connection between left-handedness and a zero mass neutrino.

Meanwhile Marshak and Sudarshan and Feynman and Gell-Mann showed how the weak interaction should be written down. This suggested that weak interactions could be mediated by a charged vector boson, the W.

The seemingly insuperable difficulty was the large W mass. If the interaction were of the same strength as electromagnetism, the W mass would have to be about 40 GeV. But putting a mass term in the Lagrangian would destroy the gauge invariance, and the heavy vector particle would make the formalism blow up and become unrenormalizable.

As early as 1958, Salam and John Ward proposed a unified gauge theory of weak and electromagnetic interactions, involving a charge triplet of vector mesons, with the neutral component identified with the photon. They placed the electron, neutrino and positron too in a triplet. This was ingenious, but of course they could only obtain the parity-conserving part of the weak interaction. Parity violation was artificially imposed, and the W mass put in by hand.

Two years later they proposed a unified theory of weak, electromagnetic and strong interactions, based on the gauge group SO(8), a paper well ahead of its time, foreshadowing later ideas of grand unification.

But these theories did not really work; nor did similar ones proposed by Glashow and others. The major obstacle remained the vector meson mass. This was essential to make the interaction weak and short-range, but apparently incompatible with both gauge invariance and renormalizability. The only way anyone knew to make a vector-meson theory renormalizable was to use zero-mass gauge bosons.

As often happens, progress was delayed by a 'folk theorem'. Theoretical physicists sometimes quote 'theorems' that everyone believes but eventually turn out not to be true.

One such folk theorem was that the photon is massless because of gauge invariance, considered one of the predictive successes of the gauge principle. In 1961 Julian Schwinger said this theorem might be false, although he was thinking more about strong interactions at the time.

Another folk theorem came in when people began edging towards spontaneous symmetry breaking to explain the heavy gauge mesons. Here the Goldstone theorem apparently predicted unobserved massless spin-zero particles.

When Steven Weinberg came to Imperial College in 1961-62, he and Salam, collaborating at long range with Jeffrey Goldstone, spent a lot of time confirming this theorem. In condensed-matter physics, counterexamples to the Goldstone theorem were known for long-range forces. But the theorem seemed to rule out this mechanism for relativistic theories.

An important 1963 paper by Phil Anderson showed how Schwinger's suggestion of a heavy gauge field could work. One example was the plasmon: in a high-density plasma the photon acquires a non-zero 'mass' — the plasma frequency. But Anderson also pointed out, using the example of superconductivity, how Goldstone bosons could 'become tangled up with Yang-Mills gauge bosons and, thus, do not in any true sense have zero mass'. He concluded 'the Goldstone zero-mass difficulty is not a serious one, because we can probably cancel it off against an equal Yang-Mills zero-mass problem'. This is exactly what is now known as the Higgs mechanism.

This should have cleared everything up, but these new ideas were difficult to understand. By the time Gerry Guralnik and Dick Hagen, both at Imperial that year, and I had also realized the Goldstone theorem doesn't apply to gauge symmetries, others were there too. The result was published independently in 1964 by Englert and Brout and by Peter Higgs.

So by 1963-64 the problem of the

origin of mass was solved, at least in principle. But there was still another major hurdle, to unify weak interactions, which are parity-violating, with electromagnetism, which is not. It took another three years to realize that for the photon to coexist with the parity violation of weak interactions, the gauge group had to be extended from SU(2) to SU(2)xU(I), with two neutral particles rather than one.

Actually the solution, or something very like it, was already there in Sheldon Glashow's 1961 paper which had proposed SU(2)xU(1) with mixing between the neutral particles, but this was before the key concepts of spontaneous symmetry breaking and the Higgs mechanism had been developed.

At Imperial, Salam kept plugging away at the problem, especially in collaboration with John Ward. In autumn 1967, Salam gave a series of lectures at Imperial in which he described the SU(2)xU(1) theory. Meanwhile the same model had been found independently by Steven Weinberg.

When Weinberg's paper appeared I was at Rochester, where Bob Marshak asked me to give a talk to his weekly discussion group.

I mentioned that Salam and Ward had been working on very similar ideas, and focused on the problems in constructing a unified theory of weak and electromagnetic interactions and how ingeniously the new model avoided them. However I described it as a wonderful toy without any connection to the real world!

While I was myopic, in a sense I was right. The whole thing seemed much too right. The whole thing seemed much too ad hoc and ugly, with its curious built-in asymmetry between the left- and right-handed fermions and its large number of independent parameters. If it is part of the final theory, it is ugly, surely the Creator was having an off day! But that is not the right way to look at it. Seen merely as one step towards a still undiscovered final theory, the intricate way the electroweak picture fits together does have a remarkable beauty.

It is sad that Paul Matthews, who died tragically six years ago, could not have given this tribute. For many years, Imperial was Salam and Matthews. They made a superb team, exactly complementing each other's strengths and abilities.

Abdus Salam in Munich, 1947.

First crumb of research

In 1964, Abdus Salam introduced Paul Matthews' inaugural lecture at London's Imperial College. It was a poignant moment. Salam, who had taken his first steps in theoretical physics at Cambridge under Matthews' watchful eye, had become Imperial's first professor in Theoretical Physics. Now he was overseeing the promotion of his former supervisor.

Salam recalled his 1949 research debut at Cambridge, where, because of impressive examination results, he had initially been directed towards the laboratory.

'Soon, I knew the craft of experimental physics was beyond me, experimental physics was beyond me, wrote Salam later. 'It was the sublime quality of patience which I lacked.' Looking towards theory, he had gone to Nicholas Kemmer (in the front row at Matthews' inaugural). Kemmer had said he had enough students already and did not want another. Salam had pleaded, and fortunately Kemmer had relented.

'All theoretical problems in quantum electrodynamics have been solved by Schwinger, Feynman and Dyson,' Kemmer had told Salam.' Paul Matthews has applied their methods to meson theories. He is finishing his PhD. Ask

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"Highlights of Particle and Condensed Matter Physics" (Salamfest)

A Conference on "Highlights of Particle and Condensed Matter Physics" was organized from 8 to 13 March 1993 to honour Professor Abdus Salam, the founder of the International Centre for Theoretical Physics (ICTP) some thirty years ago, and its Director ever since. It was also scheduled to coincide with his formal retirement as a Professor at Imperial College, London. In particular, Salam's colleagues, collaborators and former students wanted to acknowledge his scientific contribution to the development of physics and its dissemination, as well as his personal influence on their scientific careers. To this end, most of the speakers began their talks by reminiscing on their past recollections of Salam and his unique personality.

On the scientific side, the conference highlighted recent advances in experiment and phenomenology in particle and condensed matter physics, as well as reviewing the achievements in formal aspects of quantum field theory and string theory. Special emphasis was given to Salam's scientific works.

The organizers were A. Ali (DESY), D. Amati (SISSA), J. Ellis (CERN), S. Randjbar-Daemi (ICTP), S. Weinberg (Austin, Texas) and Yu Lu (ICTP). (Austin, Texas) and Yu Lu (ICTP). Invited speakers and participants came from all five continents, and included three Nobel Laureates (J.R. Schrieffer, K. von Klitzing and C.N. Yang), as well as a large number of Salam's previous students and collaborators.

The speakers were: A. Ali, U. Amaldi, J. Bahcall, E. Bellotti, N. Cabibbo, A. Chamseddine, R. Delbourgo, M. Duff, J. Ellis, J. Feltesse, M. Green, D. Gross, T. Kibble, R. Laughlin, G. Mack, A. Mueller, L. O'Raifeartaigh, J. Pati, R. Peccei, S. Randjbar-Daemi, V. Rubakov, D.

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Science and Technology in Tanzania

An Interview with H.E. Prof. B.W. Mkapa, Minister of Science, Technology and Higher Education of Tanzania

Minister B.W. Mkapa visited the international institutions in Trieste on 18 August 1993. He met with officials of the International Centre for Theoretical Physics (ICTP), the International Centre for Science and High Technology (ICS), the Third World Academy of Sciences (TWAS) and the Third World Network of Scientific Organizations (TWNSO) with whom he discussed opportunities for cooperation. In the interview which follows, he illustrates the situation of Science & Technology in his country.

Q.: Your Excellency, the fact that you are a Minister of Science, Technology and Higher Education is a token that your country attaches a certain priority to Science & Technology (S&T). Can you please tell us what Tanzania expects from S&T for its social and economic development?

A.: In developing countries it is now universally acknowledged that if there is a decisive factor for the economic and social transformation of a country, that is the application of S&T to the process of production. Therefore, we consider the whole system of acquisition of scientific knowledge through the education process as well as the system for the application of scientific knowledge through the transfer of technologies or application of scientific knowledge through the transfer of technologies or adaptation of technologies so that there is access to them in our country, and through the dissemination of these technologies, so that the end-users — those who would use them to increase production which will ultimately transform the lives of people — can have access to. My Ministry's responsibility is, therefore, to promote S&T and their application to the development in our country.

Q.: Which scientific and technological sectors does your Ministry encourage most and how does that happen?

A.: Our chief instrument for advancing S&T in our country is the National Commission for Science & Technology. The Commission allocates funds which are spent in the following ways: first for the organization of scientific encounters, conferences within the country — these can be interdisciplinary or oriented ones; secondly, for scientific education, popularization of science, not only in schools but in the general public; thirdly they are utilized for specific research projects proposed by scientists in the country, and fourthly they are used to reward achievements in specific fields of S&T, and in particular to identify promising inventive minds. This is the way we work. However, a great amount of scientific and technological work is done through universities and the para-statal institutions which do carry out activities related to Research & Development (R&D). For some basic research, the universities also receive funds, which are piloted through my Ministry. In addition, other para-statals and other ministries dispose of resources for research which can be applied to the development of the country.

Q.: In the majority of the developing countries, research is funded by the government. The role of the private sector in research is very small. Is this also the case in your country?

A.: This is very much the case in my country and, clearly, this state of affairs is unsustainable, in the long run. First, because I believe that this situation contributes to perpetuating a dependence-syndrome on the part of the private sector for imported technology; it discourages innovativeness by scientific or industrial workers because they are quite assured of an inflow of existing or new technology. Therefore, creativity among them is not stimulated, but more importantly, with government funding very much on the decrease because of economic difficulties, less and less resources are being made available for research. Clearly, without a large amount of work being undertaken in the field of R&D, the country cannot develop. For this reason, I am trying to persuade the private sector to realize that industrial growth requires a parallel effort in R&D on their behalf.

Q.: There are problems, for instance, in public health, agriculture, cattle breeding, exploitation of natural resources which are shared by many African countries. Does your country co-operate with its neighbours for solving common problems?

A.: Tanzania does co-operate with its neighbours but, regrettably, this co-operation is not sufficiently

Prof. B.W. Mkapa, Minister of Science, Technology and Higher Education of Tanzania met African scientists in the ICTP Conference Room.

institutionalized and not adequately practically-oriented. Each one of those neighbouring countries has its own research institutes in all these domains. To the extent that these institutes can cooperate, they organize conferences on themes of common interest. If the co-operation extended intimately in the actual process of research, I think that results might be more dramatic. They would certainly lend themselves to greater commercialization, and make it easy to disseminate them so that, as I said earlier, end-users could have access to them quickly. This is what I would like to see.

Q.: This is important because if you have common research problems, and if you can also pool your resources, you can obtain funding from international sources, I believe.

A.: That is exactly one of the reasons why we should cooperate more intimately than we are doing now.

Q.: The Third World Academy has provided some assistance to Tanzania, for example in terms of research grants and supporting scientific meetings, but not as much as one would expect if one thinks of the number of scientists from your country who know about the Academy and about the ICTP. Would you have an explanation for that?

A.: The main explanation may be that perhaps not enough is known about the programme of activities and of the possible resources that can be funded or that can be secured to our nationals through the Third World Academy of Sciences. This is one of the questions I shall address upon my return home. Another reason, though, is the distance between the scientific community and the government. The scientific community, and this was told to me to my face, feels that it has been somewhat isolated in the policy-making or in the planning process of the government and that, for this reason, the government may not have been as energetic as it should have been in advancing the cause of staff development and of broadening the frontiers on the sides of the scientific community. This, again, is an issue that I want to address.

Q.: Well, you know this is a problem that Professor Salam has discussed many times. He always feels that the scientists are not intimately involved in the planning and in the decision-making in the developing countries. Now I would like to ask you, as a distinguished member of the Third World Network of Scientific Organizations (TWNSO), what you think of the future of TWNSO, particularly regarding the establishment of centres of excellence promoted by Professor Salam, in collaboration with ICSU, UNESCO and UNIDO. What do you think of the future; is this realistic, will this happen, and on which factors does it depend?

A.: I think the initiative by TWNSO in this respect is critical. It is central, I think, to the recognition and the strengthening of the concept of S&T as a major factor of development in the Third World countries. It is a good forum for ministers who may not be scientists themselves, to better appreciate what driving force they can be in advancing the role of S&T, and with the notion of centres of excellence one pushes the concept of regional co-operation in the advancement of S&T. Moreover, it would enable research and training results to have a decisive impact on the social and economic transformation of the various member countries of the regional centres. This is critically important. It is being proven in the instance of agricultural R&D with the centres of excellence in agricultural research. Likewise, I think one could envisage a similar situation with the concept of S&T driving not only national but regional development through the activities of these centres of excellence in R&D.

Q.: Now a very easy question. What are your impressions after having seen ICTP and TWAS?

A.: First, as a non-scientist, I am overwhelmed by the activities going on here, but also as a politician I feel immensely gratified by the scope and depth of these activities and, particularly, by their bringing scientists of the Third World in an environment where they have access to information, research techniques and equipment which might not be available in their individual countries, and by their enabling them to interact with scientists from the more developed countries who are engaged in the same field of R&D. Above all, I am impressed by the spirit of confidence which I find among the members of staff here. They are doing a worthwhile job which I endorse wholeheartedly. Therefore, I return home with the commitment to make sure that our participation in the activities here is enhanced in the months ahead. ____ ♦

André-Marie Hamende

Special ICTP Prize Ceremony

On Tuesday 10 August 1993, on the occasion of the ICTP Prize Ceremony, Professor Paolo Budinich, former Deputy Director, International Centre for Theoretical Physics, presented a special ICTP Medal to the Prince of Torre e Tasso of Duino Castle, Trieste, Italy, in recognition for his contribution to the development of scientific activities of the national and international institutes in Trieste.

Prof. Paolo Budinich gave a short speech on the occasion. The original speech is given below:

"Recently the name of Trieste has been more and more often associated with the qualification as "The City of Science". This is the recognition of the success of an enterprise which started more than 30 years ago. At that time (and even now) very few people understood how important this enterprise could have been and will be for the future of our town. One of them was Prince Raimondo della Torre e Tasso and he was the most enthusiastic in sustaining and soliciting the local institutions for the candidature of Trieste as the seat for the International Centre for Theoretical Physics. He immediately offered a large piece of his land to support the candidature whose final success in 1963 was determinant for most other scientific institutions in the area. At that time he was just continuing the noble tradition of his family as patrons of art and culture and now his son Carlo Alessandro is continuing that tradition.

The Princes di Torre e Tasso have made of the Duino Castle one of the meeting points for the most outstanding scholars of our time. The European Association of University Students; the

On the occasion of the J.R. Schrieffer Prize Ceremony, Prof. Paolo Budinich, former Deputy Director, International Centre for Theoretical Physics, presented a special ICTP Medal to the Prince of Torre e Tasso of Duino Castle, Trieste, Italy.

Course, which later developed into the Institute for the Study of Transports in the European Integration; the World Organization I.F.I.A.S. with 5 thousand professors of the main universities of the East and West; the Research Centre Rainer Maria Rilke and His Time; the International Music Contest "Duino Castle"; the United World College; the Trieste International Foundation for Scientific Progress and Freedom and the Third World Academy of Sciences were all founded in Duino.

Like his father Raimondo, Carlo Alessandro, staunch supporter of Europeanism and equally convinced of the necessity of uniting the humanistic culture with the scientific one, is administering and developing the spiritual inheritance of supernationality received from his family.

The International Centre for Theoretical Physics at Trieste, in this difficult time when the highest civil values seem lost, presents a reward of public merit to H.H. Prince Carlo Alessandro della Torre e Tasso as an expression of gratitude, encouragement and good will from the international scientific community for the function which irradiates from the Duino Castle, today as well as in the past, as cultural reference at the service of a peaceful world." ♦

1993 Dirac Medals of the ICTP

The 1993 Dirac Medals of the International Centre for Theoretical Physics (ICTP, Trieste, Italy) have been awarded to: Professor Sergio Ferrara (Theory Division, CERN, Geneva), Professor Daniel Z. Freedman (Department of Mathematics, MIT, Cambridge) and Professor Peter van Nieuwenhuizen (Department of Physics, SUNY, Stony Brook).

Professors Sergio Ferrara, Daniel Z. Freedman and Peter van Nieuwenhuizen are honoured for their discovery of supergravity theory in 1976 and their major contributions in the subsequent developments of the theory. Their discovery led to an explosion of interest in quantum gravity and it transformed the subject, playing a significant role in very important developments in string theory as well as Kaluza-Klein theory. Currently any grand unified theory incorporating gravity is based on a supergravity theory coupled to matter in four dimensions, which naturally emerge from the compactifications of the ten dimensional heterotic string.

The Dirac Medals of the International Centre for Theoretical Physics were instituted in 1985 in memory of Professor P.A.M. Dirac, an honoured guest and staunch friend of ICTP. They are awarded every year on Dirac's birthday — 8th August — for contributions to theoretical physics.

In 1985, the Dirac Medals were awarded to Professor Yakov Zeldovich (Institute for Space Research, Moscow, Russia) and Professor Edward Witten (Princeton University, USA) and in 1986 to Professor Yoichiro Nambu (Enrico Fermi Institute for Nuclear Studies, Chicago University, USA) and Professor Alexander Polyakov (Landau Institute for Theoretical Physics, Moscow, Russia). In 1987, they were awarded to Professor Bryce DeWitt (University of Texas at Austin, USA) and Professor Bruno Zumino (University of California at Berkeley, USA) and in 1988 to Professor David J. Gross (Princeton University, New Jersey, USA) and to Professor Efim Samoilovich Fradkin (Lebedev Physical Institute, Moscow, Russia). The 1989 Dirac Medals were awarded to Professor Michael B. Green (Queen Mary College, University of London, UK) and Professor John H. Schwarz (California Institute of Technology, USA). The 1990 Dirac Medals were awarded to Professor Ludwig Dmitriyevich Faddeev (Steklov Mathematical Institute, St. Petersburg, Russia) and Professor Sidney Richard Coleman (Harvard University, Cambridge, Massachusetts, USA). The recipients of the 1991 Dirac Medals were Professor Stanley Mandelstam (University of California, Berkeley, USA) and Professor Jeffrey Goldstone (Massachusetts Institute of Technology, Cambridge, Ma., USA). The 1992 Dirac Medals were awarded to Professor N.N. Bogolubov (posthumously; formerly of the Joint Institute for Nuclear Research, Moscow, Russia) and Professor Yakov G. Sinai (Landau Institute of Theoretical Physics, Moscow, Russia).

The selection committee includes Professors S. Lundqvist, Y. Nambu, J. Schwinger, S. Weinberg, E. Witten and Abdus Salam. The Dirac Medals of the ICTP are not awarded to Nobel Laureates or Wolf Foundation Prize winners. ♦

ICTP Associate Received Tamgha-i-Imtaiaz Award

Professor Abdul Waheed Khan, Dean of Sciences in Gomal University, Dera Ismail Khan, has recently been awarded a medal of distinction (Tamgha-i-Imtaiaz) by the Government of Pakistan for his achievements in the promotion of research. Abdul Waheed Khan is a Senior Associate Member of the ICTP. According to him, many of his accomplishments materialized thanks to the support provided by the ICTP. During his last visit in Trieste, he said "In Third World Countries, physics presents a bleak picture on account of isolation, lack of laboratory facilities and of literature for research. ICTP is helping Third World scientists to overcome these difficulties by providing an excellent academic atmosphere, a well-stocked library, opportunities for interacting with world famous scientists and generous research grants. I have made every effort to improve the academic standard by promoting research in Gomal University since 1974. But it was after my first visit to the ICTP in 1986 that I could make a real progress not only in my University but also at a national level, in spite of my heavy administrative responsibilities. I thus owe a lot to the ICTP for my achievements in the scientific field which earned for me the national recognition in the form of a medal of distinction ."

Prof. Abdul Waheed Khan obtained his Ph.D. in 1973 with specialization in experimental high energy physics. After a spell of post-doctoral work he joined, in 1974, the Gomal University which was established in the same year. He turned down attractive offers from other institutions in Pakistan as he thought his services were more required in a university which was in the making, and strove to promote scientific research particularly at Gomal University, with the motivation that other educational and research organizations in Pakistan would benefit from them. Among others, he created a track detection laboratory at Gomal University to investigate heavy ion reactions at low energies, the first ever established in any Pakistani university. This was followed by his launching of a project for introducing Medical Physics oriented research in Pakistan on the effects of radiations with the same technique. More than 60 research papers have been published in international journals, like *Nuclear Instruments & Methods*, *Nuclear Tracks*, *Health Physics* and *Hadronic Journal*, by his group over a period of less than seven years. Recently he established the first research unit in Pakistan for experimental investigation in the field of high energy physics with the nuclear emulsion technique. On the occasion of the international conference on 'Quark Matter and the Heavy Ion Collisions' organized by him at Gomal University in January 1992, he started a regional collaboration with Sharif University of Technology, Tehran (Iran), and the Institute of High Energy Physics, Beijing (China), for investigating heavy ion nuclear collisions at ultra-relativistic energies by using the nuclear emulsion technique. This collaboration has been approved by the Government.

While at the ICTP, Professor Waheed always successfully tried to utilize the facilities offered by the ICTP and the Third World Academy of Sciences, to achieve his scientific objectives at home. During his first visit to the ICTP in 1986 he founded the Turkey-Iran-Pakistan Society for scientific collaboration, which has resulted in the formation of a regional network for the mathematical sciences.

Professor Abdul Waheed Khan has been an Associate of the ICTP (1985-91) and is now a Senior Associate. From 1987 to 1989 he worked at the laboratory of the Istituto Nazionale di Fisica Nucleare of Legnaro (Italy), where his collaboration with Professor G. Moschini won him the Medal of the University of Padua. He was appointed as ICTP visiting scientist at Cukurova University, Adana (Turkey), in 1990. He has been nominated as UNESCO Expert for Curriculum Development for Pakistan. Professor Khan is a member of the American, European and Italian Physical Societies. He is Vice-President of the Pakistan Physical Society. ___♦

J.R. Schrieffer Prize Ceremony

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Russia. He has received honorary degrees from universities in the US and abroad. Professor Schrieffer is the author of a large number of important scientific papers on microscopic theory of superconductivity and recent advances in the theory of superconductivity.

He has served on numerous committees of federal agencies, including the NSF, NASA and the DOE. From 1988 to 1992 he was Director of the High Temperature Superconductor Theory Program of Los Alamos National Laboratory, where he is a Laboratory Fellow.

He is a Member of the Board of Directors of Superconductor Technologies Inc. and Chairman of its Technical Advisory Board. Recently he was appointed Chairman of the Scientific Council of the International Centre for Theoretical Physics (ICTP) in Trieste, Italy, a facility which fosters research in developing countries. His current research centres on strongly correlated fermion systems and magnetic effects in solids.

Annual ICTP Prizes were created in 1982 by the Scientific Council of the ICTP in recognition of outstanding contributions to physics and mathematics by scientists from, and working in, developing countries. Every year, a Prize in honor of an eminent scientist is announced in a specific field of interest. The Prize consists in a medal, a certificate and a US$ 1,000 cheque. One Prize is awarded each year. ____♦

From left to right: Professor W.P. Garg, Dr. G. Sciarabba, Scientific Attaché at the Italian Embassy in India, Prof. G. Furlan (ICTP), Dr. E.G. Menegatti, Ambassador of Italy in India and the President of IIT.

An ICTP Chapter in India

Due to the initiative of Professor W.P. Garg from the Indian Institute of Technology in New Delhi, an ICTP Chapter has recently been founded in India. The Steering Committee of the Chapter met two months ago and elected W.P. Garg as its President, Prof. R. Ramasarmy as Vice-President, and Prof. (Ms.) A. Kapur as Secretary. The Chapter will not only assemble all Indian ICTP alumni, it will act as a coordinating body for many of the collaborative efforts between the Indian scientific community and ICTP.

The idea of creating the Indian Chapter was proposed during a workshop on "The impact of ICTP on Indian science", held in March 1993 in New Delhi, which was attended by more than one hundred scientists representing 1500 physicists and mathematicians who have taken part in the activities of the ICTP during these last years. Prof. G. Furlan, Director of the ICTP Programme for Training in Italian Laboratories and close collaborator of Abdus Salam, represented ICTP in the workshop. The role of the ICTP in the advancement of science in India was acknowledged by many and in particular by Prof. Yash Pal, former Chairman of the University Grant Commission and Member of the ICTP Scientific Council. As Prof. Furlan remarked, the cooperation between Indian scientists and ICTP has contributed to the dissemination of fundamental knowledge which, in turn, has generated joint specific research projects involving not only the Trieste facilities but also other Italian institutions.

The workshop was attended by H.E. Dr. E.G. Menegatti, Ambassador of Italy in India. It also offered an opportunity for Profs. Furlan and D. Nobili (from the Italian National Research Council) to meet high officials of the Indian Ministries for Science and Technology and of Non-conventional Energy Sources, and to discuss further possibilities of collaboration between India and ICTP, including the laboratories enlisted in the ICTP Programme for Training in Italian Laboratories, in particular, in the domain of large photovoltaic power plants and in industrial automation.

The Director of ICTP, Abdus Salam, looks at the ICTP Indian Chapter as a very important initiative which should be emulated by other countries. The more scientists from the Third World will unite, the better their voice will be heard by the decision-makers in their countries.

André-Marie Hamende

Conferences and Lectures

Prof. S.J. Abbasi from Karachi, a Post-doctoral student in the ICTP Mathematics Research Group, presented the talk "Matrix near-rings and pseudo-distributivity" at the Conference on Near-rings and Near-fields, held at the University of New Brunswick in Fredericton, Canada, from 19 to 23 July 1993. ♦

The Genesis of Unified Gauge Theories

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him.'

At Imperial in 1964, Salam recalled that first meeting with Matthews in 1950.

'What are you reading?' Matthews had asked.

'Heitler's Quantum Theory of Radiation,' had come the reply. It was the only standard text at the time.

Matthews quickly recommended instead the new work by Schwinger, Feynman and Dyson, then known only to a privileged few.

Later, his PhD complete, Matthews left a research 'crumb', as Salam put it. The agreement was that Salam would look at a continuing problem in meson field renormalization while Matthews took a few months off before starting work at Princeton in the fall. If Salam had made no progress, Matthews would repossess the problem.

Characteristically, Salam's first act as a research student was to phone Freeman Dyson (his 'hero'), then visiting Birmingham, and ask for an interview. The discussion continued on the train to Southampton, where Dyson was to embark for the US. The seeds of the solution were sown and soon the 'crumb' problem was solved. It was the start of a meteoric career. ♦

The Institute for Advanced Studies in Basic Sciences, Gava Zang–Zanjan, Iran

Courtesy of TWAS Newsletter Vol. 5 No. 2, March-June 1993

A first group of students were admitted at the newly established Institute for Advanced Studies in Basic Sciences in Zanjan in February 1993. These students will study either for a MSc or PhD degree in Theoretical Physics, Astrophysics, Relativity, Quantum Optics and Dynamical Systems. They are all of Iranian nationality but later on, in Fall 1994, when the Institute plans to start its graduate programme in Mathematics, foreign students from neighbouring countries will be enrolled as well.

The concept of creating the Institute for Advanced Studies in Basic Sciences is the fruit of reflections of my colleagues and myself, following our association with the International Centre for Theoretical Physics (ICTP) in Trieste, founded by Abdus Salam and directed by him since 1964. Impressed as we were at the influence exercised by such a Centre on the scientific future of developing countries, my colleagues and I thought of a similar institution for our country. We decided, during a walk in the Val Rosandra, a delightful little valley in the vicinity of Trieste, to translate our intentions into a project which we submitted to the Ministry of Culture and Higher Education of our country. This was in 1989. A decree issued in 1990 was the first step of our project. One year later, the establishment of the IASBS was approved and budgeted by Parliament. Since then, R. Mansouri, M.R. Khajehpour and I have pursued the matter and taken the necessary actions for the creation of the Institute.

Zanjan, the seat of the Province of Zanjan, is a city of 260,000 inhabitants, located 300 km to the North-West of Tehran, with three universities. A high-way and turbo-train provide good communication with the capital of the country. Zanjan was chosen as the seat of the IASBS because the city is far enough from Tehran to enjoy a quiet atmosphere but also close enough to benefit from the advantages of the metropolis. Moreover, the municipality of Zanjan has made available 85 hectares of land for the permanent seat of the Institute and

Prof. Y. Sobouti, Director of the IASBS, is a Member of the ICTP Scientific Council, a Fellow of TWAS, Executive Secretary of Tehran Regional Office of TWNSO, Fellow of the Academy of Sciences of Iran, Professor of Shiraz University, and Founder of the Biruni Observatory of Shiraz.

continues to provide considerable financial and communal support.

From the outset of our project, we were encouraged by our national authorities. The Ministry of Culture and Higher Education financed the project generously. The funds to buy 5000 square metres of temporary premises were provided by the Presidential Office and we have had the full support of the Planning and Budget Organization.

At present, the Institute counts four Planning and Budget Organization.

At present, the Institute counts four full-time and six part-time faculty members. The library has 3,000 books on its shelves and subscribes to 200 scientific periodicals. Computer facilities are adequate. There is a dormitory for the students and housing is provided for the lecturers.

Our main concern at the IASBS is quality, that is to say the quality of the teaching and of research, the quality of the students and the quality of the scientific environment. We are convinced that our collaboration with ICTP will help us in this search for excellence. Three eminent scientists of the ICTP are members of the International Advisory Committee of our Institute. We also like to think of the creation of IASBS as a concrete follow-up of the recommendations made by Professor Abdus Salam in 1990 at the TWAS Third General Conference in Caracas, Venezuela.

The International Advisory Committee of the Institute for Advanced Basic Sciences (IASBS) in Zanjan is comprised of Prof. Abdus Salam, Nobel Laureate; Profs. S. Chandrasekhar, Nobel Laureate, University of Chicago; F. El-Baz, Boston University; M. Kardar, Massachusetts Institute of Technology; S.S. Lee, KAIST, Seoul; M. Narasimhan, Tata Institute of Fundamental Research and ICTP; N. Peyghambarian, University of Arizona; H. Rajavi, Dalhousie University; S. Randjbar-Daemi, ICTP; G. Swarup, Tata Institute of Fundamental Research; and C. Vafa, Harvard University. ♦

Salamfest

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Schramm, J.R. Schrieffer, H. Schröder, D. Sciama, E. Sezgin, Q. Shafi, C. Vafa, P. West, B. Winstein and C.N. Yang.

Topics discussed included: electroweak physics, underground physics, physics at HERA, collider physics, flavour physics, scalars in particle physics, critical review of SUSY GUTs, particle astrophysics and cosmology, formal aspects of quantum field theory, condensed matter physics and related fields.

During the week of the Conference, an Honorary Degree was conferred on Salam by Academician S.P. Merkuriev, the Rector of St. Petersburg University. This was in recognition of Salam's outstanding contribution to science and to the development of civilisation. In his speech, Professor Merkuriev drew special attention to Salam as a unifier — "in physics he unifies interactions, in society he unifies people through science". ♦

Activities at ICTP in July-August

Title: SUMMER SCHOOL IN HIGH ENERGY PHYSICS AND COSMOLOGY, 14 June – 30 July.

In collaboration with the International School for Advanced studies (SISSA) and the Italian National Institute of Nuclear Physics (INFN).

Directors: Professors E. Gava (University of Trieste, Italy), A. Masiero (Italian National Institute of Nuclear Physics, Padua, Italy), K.S. Narain (ICTP), S. Randjbar-Daemi (ICTP) and Q. Shafi (University of Delaware, Newark, USA).

Lectures: Introduction to QCD and chiral Lagrangians. Introduction to the electroweak model; grand unification. Introduction to functional methods, gauge theories and quantization. Introduction to supersymmetry. Beyond the standard model. Precision tests of the electroweak model. CP violation. LEP results/prospects. Quark-gluon plasma. Superstring phenomenology. Neutrino physics. Non-perturbative electroweak effects and baryogenesis. Lattice gauge theories. Topological defects in cosmology. "Standard" cosmology. Inflation. High energy instantons. Cobe. Structure formation. Weak decays of heavy flavours. Introduction to spin systems. Review of conformal field theory. Spin chains and integrable systems. N=2 and topological theories. 2-dim, Yang-Mills theories. Duality and inflation in string cosmology. Duality symmetries. Topology change in string theory and related developments. S matrices and massless flows. Topological and Yang-Mills theory. The birth of dual models. Dual models as field theories. Renaissance of string theory. Induced QCD at large N. Topological formulation of non critical strings. G/G models and the Verlinde formula.

Colloquium: Underground particle astrophysics — Physics where the sun does not shine.

Workshop on superstrings and related topics (29–30 July): Background independence in string field theory. Topological amplitudes in string theory. Topological conformal algebra in 2d gravity coupled to minimal matter. BRST operator for superconformal algebras with N>4. Non critical superstrings and superspace approximation: comparison between discrete and continuum approaches. Symmetry, observables and solutions of induced QCD. C=1 matrix model formulation of QCD2. Space-time interpretations of chiral gauged Wess-Zumino-Witten models. Plane waves in Wess-Zumino-Witten models. Chern-Simons theory and the Verlinde formula. Thermodynamics and form factors of SUSY integrable field theories. From Bethe equations to character formulas. Universal properties of self-avoiding walks from 2d quantum field theory. W-algebras in conformal field theory. BRST — analysis of W-symmetries.

The School was attended by 223 lecturers and participants (148 from developing countries).

The programme of the Research Workshop on Condensed Matter Physics (21 June – 3 September) shall be published in the next issue of News from ICTP.

Title: ADRIATICO RESEARCH CONFERENCE ON SCATTERING FROM SURFACES, 6 – 9 July.

Co-sponsored by the Commission of the European Communities (CEC), Italian National Research Council (CNR), Fondazione IBM Italia, and International School for Advanced Studies (SISSA).

Organizing Committee: Professors S. Lundqvist (Chairperson; Chalmers University of Technology, Göteborg, Sweden, and ICTP), H. Cerdeira (Co-chairperson; Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP), M. Tosi (Scuola Normale Superiore, Pisa, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

Directors: Professors V. Celli (University of Virginia, Charlottesville, USA), D.L. Mills (University of California, Irvine, USA) and E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP). Professor E. Burstein (University of Pennsylvania, Philadelphia, USA) was Honorary Director.

Lectures: Growth modes and their manipulation in metal-film homoepitaxy; combined He-scattering and STM investigations of metal surfaces. The utility of Ne-diffraction for surface structural research. Adsorbate vibrations and diffusion. Electron-phonon resonances from inelastic HAS intensities. Theory of metal surface phonons, and atom scattering. Surface dynamics of epitaxially grown thin alkali halide films by helium atom scattering. First principles study of potassium adsorption on graphite. Growth and ordering dynamics for Au deposition on Au(110)(2x1). Inelastic scattering of electrons from surface phonons. Theory of inelastic electron scattering. Spin polarized electron energy loss spectroscopy. Surface phonons of some compounds studies by HREELS. Surface and resonant modes of the (111) and (100) faces of Cu and Ag. On the self-consistent barrier at a metal surface. Reconstruction, roughening and melting of crystal surfaces. Scattering from disordered surfaces. Quantum state specific interaction dynamics of hydrogen and deuterium with Cu(111). Time dependent quantum methods to study gas-surface scattering. Quantum theory of sticking. Molecular beam scattering studies of metal surfaces: surface relaxation, oxidation, and phase transitions. Diffractive atom optics with surfaces. Interaction of inert gases with metal surface from scattering experiments. Multiphonon energy exchange in atom-surface scattering. Conditions of validity of the trajectory (TA) and the Exponentiated Born Approximation (EBA) in inelastic atom-surface scattering. Scattering of oriented heavy molecules from surfaces. X-ray diffraction from surfaces. Structural studies of surfaces and overlayers using medium energy ion scattering. Probing surface vibration with hyperthermal ion scattering. Surface physics at ELETTRA: present and future. Sticking in the physisorbtion well: crystal face and isotope dependence. Structure and dynamics of organic monolayers studied by combined X-ray and atomic beam scattering.

The Conference was attended by 82 lecturers and participants (24 from developing countries).

Title: WORKSHOP ON THE LIQUID STATE OF MATTER: OPPORTUNITIES FROM NEW RADIATION SOURCES, 19 – 30 July.

Co-sponsored by the Italian National Research Council (CNR) and Sincrotrone Trieste S.C.p.A.

Organizers: Professors N. Ashcroft (Cornell University, Ithaca, NY, USA), L. Reatto (University of Milan, Italy) and M.P. Tosi (Scuola Normale Superiore, Pisa, Italy).

Lectures: Experimental methods in neutron scattering from liquids. Theory of static properties of liquids, an overview. Theory of dynamic properties of liquids, an overview. The application of specular neutron reflection to the study of adsorption at the air-liquid interface. Implanted muon studies in liquids. Molecular dynamics simulation of the density fluctuation spectra in the quasi-hydrodynamic regime. Analysis and interpretation of diffraction data based on a statistical approach. Static and dynamical properties of simple liquids. The modern theory of simple liquids: free energy functionals as related to correlation functions. Ultra cold neutrons and liquid helium: the plot thickens. Positron studies of liquids. Muon spin relaxation studies of molecular dynamics. The experimental structure factor of liquid deuterium. Molecular dynamics on a water model including polarizability and hyperpolarizabilities. The structure and properties of liquid semiconductors. Varieties of melting behavior. Fluid-fluid criticality and the metal-insulator Varieties of melting behavior. Fluid-fluid criticality and the metal-insulator transition. Simple model for electronic properties of liquid alloys. Anomalous sound dispersion in liquid water. The European spallation source and proposals for the liquid state. Neutron diffraction on gaseous and liquid Kr: an extended experimental study compared with accurate theoretical results. Microscopic approach to phase transitions in fluids. Metal-nonmetal transition and structural modification in liquids. Theory of the thermodynamics properties of liquid metals. Deep inelastic neutron scattering from liquids. Light scattering studies of the liquid glass transition. Phonon and roton temperature dependence in liquid ^{4}He. Equilibrium properties of superfluid ^{4}He. Deriving the atomic momentum distribution from the asymptotic scaling function in neutron compton scattering. Neutron studies of multilayer argon on graphite. Dynamic structure function in ^{3}He-^{4}He mixtures. Structure and electronic density distribution on the liquid alkali metals. Dynamics of classical two dimensional screened Coulomb fluids on a corrugated surface. Electrooptic Kerr effect and nonlinear dielectric effect near a critical consolute point. Synchrotron radiation and liquids. Properties of ^{4}He films and its interfaces studied by neutron scattering. Contribution of neutron scattering to the study of critical fluctuations. Phase diagram of the dipolar hard sphere fluid at low temperature. Structural study of molten germanium by energy-dispersive X-ray diffraction. High accuracy in neutron scattering determination of the structure factor in disordered materials. Ordering in metal halide melts. Inelastic X-ray scattering, a new technique to study the dynamics in liquids. Structure of liquid selenium: a tight-binding Monte-Carlo study. Molecular dynamics evidence of medium range order in simplified models of multicomponent liquids and glasses. Ab-initio molecular dynamics simulations of liquids: a review. Interatomic potentials from first principles: the force-matching method. ELETTRA: a ultrahigh brilliance source in the soft X-rays. Recent developments in the physics of wetting and interfaces. Polyelectrolites. Triplet correlations in liquid matter from X-ray absorption measurements using advanced radiation sources. Entropy and the freezing of simple fluids. Simulation studies of sources. Entropy and the freezing of simple fluids. Simulation studies of phase transitions in fluids. Experimental studies of water at a molecular level. Simulation studies of water. Study of liquids by synchrotron radiation. Study of molten salts mixtures (LiBr/KBr) by neutron scattering and computer simulation. First principles molecular dynamics simulation of liquid $Li_{12}Si_7$. Phase stability of multicomponent charged and uncharged fluid mixtures. Melting of metallic clusters in dielectric matrices. Surface order-disorder transitions: roughening and melting. Theory of liquid-solid transitions. The liquid-solid transition: an overview.

Round Tables: Advances in neutron facilities and the liquid state. Numerical modelling of simple and complex liquids: state of the art and perspectives. Synchrotron radiation applied to the structure of liquids and amorphous materials.

The Workshop was attended by 83 lecturers and participants (13 from developing countries).

Title: MINIWORKSHOP ON NON-LINEARITY: CHAOS IN MESOSCOPIC SYSTEMS, 26 July – 6 August.

Co-sponsored by the Commission of the European Communities (CEC).

Organizers: Professors G. Casati (University of Milan, and Centro di Cultura Scientifica 'Alessandro Volta', Como, Italy) and H. Cerdeira (Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP).

Lectures: Introduction to the field of mesoscopic fluctuations. Random matrices an spectral statistics. Scattering described by a prompt and an equilibrated component. Random matrices in scattering problems: disordered media. Band random matrices: structure of eigenstates and spectrum statistics. Quantum chaos in semiconductor microstructures. Chaos and quantum phenomena in semiconductor microstructures. Can the semiclassical approximation teach us anything about classical mechanics? Topological consequences on the classical phase spaces of indistinguishable interacting spins.

During the period 3-6 August the participants in the Miniworkshop attended the lectures of the Adriatico Research Conference: "Mesoscopic attended the lectures of the Adriatico Research Conference: "Mesoscopic systems and chaos, a novel approach".

The Miniworkshop was attended by 71 lecturers and participants (53 from developing countries).

Title: ADRIATICO RESEARCH CONFERENCE: "MESOSCOPIC SYSTEMS AND CHAOS, A NOVEL APPROACH", 3 – 6 August.

Co-sponsored by the Commission of the European Communities (CEC), Fondazione IBM Italia, and International School for Advanced Studies (SISSA).

Organizing Committee: Professors S. Lundqvist (Chairperson; Chalmers University of Technology, Göteborg, Sweden, and ICTP), H. Cerdeira (Co-

chairperson; Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP), M. Tosi (Scuola Normale Superiore, Pisa, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

Directors: Professors G. Casati (University of Milan, and Centro di Cultura Scientifica 'Alessandro Volta', Como, Italy) and H. Cerdeira (Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP).

Lectures: Atomic clusters: laboratory for studying chaos and ergodicity. Quantum chaos and universal physical properties of isolated mesoscopic systems. Chaos in heterostructures. Collective oscillations in large systems under global interactions. Order and turbulence in rf-driven Josephson junction series arrays. Classical diffusion, Anderson localization and spectral statistics in billiard chains. Discrete control variable: nature's gift. Dissipation in microscopic systems. Patterns and chaos in nonlinear optical systems. Delocalization of quantum chaos by weak nonlinearity. Ballistic conductance fluctuations and phase breaking in semiconductor microstructures. Weak-localization, conductance fluctuations, and integrability in ballistic cavities. Effect of exchange field fluctuations on resonant tunnelling through a semimagnetic barrier. Semiclassical banded random matrices. Ballistic transport properties of a bidimensional rippled channel. Band random matrices: transport properties of a bidimensional rippled channel. Band random matrices: level dynamics and conductivity. ac conductivity and dielectric function in complex periodic metallic systems. Quantum chaology of fractal spectra: unbounded diffusion and decay of correlations. Random matrices in the study of an Ising chain in a random magnetic field. Semiclassical theory of ballistic transport and conductance fluctuations in microjunctions. Statistics of mesoscopic fluctuations of local density of states and NMR-line in metallic particles. Orbital magnetism in an ensemble of ballistic billiards. Esponentially narrow conductance and current dips for resonant tunnelling structures of quantum dots. Effect of electron spectrum rigidity on mesoscopic fluctuations of conductance near the metal-insulator transitions. Chaos and energy level statistics. A scattering approach to semiclassical quantization: the inside-outside "duality". Antidot arrays: chaotic dynamics in magnetotransport experiments. Statistics of S-matrix fluctuations in the presence of classical chaotic diffusion. Self-similar mesoscopic structure of glasses. Chaotic scattering in the presence of external magnetic field. Random matrices, supersymmetry and "hopping" Hamiltonian. Fluctuations in quantum chaos: preliminary results.

The Conference was attended by 95 lecturers and participants (55 from developing countries).

Title: CONFERENCE ON VARIATIONAL PROBLEMS IN DIFFERENTIAL GEOMETRY AND PARTIAL DIFFERENTIAL EQUATIONS, 16 – 20 August.

Organizers: Professors P.U. Aviles (University of Illinois at Urbana-Champaign, USA) and J.F. Escobar (Indiana University, Bloomington, USA).

Lectures: Harmonic mappings between metric spaces and geometric superrigidity. Isoperimetric inequalities for the eigenvalues of the Laplacian. Univalent minimizers of polyconvex variational problems from nonlinear elasticity. On the lower bound for the extinction time of surfaces moved by mean curvature. Optimal convergence rates for discrete approximations to unstable minimal surfaces. Convergence of anti-self-dual metrics. Evolution of unstable minimal surfaces. Convergence of anti-self-dual metrics. Evolution of curves. New regularity results for the mean curvature flow. Mappings with integrable dilatation. Prescribing singularities for solutions of some nonlinear elliptic equations. Local regularity for the Schrödinger and wave equations. The spectrum of the Laplacian on forms and applications. Comparison of the index of energy and the index of area for minimal surfaces. Minimizing functionals of the curvature. Pointwise convergence of graphs and gamma-convergence to the area functional. Locally minimizing harmonic maps from noncompact manifolds. Magnetic transformation groups. Weak solutions of semilinear equations.

The Conference was attended by 80 lecturers and participants (40 from developing countries).

Title: ADRIATICO RESEARCH CONFERENCE: "VORTEX FLUCTUATIONS IN SUPERCONDUCTORS", 17 – 20 August.

Co-sponsored by the Commission of the European Communities (CEC) and International School for Advanced Studies (SISSA).

Organizing Committee: Professors S. Lundqvist (Chairperson; Chalmers University of Technology, Göteborg, Sweden, and ICTP), H. Cerdeira (Co-chairperson; Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP), M. Tosi (Scuola Normale Superiore, Pisa, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

Organizers: Professors H. Cerdeira (Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil, and ICTP), D.H. Lowndes (Oak Ridge National Laboratory, TN, USA) and P. Minnhagen (University of Umeå, Sweden).

Lectures: 2D vortex fluctuations and Coulomb gas scaling: overview and recent results. Evidence for 2D vortex fluctuations in ultrathin YBCO layers. Vortex line fluctuations of superconductors in magnetic fields. Three-dimensional vortex flux flow in LSCO and YBCO through pseudo Dc flux transformer measurements. Flux motion in $DyBa_2Cu_3O_7/(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ coupled multilayers. Superconductivity and hole-doping in $Ba_2Cu_3O_7$ coupled multilayers. Superconductivity and hole-doping in multilayered structures. New critical point for 2D XY type models. Vortex dynamics in 2D superconducting arrays. Vortices and vortex dynamics in 2D Josephson arrays. Vortex pinning. Critical dynamics of disordered Josephson junction arrays. Vortex-fluxon competition in layered superconductors: a scenario for high T_c. Vortex dynamics at high frequencies. Growth mechanism and vortex pinning in epitaxial films. The effect of static disorder on vortex transformations. Melting of a parallel flux lattice in layered superconductors: a scenario for nonlinear I-V relation. Effects of reduced dimensionality in the superconducting

properties of BSCCO-2212 compounds. Helicity modulus and Meissner effect in a fluctuating type II superconductor. Possible first order transition in the 2D Ginzburg Landau model. Report from the LT vortex Satellite Meeting, August 93.

The Conference was attended by 42 lecturers and participants (19 from developing countries).

Title: WORKING PARTY ON MECHANICAL PROPERTIES OF INTERFACES, 23 August – 3 September.

Organizers: Professors Chi Wei Lung (Institute of Metal Research, Academia Sinica, Shenyang, P.R. China), E.J. Savino (Comisión Nacional de Energía Atómica, Buenos Aires, Argentina) and R. Thomson (United States Department of Commerce, Gaithersburg, MD, USA).

Lectures: Basic and introductory lectures on fracture. Interfaces: structure and properties. Dynamic and stochastic fracture. Semiconductor multilayers. Grain-boundary brittleness and ductility improvement in intermetallic alloys. Recent internal friction research on mechanical properties and structure of grain boundaries. High temperature failure in ceramics. High resolution electronmicroscope studies on interfaces. Introduction to MD-MC methods as used in Gb's simulations and limitations. Dislocation-grainboundary interactions in f.c.c. materials — basic concepts and models. Fractal description of intergranular fractures in nanocrystals.

Plenary Seminars (in conjunction with the Research Workshop on condensed matter physics (21 June – 3 September): Structure instability and superconductivity in high T_c cuprates. Surprising elasticity: materials with negative Poisson's ratio. Interatomic potentials for the computer simulation of defects in metals. Photoinduced carriers in insulating cuprates: Fermi-glass state, metal-insulator transition and superconductivity.

Computer sessions.

The Working Party was attended by 29 lecturers and participants (21 from developing countries). ♦

Calendar of Activities at ICTP

1993

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 telematics ..... **27 September – 22 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**

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

1994

Follow-up to the Workshop on preparation of radiomaritime master plans for English-speaking African countries ..... **7-18 February**

Winter College on quantum optics ..... 14 February – 4 March

Workshop on study of atmospheric interactions by remote sensing ..... 21 February – 4 March

Workshop on fluid mechanics ..... 7 – 25 March

Workshop on science and technology of thin films ..... 7 – 25 March

Training Course on dosimetry and dose reduction techniques in diagnostic radiology ..... 16 – 25 March

Spring School and Workshop on string theory, gauge theory and quantum gravity ..... 11 – 22 April

Workshop on nuclear reactors — physics, design and safety ..... 11 April – 13 May

Spring College on quantum phases ..... 3 May – 10 June

International Monsoon Conference ..... 9 – 13 May

Workshop on commutative algebra and its relation to combinatorics and computer algebra ..... 16 – 27 May

Workshop on air pollution modelling for environmental impact assessment ..... 16 May – 3 June

Summer School in high energy physics and cosmology ..... 13 June – 29 July

Workshop on the search for new elementary particles ..... (dates to be fixed)

Research Workshop on condensed matter physics ..... 13 June – 19 August

Miniworkshop on submicron quantum dynamics ..... 13 June – 1 July

Quantum transport in nanostructures (Adriatico Research Conference) ..... 20 – 24 June

Miniworkshop on strong correlations and quantum critical phenomena ..... 4 – 22 July

Theoretical models in biological systems (Adriatico Research Conference) ..... 12– 15 July

Cooperative phenomena in many-electron systems and their response

to external fields (Adriatico Research Conference) ..... 26 – 29 July

to external fields (Adriatico Research Conference) ..... 26 – 29 July

Miniworkshop on non-linear electromagnetic interactions in semiconductors ..... 1 – 12 August

Lasers in surface science (Adriatico Research Conference) ..... 9 – 12 August

Advanced Workshop on algebraic geometry ..... 15 – 26 August

Conference on chemical evolution and the origin of life ..... 29 August – 2 September

College on medical physics: imaging, instrumentation and dose-reduction techniques ..... 5 – 23 September

International Workshop on parallel processing and its applications in physics,

chemistry and material science ..... 5 – 23 September

College in biophysics: experimental and theoretical aspects of biomolecules ..... 26 September – 14 October

Third College on microprocessor-based real-time control —

principles and applications in physics ..... 26 September – 21 October

3rd Trieste Conference on recent developments in the phenomenology of particle physics ..... 3 – 7 October

Workshop on variational and local methods in the study of Hamiltonian systems ..... 10 – 28 October

College on physics of archaeometry and preservation of work of art ..... 17 – 28 October

Fourth Autumn Course on mathematical ecology ..... 24 October – 11 November

Suivi de l'atelier sur la préparation des plans directeurs radio-maritimes

pour les pays africains francophones ..... 31 October – 11 November

Second Workshop on three-dimensional modelling of seismic waves generation,

propagation and their inversion ..... 7 – 18 November

International Conference on mathematical ecology ..... 14 – 18 November

Experimental Workshop on high temperature superconductivity (basic activities) ..... 14 November – 2 December

5th Training College on physics and applications of lasers and optical fibres ..... 21 November – 9 December

ICTP-UNU-Microprocessor Laboratory: Third Course on basic VLSI techniques ..... 21 November – 16 December

Ultrafast phenomena and applications (Adriatico Research Conference) ..... 6 – 9 December

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

News from ICTP is also available on Gopher server.

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International Centre for Theoretical Physics
of IAEA and UNESCO
P.O. Box 586
34100 Trieste
Italy

Telephone: (40) 22401
Cable: CENTRATOM
Telex: 460392 ICTP I
Telefax: (40) 224163
E-mail: postoffice@ictp.trieste.it

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