International Atomic Energy Agency

United Nations Educational, Scientific and Cultural Organization

International Centre for Theoretical Physics

# News from ICTP

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*Prime Minister and Chancellor of Dhaka University Begum Khaleda Zia handing over a silver casket containing the honorary D.Sc. degree and citation to Nobel Laureate Professor Abdus Salam, Director, International Centre for Theoretical Physics, and President, Third World Academy of Sciences, at a special Dhaka University convocation held at the Curzon Hall auditorium on Sunday May 24, 1993, Dhaka, Bangladesh.*

*Inside:*



## Professor Abdus Salam Awarded Honorary Degree of Doctorate of Science

Nobel Laureate Professor Abdus Salam, Director, International Centre for Theoretical Physics, and President, Third World Academy of Sciences, received the honorary degree of Doctor of Science (D.Sc.) at a simple but impressive special convocation of Dhaka University, Bangladesh, on 23 May 1993. The Chancellor of Dhaka University Prime Minister Begum Khaleda Zia conferred the honorary degree on the Nobel Laureate Pakistani scientist amidst applause from the Curzon Hall, Dhaka, Bangladesh.

Professor Abdus Salam was the 33rd recipient of the honorary doctorate degree from the Dhaka University since the first one was awarded by the first Chancellor the Earl of Ronaldsay in 1922, one year after the founding of the University in 1921.

It was indeed a happy and memorable day for Dhaka University as it paid homage to the highest intellectual attainments and noblest human qualities by honouring Professor Abdus Salam.

The impressive ceremony was addressed by Prime Minister Begum Khaleda Zia who paid deep respect to Prof. Salam and said "We are grateful to him for his presence in our midst to accept the honorary degree of Doctorate of Science". She said Prof. Salam's wisdom, intellect, basic contribution to science and his efforts to the expansion of scientific activities and application of science to human welfare in the poor countries are well known to the enlightened people all over the world.

"He has enriched the mankind by his uncommon talent. On this auspicious

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uncommon talent. On this auspicious occasion I pray that our country will be flooded with the light of knowledge anew and a new era of development will usher in." the Prime Minister said.

The Prime Minister recalled the science conference in 1961 in Dhaka which was presided over by Professor Abdus Salam where he had advocated for a revolution in the field of knowledge. She said the necessity in bringing about a revolution in the field of knowledge was growing after three decades in the poverty-stricken countries.

Begum Zia said there was none like Prof. Salam who had emphasised the need for cultivation of science and technology in the developing countries.

The function began with the playing of the national anthem. Vice-Chancellor of Dhaka University Prof. Emazuddin Ahmed read out the citation at the ceremony.

The original citation is given as it is:

"Professor Abdus Salam is one of the most outstanding scientists of our time; he is a great humanist too. He has been a key figure in the fascinating drama unravelling the profound mysteries of the fundamental laws of nature for more than four decades and has contemporaneously been an assiduous champion of the causes of the developing countries towards their needs for modern science.

Professor Salam distinguished himself as one of the most brilliant students of the subcontinent before he left for Cambridge; his academic success there brought him even greater glories. He became a well known physicist at a young age and won many awards for his profound contributions to theoretical physics. While still a graduate student he proved the renormalizability of quantum electrodynamics and meson field theories. His application of the two-component theory of the neutrino to explain parity violation in weak interactions, his collaborative work with Weinberg and Goldstone regarding spontaneous symmetry breaking, his early advocacy of unitary symmetry, SU(3) and higher groups, for particle classification, and his two-tensor theory of gravitation have all been seminal contributions in the development of modern particle physics.

Professor Abdus Salam's most significant contribution has been the unification of two of the fundamental forces of nature. Salam shared the Nobel Prize for Physics in 1979 with Sheldon Glashow and Steven Weinberg for their creation of the Standard Theory of Electroweak Interaction which today lies at the heart of all modern research in particle physics.

Salam's conviction in the existence of beauty and symmetry in all aspects of nature — possibly inspired by his deep knowledge and faith in Eastern philosophy and spiritual and cultural heritage — has led him to extend his quest and has resulted in the formulation of Grand Unified Models incorporating the strong nuclear force into a common gauge theoretical scheme. His later work has clarified more recent concepts such as supersymmetry and superstrings. He remains to this day one of the fountainheads of original ideas in theoretical physics.

All his life Professor Salam has endeavoured untiringly to establish science in the developing countries. The isolated scientists in the developing countries have always been his great concern. He created at Trieste the International Centre for Theoretical Physics which provided a meeting ground for the scientists from all over the world to come and share their experiences. A large number of scientists from Bangladesh have greatly benefited from visits to Trieste over the years and all feel a deep sense of gratitude to Professor Salam. In recent years new Centres have been established at Trieste in chemistry, Biotechnology, Geology and other Sciences. We hope that these new Centres of excellence together with twenty other similar Centres being established all over the world, including one in Bangladesh, will fulfil Professor Salam's dream of a unified Centre of Science for the entire world.

In honouring Professor Abdus Salam this University pays homage to the highest intellectual attainments and noblest human qualities". _____ ♦

## The International Centre of Science, Technology and Environment for Densely Populated Regions

Bangladesh, one of the world's most populated countries, will have an international centre for science, technology and environment very soon. At the foundation laying ceremony for this new centre, which took place in Dhaka on Saturday 29 May 1993, Bangladesh's Prime Minister Begum Khaleda Zia told her guest of honour, Professor Abdus Salam, of her happiness to inaugurate an institution which will respond to the needs of the country and of the region and, at the same time, fit into a project dear to the heart of Professor Abdus Salam: the network of twenty research centres of excellence in the countries of the South.

The International Centre of Science, Technology and Environment for Densely Populated Regions (ICSTED) will initially conduct research in five broad areas: environment and natural disaster protection; population control and biotechnology; computer software development and materials science, which will include development of natural products like jute, and also semiconductors and other solid-state technology. The research staff will be local and foreign, and the total work force should count approximately one hundred and fifty people. As all research will be carried out under international contracts, ICSTED will be most likely financed by the World Bank and the United Nations Industrial Development Organization (UNIDO).

In her inaugural speech, the Prime Minister Begum Khaleda Zia described science as the weapon for the economic emancipation of the developing countries. "The Third World is facing today a great challenge", she said, "the challenge of their survival; they need increased employment, facilities of education, housing and medical care", and called for scientific and technological progress to overcome these problems. She urged the United Nations, other international organizations and other countries to co-operate with ICSTED and to help in maintaining a world-wide ecological balance. The Government and, in particular, the Ministry of Science and Technology are confident that Science & Technology will be tightly linked to development issues. She concluded by quoting Professor Abdus Salam: "War is evil, war is cruel, war is inhuman, still more evil, still more cruel and still more inhuman is the slow and agonising death of daily hunger". _____ ♦

## International Centre of Science, Technology and Environment for Densely Populated Regions Will Help Tackle Third World Problems

Addressing the founding stone laying ceremony of the ICSTED, Nobel Laureate Professor Abdus Salam who was the special guest on the occasion, hoped that the proposed Centre would function as an outstanding research organisation to contribute to tackle the problems of Third World countries including Bangladesh.

Professor Abdus Salam, who is also President of the Third World Academy of Sciences (TWAS) and Director of the International Centre for Theoretical Physics, Trieste, Italy, said the ICSTED would be a centre of research for developing countries having a mission to utilise the results of successful and expensive research performed throughout the world to the context of densely populated regions of the world.

Prof. Salam said the goal of ICSTED would be precisely to see that through science and technology the conditions of regions such as Bangladesh were brought at par with the faster developing regions. The people living in high density countries like Bangladesh need, for their well-being, examine their problems with this basic fact in mind, he added.

Professor Abdus Salam said he had always felt that the real problems of the Third World needed to be solved at local level. In this connection, he recalled that he first mooted the idea of setting up 20 centres of excellence in Third World

he first mooted the idea of setting up 20 centres of excellence in Third World countries for their development through science and technology at the bi-annual meeting of the Third World Academy of Sciences held in Caracas, Venezuela, in 1990.

He said densely populated did not mean underdevelopment and pointed out that the entire South-East Asia including China was a collection of densely populated regions that were experiencing the highest sustained growth rate that the world had ever seen.

Prof. Salam said the ICSTED would also focus on the problems of women in terms of the betterment of their condition through utilisation of science and technology and added ICSTED would have a women's wing to look exclusively after this aspect.

Recalling his association with Bangladesh, Prof. Salam said "As a physicist I cannot forget that here in Dhaka, the Bose-Einstein statistics, so important to understand nature, was born". He said the University of Dhaka has a tradition that is hard to equal in the entire sub-continent. "I always look forward to renewing my fond association with Dhaka which is now the capital of a proud nation".

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### Address by Prof. Naseem Rahman, Coordinator of ICSTED

Speaking on the occasion, Prof. Naseem Rahman said the proposed centre in Dhaka would be a thoroughly international institute not as much for the fact of prestige but for the quality of work of international standard to be performed in Dhaka. He also pleaded for placing the activities of ICSTED in the purview of SAARC countries and added each of which had reasons to contribute to the success of ICSTED.

Dr. Naseem Rahman, a professor of theoretical chemistry, Department of Chemical Sciences, University of Trieste, Italy, said the ICSTED would soon be in a position to start work in the defined areas, and contacts were being

soon be in a position to start work in the defined areas, and contacts were being established with relevant scientists and technologists of the SAARC countries so that regional projects could start immediately.

Initially, research will be conducted at the Centre on five broad areas like environment and natural disaster protection, population control and bio-technology, computer software development and research in material science which will include development of the natural products like jute and also semiconductors and other solid state technologies. Both local and foreign scientists will be working in each of the five areas. The total work force at the Centre will be around 150.

Major part of the expenses in running the Centre is expected to be available as donations from friendly countries and the World Bank and UNIDO are also alikely to finance the Centre's projects. All research will be done through international contract.

The 20 countries selected to be sponsored as networks of such centres include Pakistan, Malaysia, Sri Lanka and Egypt. ♦

## Give Stress on Bio-Science for Development

Professor Abdus Salam, Nobel Laureate and Director, International Centre for Theoretical Physics, on Sunday 22 May 1993 at Dhaka, Bangladesh, called for laying emphasis on biological science along with physical science for attaining the development of Third World countries including Bangladesh.

Prof. Abdus Salam also laid stress on attaining scientific and technological advancement by Bangladesh to overcome impediments to its development.

Professor Abdus Salam was addressing the special convocation of the Dhaka University, where the Nobel Laureate was conferred with Doctor of Science (D.Sc.) Degree Honoris Causa.

Prof. Salam said for the last two years he had been working on the origin of life and the universe applying his own

he had been working on the origin of life and the universe applying his own theory.

Prof. Salam expressed his gratitude and thanks to the Dhaka University authorities for conferring him the degree and added he was proud to receive honour from an institution having tradition hard to equal in the entire sub-continent.

Prof. Abdus Salam recalled his association with the Physics Department of Dhaka University and said it was the place where Bose-Einstein in statistics, so important to understand nature, was born.

"I always felt proud to find that my portrait got a place in the Department alone, with many eminent scientists

including S.N. Bose and others who had taught here", he said.

The Nobel Laureate said many brilliant students of the Department, now working for international organisations, had made their mark in the field of research on science and technology. He mentioned that Bangladeshi scientists working for the International Centre for Theoretical Physics (ICTP) at Trieste, Italy, had earned international reputation.

He recalled his first visit to Dhaka in 1961 in connection with attending All Pakistan Science Conference. "Since then I visited Dhaka many times", Prof. Salam said, adding "I always look forward to renewing my fond association with Dhaka, now the capital of a proud nation".

Prof. Salam said he was happy to note that the present democratic government had attached priority to setting up the International Centre of Science, Technology and Environment for Densely Populated Regions (ICSTED) through incorporating the project in the annual development programme.

Prof. Salam thanked Prime Minister Begum Khaleda Zia, who as the Chancellor of the Dhaka University, conferred the degree on him. ♦

## Conferences and Lectures

Dr. V. Staicu, a Post-doctoral student of the ICTP Mathematics Research Group, gave a seminar at the Department of Pure and Applied Mathematics of the University of Padua (Italy) on differential inclusions of the evolutionary type. His seminar, which was held on Thursday 27 May, was one of the series on nonlinear analysis.

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Dr. M. Kirane, a Post-doctoral student of the ICTP Mathematics Research Group from the University of Annaba (Algeria), gave two seminars at the Institute for Applied Mathematics Research (Istituto per ricerche di matematica applicata, IRMA) in Bari, Italy, on 31 May and 4 June. The titles of his seminars were "Examples of reaction-diffusion systems in which the diffusion terms lead to blow-up" and "Global solutions to systems of strongly coupled reaction-diffusion equations". ♦

## 24th Meeting of the ICTP Scientific Council

The Scientific Council held its annual meeting on 4 May 1993. Its Members are distinguished scientists appointed in their personal capacity and chosen from several countries. They normally meet once a year to review and assess the ICTP activities of the current year and to formulate proposals and recommendations for the short- and medium-term.

Nobel Laureate Professor J.R. Schrieffer has recently been appointed as Chairman of the Council and of the Condensed Matter Research Group for the years 1993-94 since Prof. S. Lundqvist retired from the same offices.

He opened the meeting by expressing his pleasure to be even more closely associated with Prof. Abdus Salam. He welcomed all those present and especially the two new Members, Profs. Ezeilo (Nigeria) and Khalatnikov (Russia). He thanked the representatives of IAEA, UNESCO and the Italian Government for their continuing support to the Centre and Professor Salam for sharing his wisdom. He paid a tribute to Prof. S. Lundqvist, whose vigorous leadership as Chairman of the Council and promoter of the Condensed Matter activities at ICTP will always be remembered. Finally, he thanked Profs. Salam, Budinich and Bertocchi for helping him getting acquainted with ICTP matters.

Dr. H. Blix, IAEA Director General, expressed his appreciation to Prof. J.R. Schrieffer for taking over the position of Chairman of the Scientific Council.

Prof. Abdus Salam welcomed all those present and highlighted the main issues which had arisen at the ICTP since the last meeting of the Council in 1990 — the announcement by Dr. H. Blix that the administration of the ICTP would be transferred from IAEA to UNESCO, and the cash flow difficulties during 1991 and 1992. He explained that the difference between the number of visitors in 1992 versus 1991 was due to the cancelling of activities because of these difficulties.

An important feature of the past year had been the implementation of the Diploma Course — a programme recommended by the Scientific Council in 1990 — in High Energy Physics, Condensed Matter Physics and Mathematics. He hoped that this Council would recommend a fourth subject.

Prof. Bertocchi complemented Prof. Salam's presentation with an overview of the present situation of the ICTP programme. In the past, the ICTP developed as an institute for research and training. But in the last five years, emphasis has been more and more placed on research rather than on training.

At present, there are three main research groups — in High Energy Physics, Condensed Matter Physics and Physics, Condensed Matter Physics and Mathematics, each consisting of 2 or 3 resident scientists, about 20 post-doctoral students, and about 200 long- and short-term visitors per year. There are also smaller research groups in Plasma Physics and Fusion, Atmospheric Physics, Radio-propagation, and Structure of the Solid Earth and Earthquake Prediction. These smaller groups are composed of a few long-term, resident or post-doctoral scientists, and about 20-30 visitors per year. All the research group leaders are from developing countries.

In addition to the visitors, the Associate Members take part in the

research activities. At present there are about 400 of them.

He recalled that the first laboratory established at ICTP was the one on Microprocessors. Research on VLSI is carried out there, in cooperation with external institutes, in particular with the Italian Institute for Nuclear Physics (INFN). The Laboratory is funded by the Italian Government through the United Nations University (UNU).

The Superconductivity Laboratory was opened when the subject became topical. It carries out training and research activities for the preparation and characterization of superconducting materials. The Laboratory for Lasers and Optical Fibres, in cooperation with the Swiss Government through the Polytechnic School of Zurich, serves principally as a support for training activities, but also carries out some research on local area networks through optical fibres.

The ICTP training programme is carried out through a large number of courses, workshops and schools, covering subjects in all the fields of the research.

As mentioned by Professor Abdus Salam, a new part of the training programme is the Diploma Course which started two years ago in High Energy Physics and Condensed Matter Physics, and last year in Mathematics. The attendance in this programme is limited to 10-12 students per course.

In addition to the training programme in Trieste, ICTP also conducts, since 1983, a programme for Training and Research in Italian Laboratories. About 100 scientists from developing countries per year take part in the research projects of these laboratories.

Moreover, there are two more major programmes which are carried out outside the ICTP, namely, the External Activities which has four major schemes: first of all, the support to Affiliated Centres and networking of scientific institutes within geographical regions; the third and fourth components are financial and intellectual support to scientific meetings in the developing countries and the scheme for Visiting Scholars respectively.

He also reported on the ICTP Library and the computer facilities. According to many, the Library is one of the best in the region as far as physics and related sciences are concerned.

Prof. Bertocchi remarked that, over the last two years, the Centre went through financial difficulties, mainly due to the fact that money had to be borrowed to make up for delays in the payment of the budget contributions. He also noted that, due to inflation, the ICTP was forced to decrease the number of scientists taking part in each activity.

On the proposed transfer of the ICTP administration to UNESCO, Prof. Bertocchi said that the text of the Tripartite Agreement had been approved by the parties. This Agreement between Unesco, IAEA and the Italian Government, includes the provision for a Steering Committee which will guide the ICTP activity. The Agreement also states that the transfer will be effective on 1st January 1994 after all procedures have been fulfilled.

The participants in the meeting included

- *the Members of the ICTP Scientific Council:*
  Prof. J.R. Schrieffer, Chairman
  Prof. P. Budinich, Secretary
  Prof. Abdus Salam
  Prof. F. El Baz
  Prof. J.O.C. Ezeilo
  Prof. J.J. Giambiagi
  Prof. I.M. Khalatnikov
  Prof. N.H. March
  Prof. Y. Pal
  Prof. J. Palis
  Prof. Y Sobouti
  Prof. Zhou Guangzhao;
- *the representatives of the Italian Government:*
  Amb. C. Taliani
  Dr. G. Carante;
- *the representatives of the international organizations:*
  Dr. H. Blix
  Dr. S. Machi
  Prof. F. Mayor-Zaragoza
  Dr. S. Raither;
- *the representative of the Third World Academy of Sciences:*
  Prof. M.H.A. Hassan;
- *the representative of the Ad-Hoc Committee:*
  Prof. P. Chaudhari;
- *the representatives of the ICTP:*
  Prof. L. Bertocchi
  Dr. G. Guerriero
  Dr. M. Farooque. ♦


*The Scientific Council in session.*

# Dirac Medal Award Ceremony

*Professor Yakov G. Sinai receiving the Dirac Medal of 1992 from Professor Luciano Bertocchi, Deputy Director of the International Centre for Theoretical Physics, on 29th June, 1993, in the Main Lecture Hall of the ICTP.*

On 29th June, 1993, Professor Yakov G. Sinai (Landau Institute of Theoretical Physics, Moscow, Russia) received the 1992 Dirac Medal which had been awarded to him last year. Two such Medals are awarded every year on the birthday of P.A.M. Dirac — 8th August.

The ceremony took place in the Main Lecture Hall of the ICTP, Trieste. Professor Abdus Salam, Director of the ICTP and President of TWAS, was not there to preside over the ceremony as he was in London. Professor L. Bertocchi, Deputy Director, ICTP, chaired the function. Prof. S. Lundqvist, ex-Chairman of the ICTP Scientific Council was present as a special guest. Prof. L. Bertocchi presented the Medal and a cheque of US$ 5,000 to Prof. Y.G. Sinai.

Professor Yakov G. Sinai is honoured for his outstanding contribution to theoretical physics and mathematics through the development of ergodic theory and its applications to dynamical systems, in particular billiards, phase transitions, quantum chaos and hydrodynamics. Also cited is his work on the spectral analysis of Schrödinger operators and applications of renormalization group theory.

Professor Yakov G. Sinai was born in Moscow on 21 September 1935. In 1960 he obtained his Ph.D. from the Moscow State University, where he began his career as a Scientific Researcher (1960-1971). He is presently Scientific Researcher at the Laboratory of Probabilistic and Statistical Methods at the Moscow State University, Senior Researcher at the Landau Institute of Theoretical Physics of the Academy of Sciences and Professor of Mathematics at the Moscow State University. Between September 1991 and January 1992 he was Visiting Professor at Princeton University, USA.

He is a Foreign Member of the American Academy of Arts and Sciences and Member of the Russian Academy of Sciences. In 1992 Professor Sinai was elected Honorary Member of the London Mathematical Society.

In 1986 Professor Sinai received the Boltzmann Gold Medal for his work in statistical physics; in 1989 he was awarded the Heinemann Prize for his contribution to mathematical physics and in 1990 the Markov Prize for his work in probability theory.

The other 1992 Dirac Medal was awarded (posthumously) to Prof. N.N. Bogolubov formerly of the Joint Institute for Nuclear Research in Moscow during a ceremony which was held at ICTP on 2 December 1992. ♦

*Dirac Medal Lecture given by Prof. Yakov G. Sinai at the Main Lecture Hall of the ICTP on 29th June 1993.*

# Possibilities of R&D in Medical Physics and Bio-Medical Engineering in the Third World in the Light of Bangladesh Experience

*K.S. Rabbani*
*Junior Associate*

In this article I shall describe in brief the R&D work carried out in Bangladesh by the Bio-Medical Physics Group at the Department of Physics, University of Dhaka, over the last 13 years.

Work started back in 1978 when one physicist had his old father in the hospital with a fractured bone and while at the same time a foreign science report shown on the local TV talked about a technique of enhancing bone fracture healing tried in USA. This put the physicist in action and he went through the literature, talked to the doctors and finally embarked upon the project. The equipment needed was beyond the budget of the poor researcher and there were not enough details in the literature. So he came to the University looking for technical resources and skill, and formed a group with a friend of his, a senior member of the staff, who had experience in old valve-based equipment.

As a coincidence, I returned from abroad roughly at the same time after obtaining a Ph.D. in semiconductor device technology (microelectronics). I made myself convinced that we cannot put a microelectronic chip on the market from a poor country like Bangladesh and I wanted to do something useful in the context of the country. Though there were strong suggestions from senior scientists to continue in the field and there was a similar group within the Department, I did not share their ideas. the only success that could be achieved from such exercises, I reasoned, would be in training students who would join the bandwagon of brain drainees settling down in California. Why shouldn't I be a brain drainee then? I was trying out areas like solar and wind energies when I was asked to join the bone fracture healing group since I had a knack for modern electronic circuit design.

The above story is mentioned just to highlight situations that are often encountered by scientists in the Third World and to guide the thinking process of young scientists there.

The modest start in 1978 was followed by a British Council-sponsored academic link with the Department of Medical Physics and Clinical Engineering, Sheffield University, UK, which opened up the doors of other possibilities to us. With their sincere and active help we have been able to extend our research areas and have formed a reasonably large group within Bangladesh which includes people from other institutions as well.

Organised by a senior staff member of our faculty who made opportunities available to us and provided us with the necessary guidance, motivation and support, we have been able to carry out research work without much hindrance. Courses on bio-medical physics at the M.Sc. and M.Phil. levels have been established and are attracting the brighter group of students. We have collaborations with several hospitals, whether in research or in specialised patient services using equipment developed by us. The basic infrastructure necessary for further research has been established. Once the ball got rolling, innovative ideas cropped up, in the last decade or so we have been able to produce some work, which I believe, deserves commendation.

**List of R&D work in medical physics & bio-medical engineering at Dhaka University and present status**

1. Development of a micro-computerised electro-physiology equipment with signal averaging facility (Electro Myo-Gram, evoked potentials from nerve and brain for neurological investigations). *Prototype complete and is now set up in a hospital.*
2. Development of ECG on line monitor for use in intensive care units. *Prototype almost complete.*
3. Electrical Impedance Tomography (EIT) — a new technique. Equipment developed by the Sheffield group. Our work involves: (a) studies on the effect of third dimension in EIT and possibility of 3D imaging; (b) determination of location of electrodes on human body using ultrasound techniques for development of static EIT; (c) gastric emptying studies on malnourished children in diarrhoeal and non-diarrhoeal regimes using EIT. *Some progress has been made in all the three. Continuing.*
4. Optimisation of electrode configuration in order to develop a four point electrical impedance plethysmographic technique for gastric emptying studies. *Considerable progress has been achieved. Continuing.*
5. Development of a vibration technique for assessment of bone fracture healing and for diagnosis of osteoporosis (bone degeneration). *Considerable progress has been achieved. Continuing.*
6. Studies on electromagnetic stimulation for bone fracture healing. *Considerable work has been done. Less interest now.*
7. Development of a computer software to select suitable hearing aids for patients from hearing threshold data and electrical characteristics of hearing aids. *Done.*
8. Development of a low-cost secondary calibration facility for pure tone audiometers. *Done.*
9. Development of computer interface to a mechanical spirometer for data acquisition and respiration studies. *Done.*
10. Impedance plethysmography for blood flow studies. *Some progress has been made. Continuing.*
11. Development of an electrical method for blocking excessive sweating from palms, feet and armpits. *First study successful. Prototypes being distributed to patients at home. Continuing.*
12. Development of very low cost devices for destroying diarrhoeal germs in drinking water using solar energy — for rural areas and for use at disaster

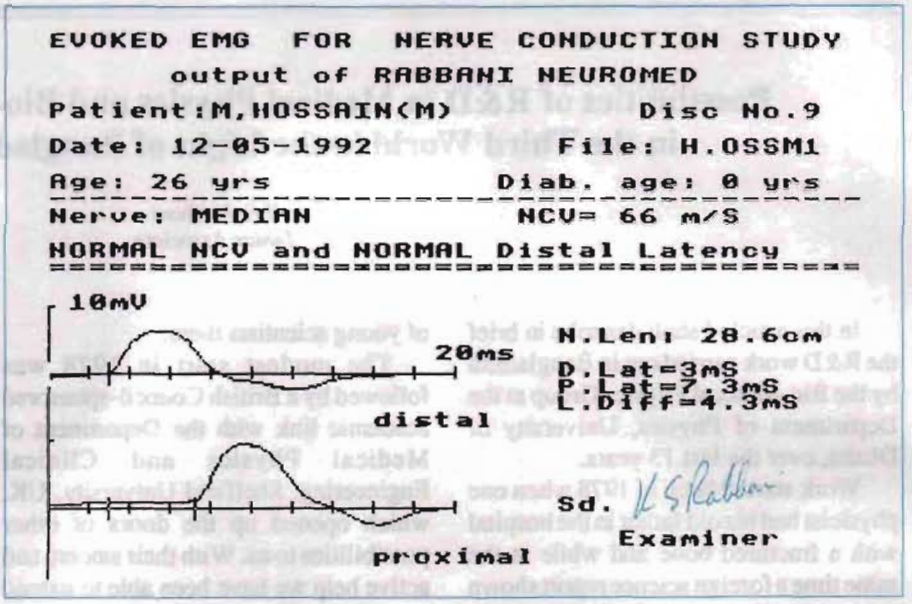



**Fig. 1**
*A typical waveform and analysis obtained using the locally developed electrophysiology equipment.*

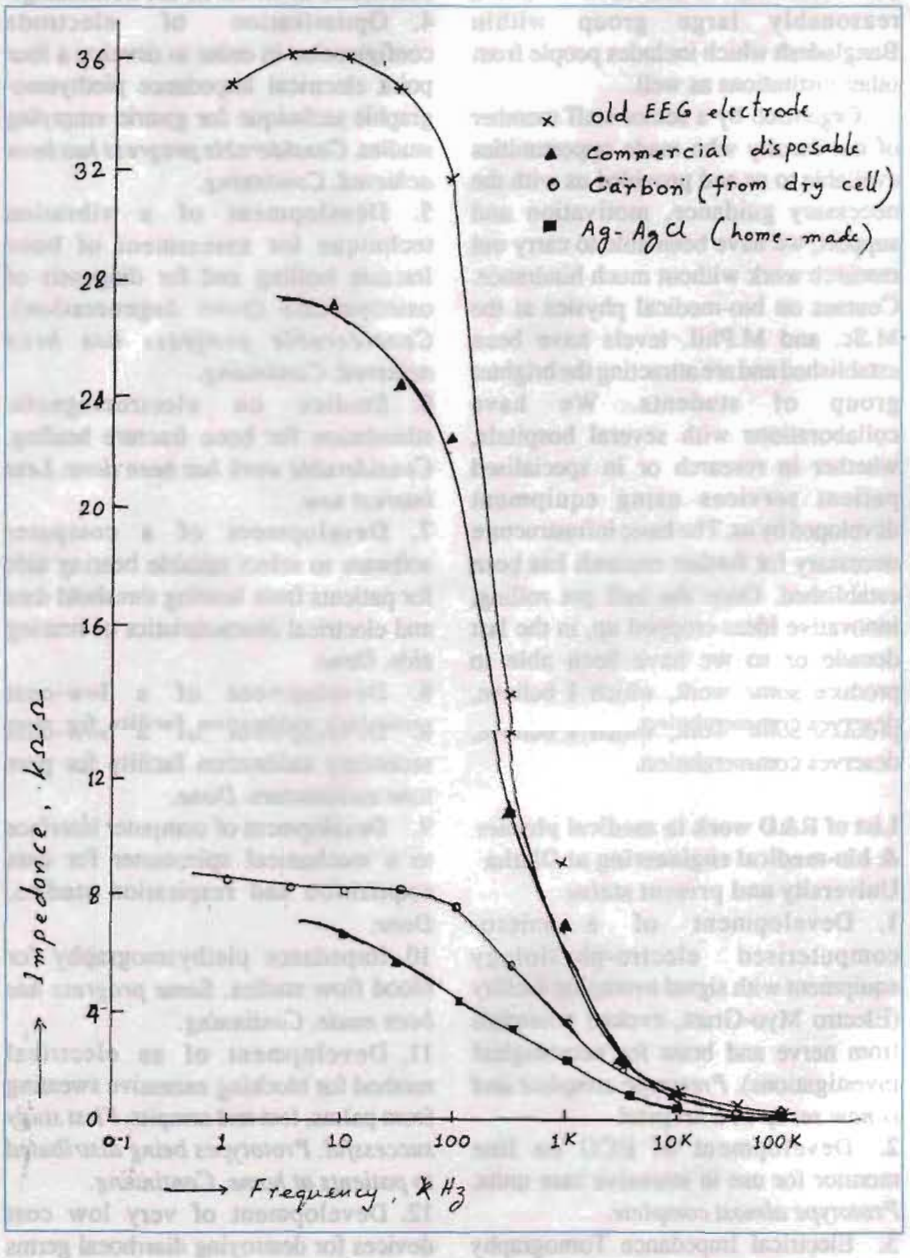



**Fig. 2**
*Impedance characteristics of electrodes.*

times. *Successful design developed. Ready for field trial.*

13. Development of low cost equipment for primary health care. *pH meter successfully made, colorimeter being developed.*

14. Correlation of studies on lungs and on gastric emptying using the new EIT technique and gamma camera. *Just starting.*

15. Development of reusable low cost skin surface electrodes for use in ECG and other electro-physiological investigations. *Success achieved in initial trials. Continuing.*

16. Vectorcardiography (VCG) — a new representation of the heart for research and diagnosis. *Considerable progress has been achieved. Continuing.*

It needs to be mentioned that almost all the equipment developed in this programme would cost much less (half to one fifth) than similar imported products even after pricing on a commercial level. This is because medical items are not sold in large quantities, so overhead is high. Besides, to compete in the world market, the giant companies have to invest highly in R&D efforts, particularly in high level manpower. Even if it adds a minor gimmick which may not be that essential but the cost rises sky-high. The cost of similar high level manpower in the Third World is orders of magnitude lower and this places us at a considerable advantageous position. Fig. 1 shows an electrophysiological waveform obtained using our equipment which is no different than that obtained

using imported equipment. Rather some of the imported ones use special papers for recording which again increases the cost of investigations besides making it supply dependent.

While working in these areas we encountered situations for which no solution exists in the available technology and this leaves room for innovation and new studies. This is expected since a researcher in the developed countries cannot conceive of the situation encountered in the Third World. Besides, poverty itself calls for innovative ideas to make modern knowledge available to the common people at a very low cost.

To give examples from the above list, project 4 was taken up when we were faced with high expenses as well as practical logistic problems of connecting 16 disposable electrodes to malnourished children. For this reason this innovative method has been attempted and has shown much promise. Now, if this approach succeeds, we will be able to offer a very cheap but effective technology, not only to the Third World but the First World as well.

Project 15 was taken up to reduce our expenditure on disposable electrodes. Though these are cheap compared to the income level in the rich countries, it is not so in the Third World and it has been found that attempts are made to re-use disposable electrodes increasing chances of cross infection. It was also found that many of the imported disposable electrodes did not have the desired performance. Coming to reusable electrodes, they even lose their performance with use, and without knowing a Third World technician will continue using them. The electrical impedance characteristics of some of these electrodes and of some indigenous ones are shown in Fig. 2. It can be seen that both the disposable electrode (which was freshly brought out of a sealed package) and the old EEG electrode show rather high impedance which is a sign of poor performance. One reason for the disposables could be long storage which cannot be avoided due to import procedures.

This also shows the use of carbon from dry battery cells as a satisfactory electrode material which could be made very cheaply. It was also found that some local tree resins could be used as satisfactory conductive jeliy bridging between the skin and the electrode. This, if pursued further, may be able to reduce dependence on expensive imported conducting jelly besides opening up opportunities of manufacture and export as well.

Many equipment need the use of different types of sensors. Some of these may be made at low cost developing the appropriate expertise. The vibrator and piezoelectric accelerometer needed for project 5 were developed locally and calibrated using an industrial standard. The optical part of the equipment listed in project 13 were developed from cheap commercial photodiodes.

Again coming to project 12, the requirement for such devices cannot be conceived of by a scientist in the developed world. Every year about 300,000 children in Bangladesh alone die of diarrhoea and to a Third World scientist these problems should get top priority. It is now being planned to perform controlled experiments to evaluate all innovative attempts that have been taken throughout the world in this direction and to make manuals of them so that the people themselves can fabricate them at times of need.

As can be envisaged from the Bangladesh example, most of the work can be done if only expertise in different types of sensors, electronics and computers (interfacing & software development) are available, which is already there in most of the Third World. If not, they should urgently make policies in developing manpower in these areas. Most of the special equipment needed for the work in Bangladesh were developed by us at a fraction of the cost needed to import equipment. This can be seen in Fig. 3 where both a test phantom and the specialised electronic equipment were developed indigenously. In imported equipment often we have to pay for a host

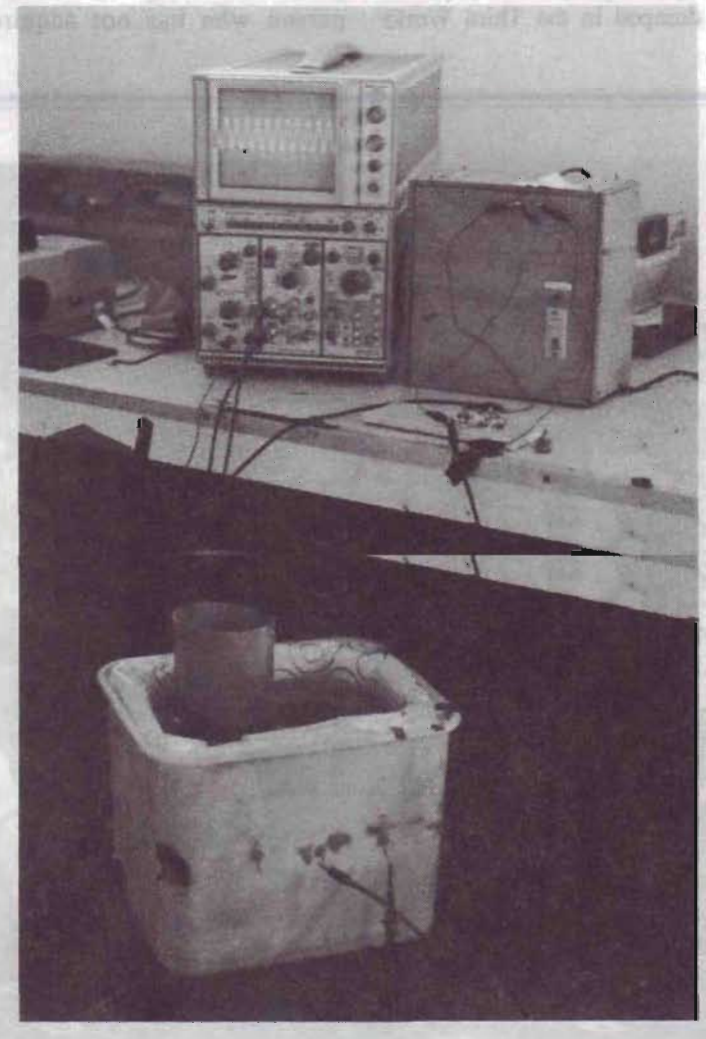


**Fig. 3**

*Improvised experimental set-up for development of a simple impedance measurement method in relation to gastric emptying studies.*

of functions when we need only one! With a few test equipment like multimeters, signal generators and oscilloscopes, many items of international standard may be developed. Hence the investment needed is minimal. It is not hard to find latest electronic components and sensors through catalogues and correspondence which are in fact the backbones of modern technology. Even ultrasound imagers may be developed within the Third World country. As mentioned before, huge imaging equipment like CT scanners and MRI or PET imagers may not be built in the Third World in the near future, but there are hundreds of other equipment required in daily use that can be developed. In fact only a fraction of percentage of the total population in a Third World will be able to reap the benefit of these expensive imagers but the benefit size is very large for most of the other equipment that we can innovate and develop.

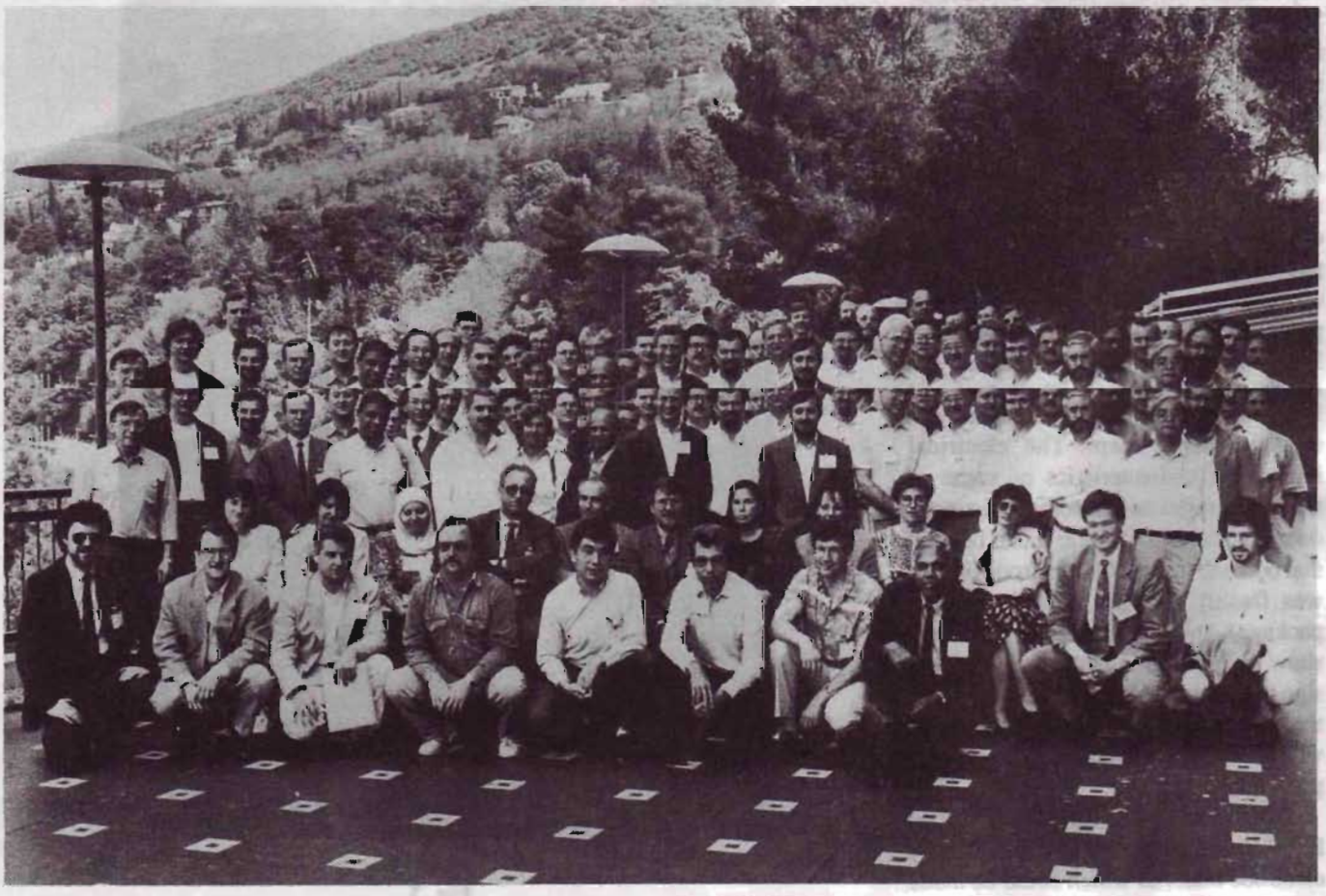
Many expensive imported equipment are often dumped in the Third World once these become out of order, because repair is expensive and sometimes a prohibitive proposition. These equipment are used virtually as disposable products. It is an irony that the poorest country has to carry on with such luxury while the developed countries use these equipment for ages because of proximity of manufacturers or their service centres. Hence it is essential that Third World scientists and technologists develop their own equipment and expertise which will help them in maintaining and repairing other imported equipment as well.

Though the above discussion circled around medical physics and bio-medical engineering only, the same is true for many other branches of science and technology which heavily depend upon the use of electronics and computers.

**Technology transfer**

There has been a lot of talk on this matter, but virtually nothing has taken place. It is not easy to transfer skills to a person who has not acquired and maintained certain skills up to a standard. Particularly, the modern technology is moving so fast that it needs a dedicated and persistent adherence to practical work without which a person would soon be out of place. I would like to emphasize on motivation and dedication which are the very essential ingredients to survive in this field. Hence Third World scientists and technologists have to come up themselves to face up the challenge.

However, this is not the only solution. Motivation and dedication are linked to the economic and political conditions in the society and the responsibility lies with the respective leaders in the Third World. A large economic gap between the privileged and the unprivileged classes in the Third World can never bring this motivation. "Why should I work if the monetary gain that my work will produce goes only to a handful of people?" — This is the natural question asked by a scientist who is ready to sacrifice the affluence of the developed world and not become a brain-drainee. ♦



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

# Activities at ICTP in May-June

**Title:** SIXTH WORKSHOP ON PERSPECTIVES IN NUCLEAR PHYSICS AT INTERMEDIATE ENERGIES, 3 – 7 May.

**Organizers:** Professors L. Bertocchi (ICTP), S. Boffi (University of Pavia, Italy), C. Ciofi degli Atti (Istituto Nazionale di Fisica Nucleare, INFN, Rome, Italy) and M. Giannini (Istituto Nazionale di Fisica Nucleare, INFN, Genoa, Italy), in collaboration with the Italian National Institute for Nuclear Physics (INFN).

**Lectures:** Polarization experiments at BATES and the neutron form factor. A first measurement of GE in the d(e-pol, e'n)p at MAMI. The NE11 experiment at SLAC and the neutron form factor. Nuclear effects in polarized electron scattering off polarized 3He and the neutron form factor. The SLAC E142 Experiment. The SMC Experiment. The HERMES Experiment. Nuclear effects in polarized DIS off polarized nuclei. Low Q**2 behaviour of nucleon's spin structure functions. Theory of spin structure functions (GT). Colour transparency in (e,e'p) experiments. Role of Fermi motion in colour transparency. Nuclear transparency in the deuteron. Deep inelastic scattering (GT). Multiparticle production in deep inelastic scattering. Quasi exclusive deep inelastic scattering off nuclei. Quark-gluon structure of nuclei and the origin of the nuclear force. Spin observables in pion photoproduction on light nuclei. Electron scattering on tensor polarized deuteron: a status and recent results of the experiment at VEPP-3 in Novosibirsk. Relativistic effects and spin observables in deuteron electrodisintegration. Polarized deuteron form factors at high Q2. Out-of-plane measurements with polarized electrons. Short-range correlations and natural orbital representation in nuclei. Wave function calculations for finite nuclei. Final state correlations in realistic (e,e'p) calculations. Structure functions in the (e,e'p) reaction including electron distortion and two-body currents. Studies on the mechanism of the (e,e'p) reaction. A study of the 12C(e,e'pp) and 12C(e,e'p) reactions in the dip and delta resonance regions. Two-nucleon emission at intermediate energies. Direct two-nucleon emission induced by an electromagnetic probe. Nucleon-nucleon correlations and photon induced two-nucleon emission processes. The (gamma,pn) reaction on p-shell nuclei using tagged photons. Photon absorption by two protons in 3He. Three-body photodisintegration of 3He. Multi-nucleon emission in quasi-elastic scattering. High pt processes (GT). Electromagnetic investigations of nucleon resonances (GT). N* excitations in (pi,N) and (gamma,N) reactions. A U(7) model of collective excitations of baryons. Investigations of nucleon resonances and meson production with tagged photons at MAMI. Total photon absorption experiment at ADONE. Compton scattering on the proton in the Delta-resonance region. Electro-excitation of 12C in the delta region and its decay in 4Pi BGO detector. Inclusive electron scattering in medium-light nuclei at intermediate energies. Nucleon resonances in nuclei and quark effects. Spin observable in exclusive processes at Saturne. First results of p(gamma,K+) lambda/sigma at the SAPHIR detector. Strangeness electroproduction on the proton. Eta-photoproduction experiments at ELSA. Eta-photoproduction experiments at MAMI. Photonuclear physics with eta-mesons. Strange hyperons in the bound state soliton model. Spin observables in kaon photoproduction. Open problems in strange particle nuclear physics (GT).

The Workshop was attended by 130 lecturers and participants (27 from developing countries).

**Title:** WORKSHOP ON QUALITATIVE ASPECTS AND APPLICATIONS OF NONLINEAR EVOLUTION EQUATIONS, 3 – 14 May.

**Organizers:** Professors H. Beirao da Veiga (Centro Linceo Interdisciplinare "B. Segre", Rome, Italy) and Li Ta-Tsien (Fudan University, Shanghai, P.R. China).

**Lectures:** Heat flow method: monotonicity formula and small energy regularity theorem; global existence and finite time blow-up. Microlocal order of singularities for distributions and trace formulas of hyperbolic type. Qualitative behaviour of global solutions for inhomogeneous quasilinear hyperbolic systems. Operator-splitting methods for evolution equations. Mathematical properties of the Van der Waals model with capillarity. Continuum limits of discrete particle systems with short range potentials. Global smooth large solutions to the equation of a viscous, heat-conducting, one-dimensional real gas. Incompressible limit for the compressible Navier-Stokes equations. Integrable systems and solitons in space-time $\mathbb{R}^{n+1}$. Global solutions to some free boundary problems for the system of compressible flow through porous media. On nonlinear gauge theories in Minkowski space-time. Sobolev inequalities associated with conformal vector fields. Blow-up of the solutions to semilinear wave equations. Oscillatory and time periodic solutions to conservation laws — new examples. Weak linear degeneracy and global classical solutions for first order quasilinear hyperbolic systems. The breaking soliton equations. Auto-Backlünd transformations and multisoliton solutions of MKdV's system. Analysis of integro-differential equations in epidemic models and their vaccinations and some numerical results. Geometric aspects of soliton-like equations. Neumann operator for wave equation in a half space and microlocal orders of singularities along the boundary. Uniqueness of global quasi-classical solutions of Cauchy problems for nonlinear PDE's of first order. Yang-Mills and Dirac fields with bag boundary conditions. The differential equation for the interface in a porous media-type equation. On closed-form solution of some partial differential equations with source term. On the Cauchy problem for nonlinear weakly hyperbolic equations. Semiflows and global attractors. The initial boundary value problem for symmetric hyperbolic systems with characteristic boundary. Mixed problems for symmetric hyperbolic systems with characteristic boundary conditions. Inertial manifolds of nonlinear evolution equations and applications. Nonlinear evolution equations for wave propagation in random media. Superstructures in nonlinear reaction-diffusion equations. Classical solution for linear hyperbolic systems with discontinuous coefficients modelling propagation of acoustic waves. Global attractors for some nonlinear evolution equations. Existence

and regularity of solutions to nonlinear thermoelastic systems. The trace theorem in a weighted Sobolev space $H^m_\alpha(\Omega)$. Global solutions to a system of strongly coupled reaction-diffusion equations. Dynamics of solitons in perturbed Klein-Gordon equations. Supersolutions and stabilization of the solutions of some quasilinear parabolic equation. Global existence results for equations of Kirchhoff type.

The Workshop was attended by 77 lecturers and participants (54 from developing countries).

**Title:** COURSE ON OCEAN-ATMOSPHERE INTERACTIONS IN THE TROPICS, 10 – 29 May.

**Organizers:** Professors G. Furlan (University of Trieste and ICTP), V. Krishnamurthy (International Institute for Earth, Environmental and Marine Sciences and Technologies, IIEM, Trieste, Italy), R. Legnani (Istituto per lo studio delle metodologie geofisiche ambientali–Consiglio Nazionale delle Ricerche, Modena, Italy), A.D. Moura (Instituto de Pesquisas Espaciais, INPe, São José dos Campos, Brazil, and National Oceanic and Atmospheric Administration, Silver Spring, MD, USA) and J. Shukla (University of Maryland, College Park, MD, USA).

In co-operation with the International Centre for Science and High Technology (ICS, Trieste, Italy) and the National Oceanic and Atmosphere Administration (NOAA, Silver Spring, MD, USA).

**Lectures:** El Niño. Observations: tropical climatology. Ocean remote sensing. Equations of motion. Observations for short-term climate prediction. Thermodynamic quantities. Internal variability in coupled ocean-atmosphere general circulation models. One and two-layer models of the ocean. How clouds heat. The ocean mixed layer. Convective boundary layer (flux profile relationships). Vertical structure of the tropical atmosphere. SST & surface fluxes. Thermal forcing. Equatorial ocean dynamics: free waves. Multinational arrangements for short-term climate prediction: IRICP. Equatorial ocean dynamics: forced waves. Equatorial ocean dynamics: adjustment. ENSO observations: Tropics. Theories of ENSO. Variability in the tropical Atlantic. Results from a coupled ocean-atmosphere model. ENSO observations: global effect. Linear instability analysis of the coupled system. Simple ENSO mechanisms. Prediction and predictability. Parallelization of the ECWMF's weather prediction code.

**Round-table Discussion:** Regional impacts of climate.

**Video show:** Computer simulation of atmospheric and ocean flows.

The Course was attended by 42 lecturers and participants (30 from developing countries).

**Title:** COLLEGE ON COMPUTATIONAL PHYSICS, 17 May – 11 June.

**Organizers:** Professors V. Kumar (Indira Gandhi Centre for Atomic Research, Kalpakkam, India, and ICTP), A. Nobile (ICTP), C. Rebbi (Boston University, MA, USA) and A. Sadiq (Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Islamabad, Pakistan).

**Lectures:** Basic numerical techniques. Introductory talk on computer mathematics. Modern parallel computing. Research with Mathematica. The mathematical basis for Monte Carlo methods. Review of basic quadrature methods. Scientific computing on a CM5 supercomputer. Random numbers. Orthogonal polynomials and Gaussian quadrature. Fortran 90. Introduction to integral equations. Inverse problems. Introduction to neural networks. High performance Fortran. Wavelet transforms. Monte Carlo simulations. Molecular dynamics. Partial differential equations. Cellular automata. Quantum Monte Carlo simulations. Multigrid methods. Phase diagram of dilute Ising systems by an efficient Monte Carlo technique. Ab-initio molecular dynamics. Graphics programming with VOGL. A simple numerical method: the method of cells. Comparison of "exact" and "approximate" density functionals: a quantum Monte Carlo study.

**Seminars:** Parallelization of the ECMWFs weather prediction code. Quantum percolation. A method for obtaining large number of converged eigenvalues of the perturbed hydrogen atom problems. Scientific visualization: computer graphics for physics research. Numerical simulation of nonlinear acoustic waves containing shocks. Combinational methods for some lattice models. Electronic structure and amorphous magnetism in transition metal-metalloid glasses. Numerical simulation of turbulent flows. Simulation of crystal growth: kinetic roughening. Numerical simulation of nonlinear wave propagation. Effect of rotational constraint on the scaling behavior of percolation. Percolation on 2D quasicrystalline and random lattices. Orbital free density functional theory. Method of numerical integration in separable metric spaces: application to Feynman path integrals. Numerical techniques used in reactor physics computation. Ostwald ripening at ion beam synthesis — a computer simulation for inhomogeneous systems. Cellular automata and hydrodynamics on parallel computers. Cluster CPA in the TB-LMTO scheme. T.L. dating. Equation of state and the superconductivity of $LaGa_2$ and $YGa_2$. Numerical simulation of dissolution and liquid-phase-epitaxial growth of silicon.

**Computer sessions.**

**Presentation of videocassette:** Visualization in computational science (some selections from the International Journal of Supercomputer Applications).

The College was attended by 102 lecturers and participants (77 from developing countries).

**Title:** SPRING COLLEGE ON PLASMA PHYSICS, 17 May – 11 June.

**Organizers:** Professors B. Buti (Physical Research Laboratory, Ahmedabad, India), U. De Angelis (University of Naples, Italy), M.H.A. Hassan (Third World Academy of Sciences, Trieste, Italy), Yu-Ping Huo (Institute of Plasma Physics, Hefei, P.R. China), S.M. Mahajan (University of Texas at Austin, USA), P.H. Sakanaka (Universidade Estadual de Campinas, Brazil) and N.L. Tsintsadze (Georgian Academy of Science, Tbilisi, Georgia).

**Lectures:** Stationary models of magnetic reconnection. Foundations and limitations of quasilinear theory. Lungmuir turbulence in space plasmas. Particle acceleration in nonlinear and chaotic fields. Kinetic-MHD theory for low frequency phenomena. MHD turbulence and turbulent reconnection. Test particle motion in a longitudinal electrostatic turbulence. Nonlinear

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

dynamics of magnetospheric activity. Some examples of systems with fast reconnection. Enhancement of quasilinear diffusion in self-consistent simulations. An introduction to anomalous transport theory. Kinetic electromagnetic simulation of MHD phenomena by 3-D implicit particle code. Analysis of magnetic field structure in a plasma. Cosmology. Quasi particle concept in plasma physics. Numerical simulation studies on nonlinear magnetohydrodynamics. Nonlinear mixing of electromagnetic waves in plasmas. Intermittency in tokamak edge turbulence. Linear and nonlinear stability in resistive magnetohydrodynamics. Introduction and historical survey. Generalized action-angle coordinates for three-dimensional magnetic fields and other non-integrable Hamiltonian systems. Lyapunov stability etc. Applications to plasma diagnostics, heating, ionosphere modification and particle acceleration. Modern turbulence theory: conceptual foundations. Renormalization group in magnetohydrodynamics turbulence. Four-wave mixing and phase conjugate reflection by a plasma. Modern turbulence theory: applications. Quasilinear theory in the context of weak turbulence in plasmas. Introduction to wave-wave interactions in plasmas. Evidence and simulations of wave particle interactions in space plasmas. Experiments on the excitation of large amplitude plasma waves for ultra-relativistic particle acceleration. Plasma physics aspects of magnetospheric activity. Lower-hybrid current drive. Relativistic Fokker-Planck equation for cyclotron radiation. Stimulated scattering of large amplitude waves in the ionosphere. Parallel electric fields from magnetic reconnection. Particle acceleration in cometary environment: Comet Halley-Giotto observations. Arrest of wave collapse, transition damping and fast electron acceleration. Kinetic electrostatic structures in plasmas. Nonlinear structures in plasmas and their role in anomalous transport. Nonlinear 1d solitons for particle acceleration and FEL applications. Laboratory simulation of space and astrophysical plasmas using intense lasers. Velocity correlations in turbulent magnetoplasmas. Particle acceleration in turbulent plasmas.

**Research groups.**

**Computation course.**

The College was attended by 97 lecturers and participants (73 from developing countries).

**Title:** MINIWORKSHOP ON STRONGLY CORRELATED ELECTRON SYSTEMS V, 21 June – 9 July.

**Co-sponsors:** Fondazione IBM Italia, Consiglio Nazionale delle Ricerche (CNR), Scuola Internazionale Superiore di Studi Avanzati (SISSA), Commission of the European Communities, International Science Foundation (ISF).

**Organizers:** Professors G. Baskaran (Institute of Mathematical Sciences, Madras, India), P. Coleman (Rutgers State University, Piscataway, NJ, USA), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP) and Yu Lu (ICTP).

**Lectures:** Recent results on 1-2-3 heavy fermions s.c. Ultrasound and electromagnetic response of heavy electron superconductors. Some remarks and discussion on UPt3. Superconductivity in Fermi systems with repulsive interactions at low density limit. Models of High $T_c$ superconductors studied with computational techniques: a status report. Superconductivity and metal-insulator transitions of correlated

fermions: recent progresses from infinite-dimensions. Gauge field theory and non-Fermi liquid behaviour. Non-Fermi liquid behaviour in an over-screened Anderson model. Review of neutron scattering experiments in heavy fermions. The multi-channel Kondo scenario for heavy fermion systems. Nonlinear susceptibility on a probe of the quadrupole Kondo effects. Scaling approach to non-Fermi liquid behaviour. Two-coupled Tomonaga Luttinger chains. Strong coupling approach to correlated electron systems. Exact diagonalization. A new Wilson RG method. Checking Fermi liquid theory by numerical methods. Large-d limit for correlated electrons. Approximate self-energy functional for large D. Space-time tunnelling. Slave boson approach in strongly correlated electron systems. What is the superconducting order parameter of $UPt_3$? Studies on the antiferromagnetic superconductor $UPd_2Al_3$. Spectral properties of the 1D & 2D Hubbard model. Is there any spin liquid in the spatially anisotropic $S=^1/_2$ Heisenberg model? Spin and charge fluctuation theory of high $T_c$ oxydes. Valence fluctuations between two magnetic configurations: candidates for non-Fermi liquid behaviour.

**Discussions:** Interlayer tunnelling and non-Fermi liquid behaviour. Non-Fermi liquid behaviour in heavy fermion systems.

**Plenary seminars:** The heavy fermion enigma. Molecular pump: active transport.

From 22 to 25 June the participants in the Miniworkshop attended the lectures of the Adriatico Research Conference on strong correlation phenomena at low carrier densities.

of the Adriatico Research Conference on strong correlation phenomena at low carrier densities.

The Miniworkshop was attended by 111 lecturers and participants (45 from developing countries).

**Title:** ADRIATICO RESEARCH CONFERENCE ON STRONG CORRELATION PHENOMENA AT LOW CARRIER DENSITIES, 22 – 25 June.

**Co-sponsors:** Fondazione IBM Italia, Consiglio Nazionale delle Ricerche (CNR), Scuola Internazionale Superiore di Studi Avanzati (SISSA), Commission of the European Communities, International Science Foundation (ISF).

**Organizers:** Professors G. Aeppli (At&T Bell Laboratories, Murray Hill, NJ, USA), P. Coleman (Rutgers State University, Piscataway, NJ, USA), F. Steglich (Technische Hochschule Darmstadt, Germany), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP) and Yu Lu (ICTP).

**Lectures:** Properties of Kondo insulators. Experimental review of the metal-insulator transition. Some old and some new aspects of mixed valence. Competition between Kondo state and magnetic polaron and Wigner crystallization in low carrier density systems — Fermi surface and heavy mass. Quantum phase transitions in itinerant fermion systems. Conservation laws and correlation functions in non-Fermi liquid metals. Semiconducting ground state in the Kondo-lattice compound CeNiSn. Magnetic correlations in the Kondo insulator CeNiSn. Magnetic response of CeBiPt '343'. Unconventional charge gap formation in FeSi and CeBiPt '343'. Optical properties of doped insulators and correlated metals. Spin gap and charge gap in Kondo insulators. A new approach to the 1D Kondo insulator. Spin gaps and superconductivity in a class of cuprates. Heavy fermions in electron doped cuprates. The low carrier density heavy fermion compounds $S_{m3}T_{e4}$, $S_{m3}S_{e4}$ and $Y_{b3}A_{s4}$. Low temperature transport properties of dilute magnetic semiconductors on approaching the insulator-metal transition. Interaction effects in localization: an overview. Incommensurate spin correlations close to the metal-insulator transition in $V_{2-y}O_3$. Spectroscopy of low-dimensional metals and of heavy fermions. Magnetic excitations of high $T_c$ cuprates. Is FeSi a Kondo insulator? Systematic evolution of temperature dependent resistivity as a function of doping in $La_{2-x}Sr_xCuO_4$ and $Ba_2YCu_3O_{z-y}$. Spin fluctuations in $La_{2-x}(Sr,Ba)_xCuO_4$ across the insulator-metal transition.

The Conference was attended by 121 lecturers and participants (29 from developing countries).

**Title:** THIRD SCHOOL ON NON-ACCELERATOR PARTICLE ASTROPHYSICS, 28 June – 9 July.

**Organizers:** Professors E. Bellotti (University of Milan, Italy), G. Giacomelli (Istituto Nazionale di Fisica Nucleare, INFN, Bologna, Italy), N. Paver (University of Trieste, Italy) and J. Stone (Boston University, MA, USA).

**Lectures:** Particles and fields: the standard model. Cosmic ray physics. Report on LEP results. Introduction of solar neutrinos. Status of proton decay searches. HE gamma ray and neutrino sources. Black holes and kaon physics. The INFN programme of non-accelerator physics. Atmospheric neutrinos. Atmospheric neutrino measurements: an overview. Neutrino physics and astrophysics: problems and orders of magnitude. Extensive air shower arrays. Solar neutrino experiments: an overview. Magnetic fields in the Universe. The ICARUS Experiment. Bolometers. "Standard" cosmology. $e^+e^-$ and hadron-hadron high energy interactions. Double beta decay. Cosmological models of the early universe. Challenge problems for students. Magnetic monopoles. The MACRO Experiment at Gran Sasso (Italy). Neutrino oscillations and neutrino masses. Antimatter search with the Si/W calorimeter. Physics with multiple muons. Transition radiation detectors. Extensive air shower physics. Dark matter experiments.

**Seminars and presentations by students:** The EROS Experiment: detection of baryonic dark matter. Restrictions on very light dark matter candidates from laboratory experiments. Dibaryonic effects in neutron stars. TeV gamma emission from close binaries. Fragmentation in relativistic heavy ion collisions. W-boson and gluon condensates in the early universe. Collective annihilation of electron-positron plasma. Matter induced neutrino decay. Weak interaction rates for supernova theory. Determination of the geomagnetic external contribution by nonlinear optimization methods. Radiation-driven diskons. Towards an optimum principle in hadron-nucleus and H H scattering at high energies.

The School was attended by 77 lecturers and participants (35 from developing countries). ♦

# Calendar of Activities at ICTP

## 1993

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
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

ICTP-UNU-Microprocessor Laboratory: Third Course on basic VLSI techniques ..... 10 January – 4 February
Follow-up to the Workshop on preparation of radiomaritime master plans
for English-speaking African countries ..... 7-18 February
College on physics of archaeometry and preservation of work of art ..... 7 – 25 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 study of atmospheric interactions by remote sensing ..... 21 February – 4 March
Workshop on science and technology of thin films ..... 7 – 25 March
Workshop on fluid mechanics ..... 7 – 25 March
Ultrafast phenomena and applications (Adriatico Research Conference) ..... 8 – 11 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

**Submicron quantum dynamics (Adriatico Research Conference) ..... 14 – 17 June**
**Miniworkshop on submicron quantum dynamics ..... 20 June – 1 July**
**Miniworkshop on quantum phase transitions ..... 4 – 29 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**
**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**
**International Workshop on parallel processing and its applications in physics, chemistry and material science ..... 5 – 23 September**
**College on medical physics: imaging, instrumentation and dose-reduction techniques ..... 12 – 30 September**
**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**
**College in biophysics: experimental and theoretical aspects of biomolecules ..... 3 – 28 October**
**Workshop on variational and local methods in the study of Hamiltonian systems ..... 10 – 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**

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

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