



*This historic photograph portrays the participants in the Symposium on elementary particles, organized by the Faculty of Physics of Trieste University and held in the "Small Castle" in Miramare Park near Trieste in June 1960. It was the first time Professor Abdus Salam (4th from right) interacted with the physicists of Trieste. Among the young participants, there were a few who would become very important for the ICTP: Prof. C. Villi (centre), President of the Consortium of Physics Institutes of Trieste University which built the ICTP building; Prof. P. Budinich (6th from right), one of the founders and former Deputy Director of the ICTP, Prof. L. Bertocchi (11th from left), Deputy Director of the ICTP since 1983, Prof. G. Furlan (4th from left), Head of the Training and Research in Italian Laboratories Scheme, and Prof. D. Amati (5th from right), Director of the International School for Advanced Studies (SISSA).*

## ICTP: THIRTY YEARS AFTER

**P. Budinich**

*Emeritus Professor, International School for Advanced Studies, Trieste, Italy.  
Courtesy of Trieste International Foundation for Scientific Progress and Freedom.*

To be thirty years old for an institution like the International Centre for Theoretical Physics (ICTP) means to be in the prime of youth, when the prospects for the future and the hopes for a worthy destiny are still more important than the memory of the past.

In a relatively short time, the ICTP has gained a world-wide recognition, has built up a noteworthy capital of gratitude, and acquired a multitude of faithful friends in most countries of the world. Therefore, the hopes and prospects for a worthwhile future are well-grounded and do have concrete possibilities for becoming a reality.

However, in order to better plan for that future it is appropriate, at this stage,

to examine and understand how and why the Centre came into existence, how it operated, and what it did to acquire its high reputation: in short, to study once again its not long but intense history.

One question which is often asked is, how is it that, in 1964, the Centre was created in Trieste, in a town with hardly any tradition in the field of science at that time? As it often happens in human history, the reason lies in accidental coincidences of a series of highly improbable events.

The first was a consequence of the last world war which had left this town with a border, called at that time the "iron curtain", dangerously close to it. A border which could have easily strangled the city



INTERNATIONAL  
ATOMIC ENERGY AGENCY  
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INTERNATIONAL  
CENTRE  
FOR THEORETICAL  
PHYSICS

# NEWS FROM ICTP

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to death, cutting it off from its natural hinterland and generating poisonous nationalisms. For us at the Department of Physics of the newly born University, one of the few possible remedies to that disaster was to establish cultural links and collaborations, especially in science, which by its nature is international and does not recognize borders of any kind, with our natural neighbours, not only on our side but also behind that "curtain". And in fact, fruitful links were established with physicists from Vienna (W. Thirring), Göttingen (W. Heisenberg, K. Siemanzik), Graz (G. Urban), Padua (N. Dallaporta, A. Rostagni, C. Villi), Bologna (A. Stroffolini), as well as from Prague, Budapest, Zagreb and Ljubljana.

But that by itself would not have been sufficient; more accidental improbable events were necessary.

One of these was that in 1960, Abdus Salam, a young brilliant Pakistani physicist working in England, was in Geneva assisting the Swedish Professor S. Eklund in organizing a United Nations conference on the peaceful uses of nuclear energy. Geneva was near enough, for our meagre finances, to afford to pay for his travel expenses for joining us at one of the informal international meetings we used to have in Trieste at the *Castelletto* ("small castle") of Miramare.

Even that was not enough. It also happened that just in those years the idea of creating a new International Centre for Physics under the flag of the United Nations was circulating in the international community of physicists. The idea had a great authority since it was born in the minds of N. Bohr, A. Einstein and R. Oppenheimer after the nuclear explosions over Nagasaki and Hiroshima, and it was aimed at preventing the repetition of such calamities.

Abdus Salam, who had been in Miramare in June 1960, proposed that project, as a member of the Pakistani delegation, proposed that project, as a member of the Pakistani delegation, to the General Conference of the International Atomic Energy Agency (IAEA) in Vienna, which was held in September of the same year. And he did that with great drive indeed.

We learned casually of this initiative a few days later while I was in Rome, from E. Amaldi, who had just returned from that General Conference in Vienna.

Informal scientific meetings create spontaneous friendships. It was therefore natural for me to write immediately to Abdus Salam and to propose him to collaborate in establishing the projected institute in Trieste. For us, the banner of the United Nations would have been a blessing we did not even dare to dream of.

He answered immediately with two letters. One was cordial and friendly while the other was very formal and was to be

shown to authorities.

Authorities are sometimes clever, able to foresee the future and the general interest, and work for it. We found them both in Trieste and in Rome. Here, the first personality who became fond of the idea of helping our town which was suffering from the misfortune of the past war, was Prince Raimondo della Torre e Tasso. He had just returned to live in his Castle in Duino. He was enthusiastic at the possibility of continuing the high traditions of his family in the field of culture. His historical Castle was famous for having hosted such guests as Dante Alighieri, Franz List, Mark Twain, and Rainer Maria Rilke. He once told me: "I consider Trieste as my daughter. Bringing here an international centre for science could be an occasion for a good marriage for her, and I wish to offer her an endowment". And he donated a large piece of his land in view of the candidature of Trieste as the seat of the Centre. Then the Mayor of the city, Mario Franzil, chaired a "Town Committee" (or *Comitato Cittadino*) which submitted the candidature to the government in Rome where the proposal was immediately accepted. The candidature for Trieste was formally presented to the IAEA with the commitment of providing an appropriate building, an annual financial contribution of US\$ 200,000 for four years, a first nucleus of the library, a first core of staff (former employees of the Allied Military Government) and an international elementary school in the English language for the children of foreign scientists visiting the ICTP. Ambassador Egidio Ortona at the Foreign Ministry immediately started the diplomatic actions.

It was clear to these gentlemen that trying to constitute an international institution devoted to high culture in science in Trieste was a good investment for wresting the town from its decline and for its possible political role in the center of Europe. The coordinated actions began and, after several national and international diplomatic battles, the ICTP was inaugurated on 1 October 1964 in Trieste.

Immediately the Consortium of Physics Institutes of Trieste University was founded and provided for the first needs of the ICTP as for example the first nucleus of the library and the International Elementary School. The President of the Province, Giordano Delise, had immediately provided a wonderful building in the center of the town while the President of the *Cassa di Risparmio* Bank, Guido Sadar, and the President of the Region Friuli-Venezia Giulia, Alfredo Berzanti, provided the funds for the construction of a new building in the vicinity of the Castle of Miramare — the best location in Trieste since we wished to attract, also with the beauty of the location, the best scientists



of the world.

Were it not for all those accidental yet timely coincidences and for the moves of these people, the ICTP would not have been created in Trieste. The most probable locations could have been one of the competing prestigious candidate cities, in the following order: Copenhagen, Vienna, Dubrovnik — in other European countries, Florence or Naples in Italy. We do not know whether it would have been better or worse for the ICTP, certainly it would have been worse for Trieste!

In fact, the flag of the United Nations together with the fame and restless energy of Abdus Salam, the support of the entire international scientific community and the help from our many eminent friends in Italy worked the miracle of transforming a town, traditionally devoted to trading and to international maritime traffic, with a small but lively community of poets and writers (S. Slataper, J. Joyce, I. Svevo, U. Saba, B. Marin), into "The City of Science" as several people, perhaps with a bit of optimism, like to call it now.

What is true is that it was precisely because of the establishment of the ICTP that several new scientific initiatives and institutions, with an international flavour and reputation, were created in the area of Trieste after 1964. Examples are the International Centre for Genetic Engineering and Biotechnology (ICGEB), the International School for Advanced Studies (ISAS or SISSA), the Research Area (AR), the Synchrotron Radiation Laboratory, the Third World Academy of Sciences (TWAS), the International Centre for Science and High Technology (ICS), the United World College of the Adriatic, the Trieste International Foundation for Scientific Progress and Freedom, the Scientific Imaginary Laboratory, the International Prize Primo Rovi and others. These institutions together with those already existing like the Geophysical Observatory (OGS) and the Astronomical Observatory and, naturally, the University, build up what is sometimes called the *Trieste System*, now rather well known in Italy but even more in many parts of the world.

Such a set of renown scientific institutions, some of which were directly or indirectly generated by the ICTP but are still rather uncorrelated, are at the basis of the idea, now often seriously considered in several circles including the Italian Foreign Ministry, of proposing that it may officially become the Science Faculty of the University of the United Nations.

The motivation for this idea lies mainly in the modalities of the activities of the ICTP in these thirty years. These modalities and, especially, the ICTP's main objective which is to help developing countries to build up and maintain their own scientific

communities — the necessary pre-requisite for their social and economical emancipation — were subsequently adopted by other institutions.

This objective was not stated in 1960 when the ICTP was conceived, but it resulted from the way the Centre came into existence. In fact, when its creation was first proposed at the IAEA, the concept was that of an international scientific institute for enhancing "East-West" collaboration and oriented towards the prevention of the future use of nuclear weapons. The opposition of most of the great industrialized powers, including USA and USSR, to that project, motivated by the preoccupation of compromising their leadership in science, was contrasted through the support of some smaller countries influenced by great personalities like N. Bohr and R. Oppenheimer. After three years of difficult diplomatic fights, to which the Pakistani delegation guided by Abdus Salam gave a major contribution, that opposition was finally defeated in 1963 by the support of Italy, Austria, Sweden, Denmark and the majority of the developing countries, an almost unique case in the history of the United Nations. Because of this evolution, assistance to the Third World became the first target in the statute of the ICTP.

This contrasted concept for its creation made the first years of existence of the ICTP a real challenge. An authoritative delegate of one of the defeated great powers told us before its creation: "You wanted to have a centre for underdeveloped countries: it will remain an underdeveloped centre". We had to prove that he was wrong. And indeed we did so thanks to the prestige and the drive of Abdus Salam and to the enthusiastic support of the whole scientific community. So much so that already in 1965, after only one year of its existence, R. Oppenheimer could write: "In all the work at the Centre, of which I know, very high standards prevail. In less than a year it has become one of the leading institutions in an important, difficult and fundamental field (elementary particle physics)".\*

In our view, to be excellent in science was a necessary condition to become useful to the scientific communities in developing countries. And in fact several of the research activities performed at the ICTP rapidly rose to an international level; not only in the field of elementary particle physics but also in those of condensed matter physics, mathematical physics and earth sciences. The seminars and workshops in specialized topics, summer schools, became events which attracted the best of the international scientific community. But that was not sufficient.

\* Message from R. Oppenheimer to the 1965 Meeting of the Scientific Council of the ICTP.



We had to invent new ways and means, new instruments to cope with the tremendous problems faced by scientific communities in developing countries which were: scientific isolation, lack of support or awareness from their governments, brain drain, lack of books, scientific journals, and scientific instruments.

During those first years, we worked hard to explore several schemes to help scientists from developing countries to overcome their adversities. It was difficult work, but a rewarding one when finally we discovered that a lot could be done to help them. However we also realized that the problems of underdevelopment were huge and that even with the best of our efforts, though we might have done something in the right direction, it would have been just a drop in the ocean of difficulties faced by the largest part of humanity.

First we organized up-to-date courses, workshops and seminars on advanced topics in pure and applied physics through which thousands of young researchers and university professors from the Third World (now about 2,000 a year) could be exposed to recent developments in their respective fields of interest. While at the ICTP, they could interact with the leading personalities of the world scientific community like P.A.M. Dirac, W. Heisenberg, A. Kastler, J. Ziman, S. Lundqvist and many others, who never spared their support to our enterprise; after all, it is rewarding to do some work for the benefit of those who badly need it.

As an example, I remember the Nobel Laureate A. Kastler from France who, for a long period, used to come every second year to the ICTP and lived for several weeks in a modest hotel in Grignano, to teach laser physics to Africans, Indians and Latin Americans. He was a great physicist and a great man. Once I told him: "I am convinced that you could spend the time you dedicate to us more profitably instead of living on our meagre UN per-diem". "Oh yes," he answered, "but you know, after all, our work in scientific research at the expense of the society is a luxury, and with the years we have accumulated a huge moral debt. By coming here and offering my knowledge to those who really need it for themselves and for their countries, I pay part of my debt and when I go back to the Ecole Normale in Paris to carry out my personal research, I feel in peace with my conscience".

But we also had to devise special instruments to deal with the specific situations faced by those scientists. The main one was scientific isolation. Many eminent scientists are born in developing countries, as a glance at the list of Nobel Laureates in the last 50 years will show; Abdus Salam himself is an

example. To those people, the problem of scientific isolation arises very early in their life: they must either renounce their scientific career or emigrate, which represents an incommensurable loss to their home country. We had to find remedies and I think we found some. One is the Associateship Scheme. Once a promising young physicist working in a developing country was identified (usually after a visit at the ICTP) he was appointed as an Associate Member by the Director General of the IAEA. This status enabled him to pay three research visits to the ICTP in a number of years (three in the first phase of the existence of the ICTP and six later on). He could choose both the duration (not more than 3 months) and the timing of the visits. This arrangement was a guarantee for him to maintain close contacts with the international scientific community, which is necessary for a profitable scientific work. The only condition for maintaining this privilege was that for the rest of his time he would remain to carry out research and teach in his home country. There are now several examples of ICTP Associates who have refused good positions in advanced countries, and even of some scientists occupying prestigious positions in industrialized countries who returned to their home countries in the developing world, once they were appointed as ICTP Associates. The ICTP now has 450 Associates from about 70 developing countries. However, there are more than 1,000 deserving scientists on the waiting list of the ICTP.

The impact of the Associateship scheme in several developing countries, especially in the East and Far East, is now visible. Those working in science know very well that the presence of an outstanding scientist in a country for several years is often sufficient to raise the level of the whole scientific community of that country (the presence of Enrico Fermi in Italy from 1923 to 1938 is a good example). But for developing countries there is also another aspect of the scheme which was quite unexpected when it was first launched. The title of ICTP-Associate conferred by the IAEA has, in time, become a title of prestige in the countries of the recipients. It often happened that ICTP-Associates were promoted in the administrative careers in their countries; several former ICTP-Associates are now Faculty Deans, Presidents of research councils, Heads of atomic energy commissions and even Ministers of Science, for the final benefit of the country; since they are good scientists they will certainly be able to properly plan the scientific policy of the country.

This could be considered as one of the main results of the ICTP's action in favour of the developing world.

Supporting the rare gifted scientists who could be identified



in developing countries was certainly an important step. However, we had to open the door of the ICTP also to the younger scientists we did not know yet. The scheme of Federated Institutes was invented for that purpose. In its framework, several national scientific institutes in the developing world were granted the title of ICTP Federated Institute which enabled their junior scientists to take part in the activities of the ICTP. Each Institute was entitled to a number of days ranging from 40 to 180. Living expenses were borne by the ICTP while travel expenses were normally to be supported by the Federated Institute. The ICTP now counts 300 Federated Institutes in 78 developing countries. Some of them have developed during the last decades to such an extent that they have been promoted to the status of ICTP-Affiliated Centres which implies an annual financial support from and special links with the ICTP, and the commitment of these Centres to carry out in their regions the functions of assistance and promotion which the ICTP is performing globally.

The experience gained at the ICTP in the course of these thirty years has taught us that a lot can be done in the field of science for helping developing countries to acquire the necessary instruments for their emancipation. But it has also clearly shown that the size of the problems is so dramatically large that much more should be done to fill the dangerously increasing gap between the industrialized and the developing world, especially in Africa and some countries of Latin America. The ICTP experience may be considered only as a good example of what could be done and as a pilot plant for future effective action in the field of science for the benefit of the developing world.

The experience of thirty years of operation at the ICTP naturally suggests the strategy of further possible developments both locally at the ICTP and outside it.

Locally, there are two main institutions which could contribute in expanding or enhancing the work already started at the ICTP. These are the Third World Academy of Sciences (TWAS) and the International Center for Science and Technology (ICS). The latter was created as a project of the United Nations Industrial Development Organization (UNIDO) in order to expand the field of action from theoretical physics to pure and applied experimental physics. In future years, this institution could perform excellent work, complementary to that already done at the ICTP, specially if appropriately supported by other experimental institutions like the Experimental Geophysics Observatory (OGS), the Synchrotron Radiation Laboratory (Elettra), and the Research Area.

The Third World Academy of Sciences (TWAS) was created in 1983 at the Castle of Duino and officially inaugurated at the

ICTP in 1985, in the presence of the UN Secretary General J. Perez de Cuellar. Its first President was Abdus Salam, and it includes among its Fellows the most prestigious scientists from the developing world. Its great potentiality has not yet been fully exploited. Several valuable projects of TWAS have not yet started. I wish to mention just one of them: that of providing each developing country with at least one complete scientific library. It is a shame that the advanced world has not yet found the appropriate means to set it in operation. As an example, the industrialized countries of the northern shore of the Mediterranean Sea (Spain, France and Italy) should start a pilot project in favour of developing countries on the Eastern and Southern coast.

Future action in fields of science other than physics which are of great interest for the developing world should also be considered. To this end, an institution created in 1986 on the model of the ICTP already exists in Trieste: it is the International Centre for Genetic Engineering and Biotechnology (ICGEB). Unlike the ICTP, ICGEB has a twin Institute in India in New Delhi plus 20 affiliated institutes in the Third World.

As yet, the ICTP and other more recent initiatives like ICS, TWAS and ICGEB which all share the objective of helping the developing world, have worked relatively independently though a certain measure of collaboration must be acknowledged. In the future, their activities should be better coordinated in order to enhance their efficiency in relation to their objectives and this could be attained by inserting these in a single structure under the aegis of the United Nations. An example of such a structure could be the already mentioned Faculty of Sciences of the United Nations University.

After thirty years of operation, the ICTP, through its Associates Members and Federated and Affiliated Institutes, could now reinforce its action by establishing a network of Science Centres in the Third World directed at reinforcing South-South collaboration.

The benefit which the ICTP has brought to the scientific communities in several developing countries is now evident and can be easily documented. In some countries of the Far East in particular, the action of the ICTP has contributed not only to the visible development of their own scientific community but also certainly contributed to their recent social and economic emancipation.

The influence of the ICTP was especially fruitful in establishing scientific and cultural collaborations with the countries of Central Europe, several of which were, for a long time, on the list of those officially classified by the UN as



developing. As such, we were then authorized to extend to them the benefit of Associateship and Federated Institute schemes. Some of these countries have a high tradition of studies in mathematics and theoretical physics and therefore the cultural collaborations were beneficial both to them and to the ICTP. Now that the "iron curtain" has fortunately disappeared, these cultural collaborations should be enhanced, also as a warranty against the newly born nationalism plaguing this part of Europe.

Italy, the host country of the ICTP, and Trieste in particular, have also benefited from the existence of the ICTP. The thousands of scientists from the Third World who have spent some time at the ICTP and have thus been helped in their scientific careers, have established links of friendship and gratitude with Trieste and Italy which, as they very well know, have substantially supported the ICTP activity. Several Associates used to tell me that they consider themselves as "invisible ambassadors" of good will for Italy. Considering that several of those scientists eventually occupy positions of administrative responsibility in their countries, this gratitude and friendship are translated into good will and good links of Italy — not only cultural — with those countries.

This aspect of the ICTP enterprise should be systematically studied, made known and publicized not only in Italy but also in other industrialized countries because the needs of developing countries are immense, their gap with respect to the industrialized world is steadily increasing and can only lead to a disaster for the world as a whole. To work for the emancipation of the Third World, for which scientific knowledge is a necessary ingredient, should not only constitute a moral duty for the rich countries; in the long range, it is also an action which will serve their own interests. The modality of the ICTP should be studied, improved and initiated by other countries, not only in the field of physics, but also in other fields of science.

The ICTP should constitute a good example to be emulated, of what to do and how to do it, for the benefit of the poor and, eventually, also for the rich countries. This is the best wish one may formulate for the future of the ICTP.

In this contribution, I have gone through the stages which have made Trieste what it is today: a city where scientists from all over the world, and particularly from the developing countries, can work together in one or another scientific institution and return home with an increased capital of knowledge for the benefit of their own society. I also have expressed my wishes and my thoughts on what remains to be done for the Trieste enterprise to continue to flourish. At this point, I wish to pay a tribute to Abdus Salam, President of the ICTP, who left the

directorship of the Centre in January 1994. To work for thirty years in this enterprise produced between us a deep friendship. Without his strong drive, his intelligence, his determination, his international reputation, but little of what I have narrated would have seen the light of the day. We thank him for all he did for science and for the scientists from the Third World, and wish him a better health and success in his new function.

#### *Biodata*

*Professor Paolo Budinich, born in Velj Losinj (then Austria, now Croatia) in 1916, is one of the people who helped to bring the ICTP to Trieste. After his studies at the Scuola Normale Superiore of Pisa (Italy), he was appointed as Full Professor of Theoretical Physics at the University of Trieste in 1954. In addition to presiding over Committees and Consortia which lead to the creation of the ICTP and contributed to its functioning, Prof. Budinich founded and directed the International School for Advanced Studies (SISSA), the Interdisciplinary Laboratory for Natural and Humanistic Sciences and the Laboratorio dell'Immagine Scientifico.*

## SCIENCE FOR PEACE PRIZE TO ABDUS SALAM AND CLAUDIO VILLI

Professor Abdus Salam, President of ICTP and TWAS, and Professor C. Villi, President of the Consortium of the Physics Institutes of Trieste University, are two of the five recipients of the Science for Peace Prize instituted by the Region of Sicily (Italy). The other recipients are Nobel Laureates Professor S.D. Drell and M. Gell-Mann, and Prof. H.W. Kendall.

While Professor Abdus Salam needs no introduction in the developing countries, the role of C. Villi, Professor of Theoretical Physics at the University of Padua, is perhaps less well known. Prof. C. Villi was the initiator of the Courses on Nuclear Physics at the ICTP. He was a Senator of the Italian Republic for sometime and, in this position, helped the ICTP considerably. The Consortium he presides over, is the local body which has provided, among others, the building and furniture of the ICTP.

The recipients were selected through a poll among the 10,000 signatories of the Erice Manifesto, organized under the auspices of the Centre for Scientific Culture "Ettore Majorana" presided over by Prof. A. Zichichi. The Prizes were presented to the recipients on 6 November 1994 in Erice.

The ICTP and TWAS congratulate Professor Abdus Salam for this new and important award.

*A.M. Hamende*





DIRAC MEDAL  
OF THE ICTP  
1994

## PROF. FRANK WILCZEK

Prof. Frank Wilczek received the Dirac Medal of the ICTP 1994 during a ceremony which was held in the Main Lecture Hall of the institution on 4 October 1994. In the presence of Prof. L. Bertocchi, Deputy Director and Acting Director of the ICTP, Dr. J. Strathdee read out the citation, while Prof. L. Maiani, President of the Italian National Institute for Nuclear Physics, handed the Medal to the winner.

Professor Frank Wilczek was honoured for his contributions to the development of theoretical physics. In 1973 he was one of the discoverers of the phenomenon of "asymptotic freedom" in non-Abelian gauge theories. This fundamental observation — that the effective interaction at short distances becomes weak, even in strongly interacting systems — led to the development of a realistic model for hadron physics. In particular, it provided an explanation of scaling and its logarithmic corrections in hadron physics at high energies. Asymptotic freedom has become a cornerstone of the Standard Model of elementary particles and of the theoretical extensions of this model that aim to unify the fundamental forces.

Wilczek has also made important contributions to the study of particle-like excitations in 2-dimensional systems that obey "fractional statistics". These particles, for which he coined the name "anyons", are now recognized to have a role in phenomena such as the fractional quantum Hall effect.

### ERRATA

*The Dirac Lecture by Professor Peter van Nieuwenhuizen which was published in News from ICTP No. 78 contains an erroneous 3D symbol in every formula and equation, due to the electronic transmission of the file.*

*We apologize to Prof. van Nieuwenhuizen and our readers for any inconvenience that his may have caused.*



*Prof. F. Wilczek was awarded the Dirac Medal of the ICTP 1994 during the Conference on Recent Developments in the Phenomenology of Particle Physics (3-7 October 1994). The title of his lecture was "Two kinds of asymptotic freedom".*

Professor F. Wilczek was born in New York in 1951. In 1974 he obtained his Ph.D. in physics at the University of Princeton. From 1974 to 1981, he held different positions at the University of Princeton where he became Professor in 1980. From 1980 to 1988 he was Professor at the University of California at Santa Barbara and Member of the Institute for Theoretical Physics at the same University. From 1986 to 1988 he was appointed Regent's Fellow at the Smithsonian Astrophysical Observatory. From 1987 to 1988 he was Visiting Professor at Harvard University. In 1989, he was appointed Professor at the School of Natural Sciences at the Institute for Advanced Study at Princeton.

Professor Wilczek is member of prestigious societies and editor of many scientific journals. In 1986 he was awarded the J.J. Sakurai Prize of the American Physical Society.

The Dirac Medals were instituted in 1985 by the International Centre for Theoretical Physics (Trieste, Italy) to honour one of the greatest physicists of this century and a staunch friend of the institution. They are awarded on P.A.M. Dirac's birthday — 8th August — for contributions to theoretical physics and mathematics. The Selection Committee included Professors N. Cabibbo, S. Lundqvist, Y. Nambu, S. Weinberg, E. Witten and Abdus Salam.

The Dirac Medals of the ICTP are not awarded to Nobel Laureates or Wolf Foundation Prize winners.



## SATYEN BOSE IN DHAKA

A. M. Harun ar Rashid,  
University of Dhaka, Bangladesh.

*The Bangladesh Physical Society held the International Symposium on the Hundredth Birth Anniversary of Satyen Bose, which was partly sponsored by the ICTP, from 8 to 9 March 1995. We publish hereunder the speech delivered on that occasion by Professor A.M. Harun ar Rashid, Senior Associate of the ICTP.*

Satyen Bose came to Dhaka sometime in May or June in 1921, and thereafter the name of this old frontier town of the Mughal Empire did not remain confined in the pages of history. It made its glorious entrance in the arena of Twentieth Century Science. It was in that year that the University of Dhaka was established by the Government of India in the teeth of stiff opposition from a powerful section of people in Calcutta who felt that this would lead to an "internal division of Bengal". On the contrary, it is now clear that the establishment of the University of Dhaka had unleashed powerful forces of Bengali nationalism leading ultimately to the creation of a Sovereign and Independent state. Satyen Bose was one of the first torchbearers of this Renaissance.

I met Bose during the celebrations on the occasion of his eightieth birthday in 1974. Sitting by his side on a sofa on the Raj Bhaban at Calcutta, I asked him many questions, and I found that his mind was as sharp as ever. I asked him, "How did you come to form such a clear idea about the logical inconsistency in the derivation by Max Planck of his radiation law?". He must have answered this particular question many times in his life, but I was not prepared for the answer that he gave me. He smiled and said simply, "You see, I was teaching radiation theory in your Department."

The discovery of the equation which made Planck world-famous in 1900 and gave birth to the Quantum Theory of Radiation contained in the derivation a serious logical flaw. Many people were aware about this logical inconsistency, people like P. Debye, A. Einstein, E. Schrödinger, W. Pauli and many other creators of the Quantum Theory. But it is the great good fortune of Bengal that this inconsistency was removed by a Bengali young Professor sitting in his remote room in the Department of Physics of the newly-established University of Dhaka.

In the derivation of the Planck equation, it is necessary to

determine the thermal probability of a quantum state analogous to the same quantity for a classical state calculated by Boltzmann. For this part of the calculation, Bose, in his derivation, had to make extensive use of combinatorics. I asked him, "How did you know so much combinatorics?" He replied, "I was a student of mathematics and I had learned a lot from Prasanta Mahalanabis." P.C. Mahalanabis was a great statistician and Bose thus recognized his debt of gratitude to him.

But clearly mere knowledge of combinatorics would not have sufficed for the derivation of quantum statistics. Bose in fact had introduced a novel concept which is of far-reaching importance in quantum theory. He was indeed the first person to recognize and to talk, although implicitly, about the identity of quantum particles.

One of the essential points in the derivation of Planck's law by Bose is the clear recognition for the first time that quantum particles of radiation called photons are completely indistinguishable from each other. Prior to Bose's work, we were familiar with the fact that classical objects had each an identity of its own. Each classical object can in principle be given as it were a name or a label which will distinguish it from all others. Precisely this was no longer possible in the quantum realm according to Bose, and this indeed was a very novel concept. The collective behaviour of the quantum particles is determined by treating them as identical objects, and this very idea of Bose is of such profound significance that Pais has rightly remarked, "...One can say that it is one of the few pillars of quantum theory". There is no doubt that this vital concept is the original contribution of Bose and it is for this reason that Einstein thought so highly about Bose's paper. It is gratifying to see that physics has accorded Bose the honor that is rightfully due to him by christening as bosons all elementary particles which obey Bose's statistics.

To understand the Quantum Theory, we must consider a black body kept at a definite temperature. The chief feature of such a body is that it contains radiations of all frequencies. We can experimentally measure the energy density as a function of frequency, and it is found that classical physics completely fails to explain observed facts. The experimental distribution of energy according to frequency has a very characteristic shape; it starts from zero, rises to a maximum and then falls to zero. This smooth behavior can not be explained by the classical theory of Maxwell because classical electromagnetic theory demands that energy must increase as the frequency of radiation increases. Clearly, this is intolerable since that would mean that in course of time the whole universe would be filled up with



very high energy radiation, thus making even the existence of life impossible.

Max Planck saved the situation by an inspired guess producing first an empirical equation which correctly represented the experimental distribution of radiation energy. But he did not stop there. He tried hard to find a basis for his distribution law, and in the end he came to the conclusion that he could derive his equation only if he regarded the process of emission and absorption of radiation as discontinuous. Subsequently, Einstein showed that we must regard radiation itself as composed of discrete particles. Light is not merely a wave phenomenon as we had believed with Maxwell for so long, it also consists of minute particles called photons and each photon is simply a quantum or bundle of energy which is an integral multiple of the frequency. Thus was born the Planck-Einstein Quantum Theory of Radiation.

Planck was forced to give up well-established classical physics and the revolution that he brought about was all pervading. It was therefore natural that the derivation of his equation would come under close scrutiny because the derivation indeed contained an inconsistency which did not escape the careful eyes of Bose when he was teaching the subject in Dhaka.

The difficulty is that Planck's equation is composed of two parts. One part gives the energy of the radiation. To obtain this part, Planck introduced his novel concept that radiation is discrete, i.e. it consists of energy quanta. But the second part of the equation gives that total number of proper or stationary vibrations in the closed body. This number is calculated from Maxwell's theory which is actually a wave theory. There is therefore a strange admixture of the particle concept (photon) and the wave concept (stationary vibrations). No wonder Bose was dissatisfied with this situation.

Rose found the solution by an inspired guess. He assumed

was dissatisfied with this situation. Bose found the solution by an inspired guess. He assumed that the smallest volume of the phase-space of coordinates and momenta was not zero but  $h^3$ , where  $h$  is Planck's constant. We now know that this idea of the smallest volume of phase space for quantum particles is intimately connected with Heisenberg's Uncertainty Principle. But for Bose it was simply a bold conjecture.

In June 1924, Bose sent his paper to Einstein, saying "Respected Sir, I have ventured to send you the accompanying article for your perusal. I am anxious to know what you think of it. You will see that I have ventured to deduce the coefficient  $8\pi\nu^2/c^3$  in Planck's equation assuming that the smallest phase-space element is  $h^3$ . I can not translate the paper in German since I do not know the language well enough. If you think that

the paper is publishable, I shall be grateful if you would arrange for its publication in the Zeitschrift f. Physik. I have not hesitated to make this request to you even though I am totally unknown to you. Since we have learnt from your writings, we are all your students. I do not know if you will remember that somebody from Calcutta asked your permission to translate into English all your papers on Relativity. You gave your permission. I am that person who translated your papers on General Relativity."

In a postcard dated July 2 of 1924, Einstein replied in German "Dear Colleague, I have translated your paper and have sent it to the Zeitschrift für Physik for publication. It appears to be an important scientific contribution and it has pleased me very much. Your comment on my work is not quite correct because one does not need wave theory for Wien's displacement equation and one also does not require Bohr's correspondence principle at all. But that does not matter. You are the first person to derive the factor from quantum theory, although your argument about the polarization factor 2 is not quite strong. It is certainly a beautiful scientific work. With friendly greetings." His postcard is preserved in the archives of the University of Dhaka.

Einstein was probably the only person in the world at the time who could understand the real significance of Bose's work. Indeed Bose had also sent his paper to the Phil. Mag. but it was turned down after six months. Einstein immediately translated the paper, got it published in Zeit. f. Phys. with the remark that Bose's derivation was an important advance. He lost no time in applying Bose's method to determine the equation of state for an ideal quantum gas of material particles, thus predicting the unique phenomenon of Bose-Einstein condensation.

It is amusing to recollect that Bose himself did not realize at first the singular importance of his work. Many years later, he wrote, "I had no idea that what I had done was really new."

When Bose met Einstein in Berlin in November 1925, he found

he wrote, "I had no idea that what I had done was really new." When Bose met Einstein in Berlin in November 1925, he found Einstein very excited about the new quantum mechanics which had just then been discovered by Heisenberg, Schrödinger, Dirac, Born, Jordan and others. Einstein asked him to apply the new mechanics to discover "the actual import" of the Bose-Einstein statistics. But it was not given to Bose to do this piece of work since he was presumably not keeping himself abreast with the progress of quantum mechanics. For some strange reasons, he was doing some experimental work first at Paris and then at Berlin. It is possible that he felt that back in Dhaka, where he would be required to organize experimental facilities in the newly-created Department. This he did very well, making his Department well-known throughout the subcontinent. But

*continued on Page 13*



## PRIMO ROVIS PRIZE 1994 TO ASSOCIATION DES CHERCHEURS SENEGALAIS

The Trieste International Foundation for Scientific Progress and Freedom awarded its "Primo Rovis Prize 1994" to the *Association des Chercheurs Sénégalais* (Association of Senegal's Researchers).

The award ceremony took place in Trieste at Miela Theatre on 21 November 1994, within the framework of the scientific week on "Encounters in Science and Science Fiction".

The generosity of the Foundation's Member Primo Rovis, a businessman from Trieste, has enabled the Foundation to award this yearly Prize for contributions to dissemination of scientific and technological culture. The Foundation is presided over by Professor Abdus Salam who is also Chairman of the Selection Committee.

The Prize amounts to US\$ 20,000 per year and is meant to be a token of the role which Trieste is playing in Italy and the world in the field of scientific culture.

We publish below some excerpts from the acceptance speech by Dr. Diafara Touré, President of the Scientists' Association of Senegal.

"The Association is proud of receiving the prestigious international Prize. My pleasure is made greater by the fact that an African association for the first time is awarded the Prize by the Foundation. Let me thank you wholeheartedly for your selection which honours not only our Association but also the whole scientific community of both Senegal and Africa. (...)

The role of science and technology in the development of society is a recognized fact. It is well known that technical innovation and scientific knowledge is at the basis of the development of Western countries.

Africa allots a mere 0,34% of NGP to research, while on average France allots 2,2%, USA 2,6% and Japan 5%. Nearly 70% of the resources available in Africa comes from foreign aid. In Africa, more than anywhere else, research depends on the will of managers and on the political and economic stability of nations. For these reasons, dissemination of science — which is necessary — runs into hindrances which are more difficult to overcome than they are in the rest of the world.

This situation results in a forced relinquishment of scientific research. This has grave consequences on development at the

social and economic level.

In this difficult context, the will was needed to join efforts and accept the challenge of scientific and technological development of Senegal.

ACS was founded on 7 April 1982 in Dakar, where it has its headquarters. It is a non-political, non-profit making association. It has over 400 members in every field of interest.

The main objectives of the Association are:

- to identify the scientific competence of the various national institutions and promote collaboration among them;
- to stimulate the mobilization of a dynamic scientific community around specific development programmes which are related to scientific research, dissemination, information and education;
- to let scientists have a more active and determining role in the quest for solutions of specific development problems.

ACS collaborates with all scientific institutions both at home and abroad, and has relations with both the public and private sector. At the international level, we act so as to close the gap between North and South, but also and in particular to promote cooperation between South and South, through common research programmes.

ACS is currently involved in three major projects which were launched by the Government of Senegal for the promotion of scientific culture and education in the country:

1. The biennial exhibition of science and technology which is commonly called AFRISTECH. Its second edition will be held in Dakar from 11 to 16 December 1995 and shall be on "Science, Technological Innovation and African Regional Integration".
2. The TECHNOPOLE Project in Dakar, which is aimed at developing networks of technological innovation and at liberalizing universities and research centres through joint efforts with the business sector, in order to convince more and more business persons in all the regions and in the whole country, of the importance of scientific & technological research.
3. To create a science village in Dakar for the dissemination, among the people and in particular the young generation, of scientific and technological culture which is necessary for development and economic progress.

(...) The present global situation demands a multiplication of such initiatives for progress, peace, freedom and science at the service of mankind."

(Translated into English by A. Triolo)





ICTP PRIZE  
1994

## PROF. CHAO-JIANG XU

The 1994 ICTP Prize in the fields of Mathematics, Nuclear Physics, Plasma Physics and other fields of Physics, in honour of Sir Michael Atiyah, was awarded to Dr. Chao-Jiang Xu from Wuhan University, P.R. China.

The award ceremony took place in the Main Lecture Hall of the ICTP on Tuesday, 18 October 1994. Prof. M.S. Narasimhan, Head of the Mathematics Research Group at ICTP, read out the citation as well as a message from Sir Michael Atiyah who could not be present at the ceremony. In his message, Sir Michael Atiyah said, "It is important for all of us that Chinese mathematics and science should flourish and improve its link with the rest of the world, and Dr. Chao-Jiang Xu has helped in this process".

Professor Chao-Jiang Xu has been honoured "for his contributions to nonlinear sub-elliptic problems, symbolic calculus of sub-elliptic operators and diffraction problems for nonlinear waves. He succeeded in establishing the existence and regularity of solutions for highly degenerate quasi-linear sub-elliptic partial differential equations. He developed a theory of non-homogeneous symbolic calculus."

The award was handed over to Dr. Chao-Jiang Xu by the Acting Director of the ICTP, Professor Luciano Bertocchi. Dr. Chao-Jiang Xu then gave a lecture on his scientific work. Dr. Bertocchi, Acting Director of the ICTP, Professor Luciano Bertocchi. Dr. Chao-Jiang Xu then gave a lecture on his scientific work.



Dr. Chao-Jiang Xu receiving the medal of the ICTP Prize 1994 from the Acting Director of the ICTP, Professor Luciano Bertocchi.

## OBITUARIES

### Professor Carlos Aragone

Senior Associate Member of ICTP,  
a distinguished Latin American Physicist



Professor Carlos Aragone chairing a session that took place during Professor Abdus Salam's visit to Simon Bolivar University (Caracas, Venezuela) in January 1980.

Carlos Aragone, Full Professor at the Department of Physics, Simon Bolivar University, Caracas, Venezuela, from 1972-1994, died on 4th October 1994 aged 57. He was born in Montevideo, Uruguay, in May 1937. He was President of the General Council of the Latin American Center for Physics (CLAF), and Acting Director of the Center for Astronomical Research in Mérida, Venezuela.

Carlos Aragone was a physicist of uncommon achievements including the depth of his researches in the force of gravitation. In particular we wish to recall work on the light-front gauge in General Relativity, Strong Gravity, classical and quantum General Relativity, Supersymmetry, Supergravity, and 2+1 Anyonic Physics. In addition, Aragone made significant contributions in Quantum Optics, with particular emphasis on intelligent-spin states (i.e., coherent angular-momentum states).

Other significant contributions included a key role played in the organization of scientific meetings of considerable regional impact, mainly the Latin American Symposium on Relativity and Gravitation (SILARG), which has met regularly for over two decades. This has been the main activity in that field of research in Latin America since the first meeting that took place in Montevideo in October 1972; the initiation and eventual success of this activity was mainly due to Aragone's enthusiasm and leadership.

Another major area in which Aragone played a vital role was the promotion of science amongst many generations of Latin American physicists who came into contact with him. A



typical mechanism for this purpose was his persistent care in maintaining a specialized permanent seminar in theoretical physics, which soon became a central forum for the discussion of current research topics in theoretical physics for many physicists.

He graduated in 1967 at the University of Rome with the "Cum Laude" Award under the supervision of Professor C. Cattaneo. His long association with ICTP began in 1970 and subsequent visits were possible first under the Associate Membership scheme and later in his condition of Senior Associate Member. Aragone was also a visitor at the Brandeis University where he collaborated with Professor Stanley Deser.

Amongst his various visiting professorships abroad, we may recall those at the Institut Henri Poincaré in Paris, CERN in Geneva, Centro de Estudios Nucleares, Mexico, the University of Buenos Aires and the Federal University of Rio de Janeiro. He became a Venezuelan citizen in 1977.

One of us (JCF) has pleasant memories of our early scientific collaboration at this Centre in 1971 when we both were in our first visit as Associate Members. All of us that were fortunate enough to have known, worked and personally interacted with Carlos feel that his absence is a loss for the scientific community that will be very difficult to overcome.

*Julian Chela-Flores*

*Isbelia Martin-Hernandez*

*Alvaro Restuccia*

## ***Professor Cyril Ponnampерuma***

*Courtesy of TWAS Newsletter*

Cyril Ponnampерuma died of cardiac arrest on 20 December 1994 at Washington Adventist Hospital at the age of 71. He was a University of Maryland Professor Emeritus of Chemistry and Biochemistry. He was the author of more than 400 articles and wrote or edited 17 books on chemical evolution and the origins of life. At the time of his death, he was President of the Third World Foundation of North America, a Fellow of the Third World Academy of Sciences (TWAS) and a Member of its Council. He had served as Vice-President of the Third World Network of Scientific Organizations (TWNSO) and as Chairman of its Global Frontiers of Science Committee.

Cyril Ponnampерuma was born on 16 October 1923 in Ceylon, now Sri Lanka, and went to the USA in 1959. At the time of his death he was living in Washington, having become a naturalized American citizen in 1967. Despite the long period of residence in the United States, Ponnampерuma was influential in his country of origin, as founder and first Director of the Institute of Fundamental Studies from 1984 till 1991, which has played an important role in his native country's cultural and academic life. Since 1984 he had been science advisor to the Sri Lankan presidents, and had chaired the National Science Planning Commission. The President of Sri Lanka awarded



*Professor Luciano Bertocchi, Deputy Director and Acting Director of the ICTP, awarded a plaque to Professor Cyril Ponnampерuma on the occasion of his 70th birthday.*



him the *Vidya Jothi* (Luminary of Science) Medal for his services to science and the country.

In 1959 he was awarded a B.Sc. (Honours) degree in chemistry at Birkbeck College, University of London, where he was influenced by J.D. Bernal, the noted crystallographer, who in 1949 published a seminal paper on the origin of life. Ponnampereuma received a doctorate in chemistry from the University of California at Berkeley in 1962, where he came in contact with the Nobel Laureate Melvin Calvin. This led to a series of papers on the synthesis of DNA components. He was awarded a National Academy of Sciences Research Fellowship with the National Aeronautics and Space Administration (NASA) in 1962. The following year, he joined the Exobiology Division of NASA. He became principal organic analysis investigator for the Apollo project and also worked on the Viking and Voyager programmes. He left NASA to join the Maryland faculty. Ponnampereuma played a major role in NASA's experiments for detecting life on Mars. His analysis of meteorites showed that the basic chemicals of life were not confined to the earth. In the analysis of the meteorite that fell in Murchison, Australia, in 1969, he and his co-workers provided evidence for extraterrestrial amino acids and hydrocarbons.

In 1971, he joined the Maryland faculty as a chemistry professor and head of its laboratory of chemical evolution, which he directed until his death. He was given the title of Distinguished Professor in 1978 and was presented with the University's Distinguished International Science Award in 1991 for an outstanding career combined with extraordinary services to the international community. For similar reasons France had conferred on him the title of *Chevalier des Lettres et des Artes* (for promoting international understanding).

He played a leading role in the International Society for the Study of the Origin of Life (ISSOL) from 1977 till 1986, including a three-year period as its President. He was Editor-in-Chief of the journal *Origins of Life* for nine years. Awards received include the first Alexander Ivanovich Oparin Medal granted by ISSOL at its triennial meetings for the best "sustained scientific research program" in the origin of life field (in 1980), and the first-ever Harold Urey Prize given by the Russian Academy of Creative Arts in 1993.

He had recently been named to head the University of Maryland's new North-South Center for Sustainable Development. He served as President of the Third World Foundation in Washington and was a Foreign Fellow of the Indian National Science Academy, a Fellow of TWAS, and Fellow of the Pontifical Academy of Sciences in the Vatican,

where he had been received last October by His Holiness Pope John Paul II.

Since 1990, Ponnampereuma was closely associated with the International Centre for Theoretical Physics (ICTP). He made a lasting world-wide contribution from his efforts in Trieste, driven by his belief, shared by Professor Abdus Salam, that North-South cooperation in science and technology was of vital importance. He interacted with Salam in the research on the chirality of amino acids regarded as molecular fossils of the origin of life, and tested some of these new ideas in his own laboratory of chemical evolution.

The collaboration with Salam began a longer association with ICTP in the form of a series of four conferences on chemical evolution and the origin of life, held since 1992. He left us while the Fourth Trieste Conference on Chemical Evolution, scheduled to take place in September 1995, was being planned: the meeting will be a Memorial Conference in his honour.

We are left with the very warm and pleasant memories of the 1993 Second Trieste Conference on Chemical Evolution, in which, accompanied by his wife Valli, we celebrated his 70th birthday, and almost four decades of a productive scientific career, with the participation of a large group of his former students, closest collaborators and colleagues from all over the world. Those of us who were privileged enough to know and work with him will miss Cyril's friendship, wisdom, and perennial willingness to collaborate generously for the benefit of others, who unlike him, did not have the singular opportunity to have lived through the most exciting time in which the origin-of-life-studies grew into a mature discipline, a process in which he played a significant role.

Julian Chela-Flores

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## Satyen Bose in Dhaka

continued from Page 9

he could not contribute to quantum physics any more.

This I think was a great tragedy. It was Dirac who finally solved the problem posed by Einstein. The solution simply is that the wave function of a quantum state can only be symmetric or antisymmetric in the interchange of a pair of particles and these two possibilities give rise to two different quantum statistics. If the wave-function is symmetric, the particles obey Bose-Einstein statistics and if it is antisymmetric, they obey Fermi-Dirac statistics. The particles which obey Bose-Einstein statistics are called bosons and those obeying Fermi-Dirac statistics are called fermions. Thus Satyen Bose has forever become an integral part of Physics.



# ACTIVITIES AT ICTP

## OCTOBER '94 – MARCH '95



**Title:** COLLEGE IN BIOPHYSICS: EXPERIMENTAL AND THEORETICAL ASPECTS OF BIOMOLECULES, 26 September – 14 October 1994.

**Co-sponsors:** National Science Foundation (USA).

**Organizers:** Professors H.A. Farach (University of South Carolina, Columbia, USA), S. Mascarenhas (Empresa Brasileira de Pesquisa Agropecuaria, EMBRAPA, São Carlos, Brazil) and J.N. Onuchic (University of California at San Diego, La Jolla, CA, USA).

**Report:** The College reached its objectives, namely to cover important current aspects in both experimental and theoretical aspects of the macromolecules of life. The topics were covered by 13 lecturers coming from Brazil, Denmark, Germany, Italy, Switzerland, United Kingdom, United States of America and Venezuela.

There was a poster session on Wednesday 5 October; here the participants had the opportunity to present results they had obtained in their own institutions.

There were 50 carefully selected participants with a broad background and as follows:

- (i) Academies of Science.
- (ii) Centre of Scientific Research, Advance Technology.
- (iii) Departments of Applied Microbiology, Biochemistry, Biology, Biophysics, Biotechnology, Chemistry, Mathematics, Nuclear Physics, Pharmacy, Physics, Physical Chemistry.
- (iv) Institutes of Applied Mathematics, Atomic Physics, Crystallography, Enzymology, Isotopic and Molecular Technology, Nuclear Research Centres, Nuclear Science and Ophthalmology.

The geographical distribution of the 35 countries of origin was the following:

- Africa: Ghana, Nigeria, Sudan, P.R. Congo, Kenya, Uganda.  
 Arab Region: Egypt, Iran, Syrian Arab Republic.  
 Asia: Bangladesh, India, Nepal, Pakistan, P.R. China.  
 Latin America: Argentina, Brazil, Cuba, Mexico, Peru, Venezuela.  
 European Union: Italy.  
 Non European Union: Albania, Azerbaijan, Bosnia and Herzegovina, Croatia, Hungary, Romania, Russia, Turkey, Ukraine.

	No. of Countries	No. of Participants
Africa	6	10
Arab Region	4	4
Asia	6	10
Latin America	6	15
European Union	1	2
Non European Union	8	10
Total	31	51

The main subjects discussed by the invited speakers during the College were divided as follows:

- Models of the Plasma Membrane.
- Electron Transfer in Proteins and Other Related Biomolecules.
- Experimental Techniques in Protein Structure (crystallography and nuclear magnetic resonance).
- Monte Carlo Methods in Biology.
- Protein Structure and Dynamics.
- Protein Engineering.
- Protein Water Interactions.
- Protein Folding.
- DNA Bending and Folding.
- Polysaccharide Structure.
- Site Directed Mutagenesis.
- Magnetic Techniques in Photosynthesis.

The excellent work of the Directors guaranteed the highest standard. It should be remembered in this context that 12 years of academic work in this area of the life sciences makes this College a valuable credit for the overall ICTP activities serving a vital area of basic and applied science in which ICTP has 32 Associate Members of the highest level of academic competence.

### Recommendations

The College in Biophysics is a well established activity of ICTP. It responds to a real urgent need of developing countries and should not only be continued, in spite of ICTP limited resources, but it should also be reinforced as far as the available funds will allow.

The programme Physics of the Living State benefit greatly from having a core activity such as Biophysics. It should be continued, keeping particularly in mind our associate members and affiliated institutions in the life sciences. The most valuable sector of the ICTP community may find a focal point of interest in a topic which pools together the efforts of biochemists, molecular biologists, theoretical biologists, physicists and mathematicians.

Finally, we would also like to recommend that in 1996, the Medical Physics College be followed immediately after by the





*College in biophysics: experimental and theoretical aspects of biomolecules, 26 September – 14 October 1994.*

Biophysics College, as it occurred this year. In this manner a valuable sector of the participants may maximize the benefit of their visit to this Centre.

*J. Chela-Flores*

**Title:** THIRD COLLEGE ON MICROPROCESSOR-BASED REAL-TIME CONTROL — PRINCIPLES AND APPLICATIONS IN PHYSICS, 26 September – 21 October 1994.

**Co-sponsors:** United Nations University (Tokyo, Japan).

**Organizers:** Professors C. Verkerk (CERN, Geneva, Switzerland) and A.S. Induruwa (University of Moratuwa, Sri Lanka).  
**Organizers:** Professors C. Verkerk (CERN, Geneva, Switzerland) and A.S. Induruwa (University of Moratuwa, Sri Lanka).

**Report:** The 78 participants from 48 countries had been carefully selected among 174 applicants. The principal aim of the College was again to teach physicists how to develop microprocessor-based systems for the control of their experiments or laboratory equipment. Seventeen lecturers and instructors took care of this training. Laboratory exercises were, as in the past, an essential ingredient of the course.

This year's College differed from the previous ones in the choice of equipment and software. Instead of making use of the ROSY stations, the lectures and laboratory exercises were concentrated around the use of PCs running the Linux operating system. Linux is a full implementation of UNIX, available for

free from the Free Software Foundation and various ftp sites around the world.

Apart from a few introductory lectures on the use of Linux, the topics treated in the first two weeks were "Programming in C" (A. Nobile), "Software Design Methodology" (P. Bartholdi), "Principles of Real-time Operating Systems" (C. Kavka and C. Verkerk) and "Cross-development of Embedded Systems" (Chu Ang). In addition, a few lectures introduced the laboratory exercises (R. Karnad). The last two weeks were more oriented toward applications, with lectures on "Linux Device Drivers" (U. Raich), "Programming for the X11 Window system" (U. Raich), "Programming for the X11 Window system" (U. Raich), "Networking" (A. Induruwa), "MSDOS-based Systems" (J. Wetherilt) and case studies. The latter covered the "Control System of Elettra" (D. Bulfone), "Data Acquisition for the Nomad Experiment" (G. Balocchi) and "A Cheap Control System" (R. Karnad).

Late delivery of 25 PCs caused considerable difficulties for the running of the laboratory sessions. Fortunately these problems could be solved, thanks to the very hard work of the instructors and people from ICTP's Computing Group. Several changes had to be made to the laboratory set-up; some of those were only possible thanks to the power and flexibility of Linux.

The laboratory exercises consisted of C programming during the first two weeks, programming a graphical user interface to





*Third College on microprocessor-based real-time control — Principles and applications in physics, 26 September – 21 October 1994.*

a circuit board external to the PC in the third week and work on half a dozen projects during the last.

*C. Verkerk*

**Title:** THIRD TRIESTE CONFERENCE ON RECENT DEVELOPMENTS IN THE PHENOMENOLOGY OF PARTICLE PHYSICS, 3 – 7 October 1994.

**Co-sponsors:** Italian Institute for Nuclear Physics (INFN).

**Organizers:** Professors A. Ali (DESY), G. Altarelli (CERN), J. Ellis (CERN), F. Hussain (ICTP), N. Paver (INFN and University of Trieste, Italy), and R. Peccei (UCLA).

**Report:** The aim of the Conference was to review the most recent experimental and theoretical progress in particle physics, to evaluate the current status of this field by comparing the various lines of research, and to single out the most promising future developments.

The Conference consisted of plenary talks from top level theoretical and experimental physicists, plus a number of shorter, more specialized presentations from participants. The issues debated at the Conference were:

- The precision tests of the electroweak standard model, and the perspectives to scrutinize extended theories of weak interactions, in particular the supersymmetric ones. Also, future experimental confirmations of the existence of the *top* quark.
- Current topics in perturbative QCD and related experiments.

These include the resummations of soft gluons, the polarized nucleon deep-inelastic structure functions, the Regge regime and the role of the Lipatov pomeron. Many of these aspects are still not well understood, and will represent an important future field.

- One full day was devoted to heavy quark weak decays, the so-called heavy quark effective field theory and nonperturbative methods. These phenomena call for good theoretical control over nonperturbative QCD. Thus, great attention was given to the heavy quark field theory and some still open problems, such as the consistent definition of pole heavy quark mass which is relevant to the  $1/m$  corrections. Furthermore, more formal (but still quite relevant) aspects were discussed, such as applications of effective field theories to nonperturbative physics and phase transitions.
- One full day of the Conference focused on astroparticle and non-accelerator physics: cosmic rays, neutrino physics, neutrino and gamma astronomy, monopoles, dark matter and its composition, cosmological models and genesis of matter. The presentations and discussions showed the expanding experimental and theoretical interest in this kind of physics.
- Finally, one session was devoted to the current status and perspectives to test CP (and CPT) symmetry K and B meson



weak decays, and then to clarify the origin of CP violation. This is long-standing problem, of paramount importance both for particle physics and also for cosmology.

During the Conference, the Dirac Medal was awarded to F. Wilczek. The ceremony was attended by the President of the Italian National Institute for Nuclear Physics.

The Conference was attended by 98 participants from 34 countries, and by the physicists working at the local institutions. The atmosphere was informal, and the many questions and lively discussions following the talks showed that the audience was extremely motivated. Thus we may be confident that the Conference has been both useful to the senior researchers and formative for the younger ones.

*F. Hussain, N. Paver*

**Title:** WORKSHOP ON VARIATIONAL AND LOCAL METHODS IN THE STUDY OF HAMILTONIAN SYSTEMS (Euroconference), 10 – 28 October 1994.

**Co-sponsors:** European Commission.

**Organizers:** Professors A. Ambrosetti (Scuola Normale Superiore, Pisa, Italy), and G.F. Dell'Antonio (Università "La Sapienza", Rome, Italy).

**Report:** The purpose of the Workshop was to present

recent techniques and achievements in the study of Hamiltonian systems, especially of Keplerian type, both from the point of view of ordinary differential systems (central configurations, periodic orbits and their stability, invariant tori, K.A.M. theory and Arnol'd diffusion) and from the point of view of variational calculus (existence and multiplicity of periodic trajectories, existence and multiplicity of homoclinic orbits).

In the first class of problems, lectures were given by Prof. R. Moeckel from the University of Minnesota (Minneapolis, USA) and by Prof. R. De la Llave, University of Texas (Austin, USA). In the second class, lectures were given by Prof. V. Coti-Zelati, University of Naples (Italy), and by Prof. E. Sere, New York University (USA). Each lecturer provided indications about the connections with the content of the other lectures, so that the four series of lectures were able to provide a rather coherent and comprehensive picture of the problems, the techniques, and the results.

Notes of the lectures were given to the participants.

The Workshop was a successful attempt to bring together leading experts in those aspects of Hamiltonian mechanics which are more directly related to the N-body problem in celestial mechanics, both from the "local" point of view (relative equilibria, periodic orbits and their stability, K.A.M. theory



*Workshop on variational and local methods in the study of Hamiltonian systems (Euroconference), 10 – 28 October 1994.*



and diffusion,...) and from the point of view of variational calculus.

The lectures were all of high quality, and lively discussed, and led to a very fruitful interaction between scientists with different backgrounds and techniques. All lecturers expressed their appreciation for this type of encounters, and the participants gained an overall view of the status of the field and of the most significant recent achievements.

Apart from the invited talks, every day two or three half-hour lectures were given by younger scientists, who had in this way the opportunity to present their results and to discuss them with senior scientists.

The total number of participants was 120: 77 from developing countries, and 43 from advanced countries, 11 of whom were supported with the grants of the European Commission.

*A. Ambrosetti, G.F. Dell'Antonio*

**Title:** FOURTH AUTUMN COURSE ON MATHEMATICAL ECOLOGY, 24 October – 11 November 1994.

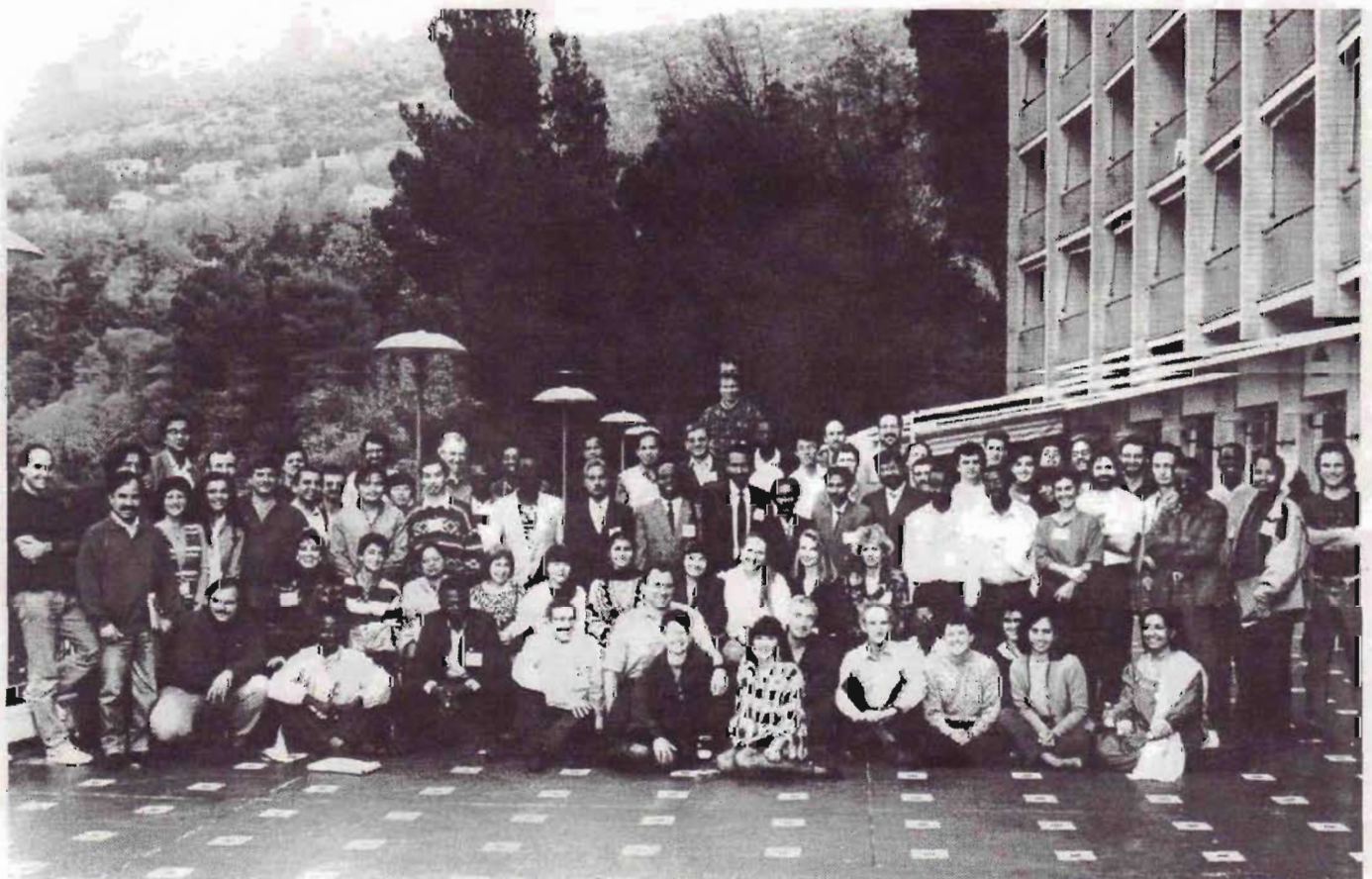
**Organizers:** Professors L.J. Gross (University of Tennessee, Knoxville, TN, USA), T.G. Hallam (University of Tennessee,

Knoxville, TN, USA), S.A. Levin (Princeton University, Princeton, NJ, USA), and G. Vidossich (International School for Advanced Studies, SISSA, Trieste, Italy).

**Report:** This activity follows in the series started in 1982. The ICTP has been the first scientific institution to organize a world meeting on mathematical ecology, and to hold it regularly. This Course has been the fourth, and two seminars for specialists have also been organized.

The purpose of the Course was three-fold: (1) to review the mathematical techniques currently used in the subject matter; (2) to enable scientists with various background (especially those from the Third World) to learn new methods and techniques; and (3) to enable Third World scientists to talk about the specific problems of their own countries of origin. These aims were fully met thanks to the exceptional quality of the faculty which was composed of the world leading experts.

Beside the lessons on the fundamentals of mathematics, numerous seminars were delivered and research groups on problems in the Third World were formed and constantly supervised by the lecturers. Special emphasis was given to discussions and personal contacts.



*Fourth Autumn Course on mathematical ecology, 24 October – 11 November 1994.*





*Second Workshop on three-dimensional modelling of seismic waves generation, propagation and their inversion, 7 – 18 November 1994.*

The following subjects were discussed:

- Mathematics: ordinary and partial derivative differential equations, finite differential equations, linear algebra, control theory, game theory, and stochastic processes.
- Ecology: topics from biology, physiology, growth of interacting populations, epidemiology, problems of global change, biodiversity, environmental problems, and climate models. These subject matters include specific problems of general interest such as the spreading of AIDS, the disappearance of fish due to fishing, the disappearance of elephants due to poaching for ivory trade, and the spreading of insects in plantations.

It is worth noting that numerous lecturers and participants came from research laboratories (26 laboratories were represented), rather than academic institutions.

Thanks to the interaction among participants, two regional groups for promoting research on environment with special interest to ecology, human impact and human health were founded: East Europe Society for Mathematical Ecology (EESME) and Asian Mathematical Ecology Society (AMES).

The number of both Italian and European participants (especially young post-doctoral students) was much higher than in the past, which is a clear sign of the high level and interest of the Course.

*The Directors*

**Title:** SECOND WORKSHOP ON THREE-DIMENSIONAL MODELLING OF SEISMIC WAVES GENERATION, PROPAGATION AND THEIR INVERSION, 7 – 18 November 1994.

**Co-sponsors:** Central European Initiative – Earth Sciences Committee, and Kuwait Foundation for the Advancement of Science.

**Organizers:** Professors A. Levshin (University of Colorado, Boulder, CO, USA, on leave from International Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences, Moscow, Russia) and G. Panza (University of Trieste, Italy).

**Report:** (University of Trieste, Italy).

**Report:**

*Organizers, Lecturers and Participants*

The Workshop was directed by Professors A.L. Levshin and G.F. Panza, Local Organizer, in collaboration with the Institute of Geodesy and Geophysics of the University of Trieste.

A staff of 20 lecturers, coming from the Czech Republic, France, Italy, Mexico, Russia, Spain, the United Kingdom, and the USA, contributed to the Workshop. There were 59 participants carefully selected from more than 200 applicants; 13 from Africa (Algeria, Guinea, Egypt, Eritrea, Ethiopia, Madagascar, Nigeria, Sudan), 2 from South America (Brazil, Colombia), 18 from the Middle East and Asia (China, India, Indonesia, Iran, Israel, Kuwait, Nepal, Sri Lanka, Syria, Viet Nam), and 26 from Europe (Albania, Bulgaria, Croatia, Czech



Republic, Greece, Italy, Russian Federation, Slovenia, Turkey, Ukraine).

#### *Purpose*

To stimulate seismological studies of the global and regional earth's structure, nature and parameters of seismic sources, evaluation of possible seismic hazard.

#### *Lectures*

On the theory of seismic wave propagation and modelling:

- Fundamentals of dynamic elasticity.
- Plane waves, diffraction of elastic waves and green functions.
- Representation theorems and the boundary element method.
- Surface waves in laterally inhomogeneous media.
- Seismic ray method for inhomogeneous isotropic and anisotropic media.
- Ray perturbation methods.
- The relation between normal modes and surface wave and body waves.
- Excitation and propagation of tsunami as surface waves.
- Mathematical modelling of active vibroseismic monitoring of a seismic-prone zone.

On seismic sources:

- Orientation of the source.
- Double-couple and non double-couple sources.
- Dimensions and complexity of the source.
- Source time functions.
- Source moment tensor retrieval in volcanic areas.
- A comparative study of source processes by surface waves inversion and analysis of aftershock data.
- Seismic source studies for point-like sources.
- Earthquake faulting — the forward and inverse problems.
- Moment tensor determination by coherence analysis of different body waves.
- Long period moment tensor inversion in 3-D media of different body waves.
- Long period moment tensor inversion in 3-D media of different body wave phases.

On structural studies:

- An integrated study of the young collision zone in Taiwan.
- Interpretation of tomography of Eurasia.
- A portable long period experiment on the Tibetan plateau.
- Ray and ray perturbation methods.
- Applications of ray methods to seismic tomography.
- Structural inversion using long-period waveforms.
- Period dependence of Q in the Earth mantle.
- Adaptive grid tomography.
- Seismic waves polarization anomalies.
- Incorporating of azimuthal anomalies into surface wave

tomography.

- The 3DMET project of ILP.
- Elastic and anelastic properties of the crust from the dispersion of P-SV waves.

On seismic hazards:

- Seismic response of topographies and alluvial basins.
- Ground motion modelling and local soil effects.
- From synthetic seismograms to seismic hazard assessment.

On general problems:

- Role of the European Union in the development of Third World countries.
- IRIS American consortium for seismological studies.

Five participants presented their recent results related to the workshop program.

#### *Computer exercises*

- Frequency-time analysis.
- Modelling of seismic response of layered media.
- Source mechanism interpretation.
- Ray tracing in 2D media.
- 2D tomography.

A total of 14 hours of laboratory sessions were held.

#### *Recommendations*

The Workshop has provided excellent opportunities to the participants to improve their academic standards and update their knowledge of modern techniques for seismic wave analysis and interpretation. One of the greatest benefits from the Workshop is the close personal contact between the lecturers, leading figures in their fields of interest, and the participants, who are either newcomers in seismology or have yet a limited experience in advanced seismic studies.

Taking into account that many developing countries represented by participants are situated in earthquake-prone areas and are just beginning to set up seismic networks and represented by participants are situated in earthquake-prone areas and are just beginning to set up seismic networks and organize seismological surveys, opportunities such as this are of extreme importance. The continuation of these workshops on a regular basis and reinforcement by additional funds are very important and should be encouraged.

*The Directors*

**Title:** ICTP-UNU-MICROPROCESSOR LABORATORY: THIRD COURSE ON BASIC VLSI TECHNIQUES, 21 November – 16 December 1994.

**Organizer:** Professor A.A. Colavita (ICTP).

**Report:** This Course may be considered a great success. Due to its hands-on characteristics, only 60 participating



scientists were selected out of 209 applications. Besides, the selection committee strove to preserve 50% of allowed places for experimental physicists, since the format of the course is mainly addressed to their needs. The schedule of the course allocated: three hours to miscellaneous information about ICTP, INFN and UNU; thirty-seven hours to theory lecturing; and a hundred and fourteen hours to laboratory work.

In its present format, the Course addresses the very difficult problem of handling complexity during the design of very large integrated circuits; that is, circuits that contain several millions of transistors. The design of an integrated circuit starts with the textual description of its function written in a hardware description language such as VHDL. We simulate the description with suitable test vectors in order to check if the text really portrays the desired functions. From this point on, the procedure is almost automatic, since the computer-aided design software (CAD) first prepares a net list with the needed components, and then places and routes the components.

The flow of design described in the previous paragraph requires very costly and advanced software tools. These software packages cost US\$ 50,000 to 75,000 per workstation. Hence, a Third World scientist would need a US\$ 100,000-worth set-up in order to design complex ICs. No course of this nature could

have a real impact if cost problems were not correctly addressed. Consequently, when organizing the Course, we decided to choose IBM PC clones as our workstations, and public domain software for our operating system and specific CAD tools. Fortunately, Linux is a good Unix-like public domain operating system that allowed us to use Alliance, a set of integrated tools with all the required characteristics for the course. Alliance was created at the Pierre and Marie Curie University of Paris, France, where it is used for a course that runs for a full year. Since no documentation was available to teach Alliance, the Microprocessor Laboratory staff had to work for several months, preparing lectures and laboratory exercises, in order to teach in just one month what is usually taught in a much longer period. The result of this effort was the present Course, whose excellence, value and success may be better judged by the comments of the participating scientists, and by the fact that already two universities, one from Switzerland and one from Malaysia, are interested in using our format. As an isolated example, we can mention that participating physicists with no previous knowledge in chip design are now capable of designing, as a project, a commercially available IC such as the Motorola PIA. Given the advanced characteristics of the Course, the staff was very small, and their work hours very long, since the Laboratory was open



*ICTP-UNU-Microprocessor Laboratory: Third Course on Basic VLSI Techniques, 21 November – 16 December 1994.*



from 9:00 until 22:00 every single day of the last two weeks. For the next edition we will be able to choose among the participants, in order to form a larger course staff.

I must explicitly mention the efforts made by Srinivasan, Venkataraman, Marco Rovati, Fabio Fratnik and Andres Cicuttin for the preparation of the Laboratory exercises. For the Lectures we had the collaboration of Silvio Turrini, Magali Estrada, Daniele Bulfone, Andres Cicuttin, Jorgen Christiansen and Nizar Abdallah; while Stanka Tanaskovic acted as course secretary.

A. Colavita

**Title:** ADRIATICO RESEARCH CONFERENCE ON ULTRAFAST PHENOMENA AND APPLICATIONS, 6 – 9 December 1994.

**Co-sponsors:** European Commission (Brussels, Belgium), and International School for Advanced Studies (SISSA, Trieste, Italy).

**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 (University of Trieste and Scuola Normale Superiore, Pisa, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

**Directors:** Professors C.H. Brito Cruz (Universidade Estadual de Campinas, UNICAMP, Campinas, Brazil) and N. Kroo (Hungarian Academy of Sciences, Budapest, Hungary).

**Report:** The purpose of this ARConference was to present the applications of a technique that was born in the last decade. Ultrafast phenomena find applications in physics, electronics, biology, chemistry and other fields of research. Also a lot of effort has been devoted into the development of new laser sources that can emit short pulses and that are tunable over a broad spectral range. The topics covered included: femtosecond pulse generation with lasers, pulse compression and parametric oscillators, ultrafast processes in semiconductor heterostructures, femtosecond dynamics of chemical reactions, and femtosecond processes in biology.

During 1994, five conferences were held under the Adriatico Research Conferences programme. They were intended to supplement and support other scientific programmes held at the Centre and at SISSA. They were held with the aim of bringing together leading experts in different fields to present their approaches and concepts and to make them interact with the other participants. An essential aspect of these conferences was

to present the up-to-date status of the field in a way accessible to non-specialists. The morning programmes consisted of keynote overview lectures giving an introduction and survey. In the afternoon, there were lectures covering more specific topics, impromptu seminars, discussions, etc.

H. Cerdeira, S. Lundqvist

**Title:** MEETING ON EARTH SCIENCES AND ENVIRONMENTAL PROTECTION, 12 - 13 December 1994.

#### **Report:**

##### *Organizers, Lecturers and Participants*

The activity, a follow-up of the Second Workshop on Three-Dimensional Modelling of Seismic Waves Generation, Propagation and their Inversion, was directed by Professors P. Varga (Geodetic & Geophysical Research Institute of the Hungarian Academy of Sciences, Sopron, Hungary), G.F. Panza, Local Organizer, (University of Trieste, Italy), and A.L. Levshin (Department of Physics, University of Colorado, Boulder, Co, USA) in collaboration with the Institute of Geodesy and Geophysics of the University of Trieste.

A staff of 18 lecturers, coming from Albania, Austria, Croatia, Czech Republic, Croatia, Hungary, Italy, Poland, Romania, Russian Federation and Slovakia, contributed to the Workshop. All of the 33 participants came from Europe (Albania, Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Romania, Slovakia, Slovenia, Ukraine).

##### *Purpose*

An interdisciplinary (Geology, Geophysics, Geodesy) approach to environmental studies in Central European Initiative countries.

##### *Lectures*

##### *Geology:*

##### *Danube Region Environmental Geology Program*

- Danube Region Environmental Geology Program – DANREG – A joint international study of Austria, Hungary, and Slovakia to clarify geological and environmental conditions.
- Review on Geological Research in Austria.
- Geological Investigations Related to Natural Parks.
- Results of the Bratislava Environment, Abiotic Component Project.
- Idrija Mercury Mine — Semi-Millennium of Continuous Operation; Impact on the Environment.
- Regional Geochemical Mapping — Possibilities of Coordination in CEI.
- Current Structure and Activity of the Geological Institute of



Hungary - Hungarian Geological Survey.

- The Possibilities of the Albanian Geological Survey for Regional and Interdisciplinary Cooperation in the Fields of Geology, Geophysics and Environmental Protection.

Geophysics:

- Seismic Zoning of the Circum Pannonian Region.
- New Geophysical Methods in Environmental Research.
- Gravimetric Study of the Alpic-Pannonian Region.
- Reconstruction of Climate Change from Geothermal Data.
- Seismic Hazard of Bulgaria (using a Deterministic Approach).

Geodesy:

- CEGROP Project as a Multilateral Cooperation of CEI Countries to set up a GPS Monitoring Network in Central Europe.
- Recent Horizontal Deformations Measured in the Pannonian Basin at Slovak, Ukrainian and Hungarian Geodynamic Observatories.
- Concise Outline of Geodetic and Geodynamic Projects Running at the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology.
- Information System of Surveying and Cadastre as a Basis of GIS in the Czech Republic.
- A Contribution of CEI Countries to the Unification and Maintenance of European Geodetic Reference Frames.

Comments

The meeting has provided an excellent opportunity to the participants to exchange their results and ideas and to formulate quite well detailed plans for their future activity. The project "Geodynamics and Geo-environmental Problems in the Circum-Pannonian and Adjacent Regions" was formulated by the Earth Sciences Committee of the Central European Initiative. GEOPAR is the result of the merging of ongoing transnational activities generously supported by the EU.

*The Directors*

**Title:** CONFERENCE ON TOPOLOGICAL AND GEOMETRICAL PROBLEMS RELATED TO QUANTUM FIELD THEORY (Euroconference), 13 - 24 March 1995.

**Co-sponsors:** European Commission.

**Organizers:** Professors P.J. Braam (University of Oxford, UK), C. De Concini (Scuola Normale Superiore, Pisa, Italy), and R. Dijkgraaf (University of Amsterdam, The Netherlands).

**Report:**

*Objectives*

The Conference was organized for an audience of experts and young mathematicians from developing countries, working in the area of geometry and topology where this relates to developments in theoretical physics.

We selected four topics for our Conference: mirror symmetry, quantum gravity, Floer homology and the theory of Seiberg-Witten monopoles. These fields have a common origin in theoretical physics but recent progress in both mathematics and theoretical physics has shown them to be inextricably related.

The areas are considered difficult to learn, and it was thought that a meeting would be particularly profitable if it consisted of experts and mathematicians from Third-World countries, and if suitable mini-courses were presented that would serve as introductions to the area.

*Structure and organization*

1. Four mini-courses;
2. Four problem sessions;
3. Seventeen lectures;
4. Five parallel sessions.

*Participation*

The total number of registered participants was 62; however, the lectures were attended by many more mathematicians and physicists present at the ICTP for other activities. Several young European mathematicians also participated and were financially supported by the Euroconference Programme of the European Commission.

*Scientific Content*

The four mini courses covered the areas of Perturbation theory in gauge theories (Axelrod), Seiberg-Witten monopoles (Braam), mirror manifolds (Candelas) and Duality in Field theories (Dijkgraaf). All of these presented very recent results in an attractive way. The most recent results were presented in the following areas:

- Mirror symmetry (lower dimensional examples, K3 surfaces);
- Symplectic Floer homology (isotopy of symplectomorphisms);
- Seiberg Witten invariants (constraints on embedded surfaces, relations with duality);
- Magnetic monopoles (relations with rational maps);
- Moduli space of vector bundles over curves (computations of the cohomology ring).

*P.J. Braam, C. De Concini, R. Dijkgraaf*



## CALENDAR OF ACTIVITIES AT ICTP IN 1995



### SMR

- 838 Seventh international workshop on computational condensed matter physics:  
total energy and force methods ..... 11 - 15 January
- 815 Tempus meeting on fiberoptics ..... 30 January - 11 February
- 841 Fourth ICTP-URSI-ITU (BDT) college on radiopropagation: propagation, informatics and  
radiocommunication system planning ..... 30 January - 3 March  
followed by
- 846 Second workshop on rural communications in developing countries ..... 6 - 10 March
- 842 Conference on ultrafast transmission systems in optical fibres ..... 13 - 17 February
- 899 First Bolivian course on computerized data acquisition techniques ..... 13 - 25 February
- 843 Theoretical and experimental workshop on the physics of semiconductor  
microstructures, held in Campinas, Brazil ..... 13 - 24 February  
including
- 844 Adriatico research conference on lower dimensionality semiconductor systems,  
held in Campinas, Brazil ..... 20 - 24 February
- 845 Second winter college on optics ..... 20 February - 10 March
- 847 Conference on topological and geometrical problems related to quantum field theory ..... 13 - 24 March
- 893 Seminar on signalling system No. 7 for French-speaking African countries ..... 20 - 24 March
- 848 Spring school and Workshop on string theory, gauge theory and quantum gravity ..... 27 March - 7 April
- 849 Conference on recent developments in statistical mechanics and quantum field theory ..... 10 - 12 April
- 894 Third ESF Workshop: Network on quantum fluids and solids "Excitations and spin-polarised systems" .. 20 - 26 April
- 852 Conference on perspectives in nuclear physics at intermediate energy ..... 8 - 12 May
- 853 Antonio Borsellino College on neurophysics ..... 15 May - 9 June
- 853 Antonio Borsellino College on neurophysics ..... 15 May - 9 June  
including
- 902 Symposium on "Dynamic properties of receptive fields and plasticity of processing systems" ..... 17 - 19 May
- 854 College on computational physics ..... 15 May - 9 June
- 855 Workshop on dynamical systems ..... 22 May - 2 June
- 856 Trieste Conference on S-duality and mirror symmetry ..... 5 - 9 June
- 865 Workshop on computational methods in material science and engineering ..... 12 - 23 June
- 858 Summer school in high energy physics and cosmology ..... 12 June - 28 July  
including Workshop on strings, gravity and related topics ..... 29 - 30 June
- 859 Research workshop on condensed matter physics ..... 12 June - 18 August  
including Working group on "Surface and bulk magnetism" ..... 26 June - 7 July  
and Working party on the fabrication, physics and applications of quantum dots ..... 31 July - 4 August



- 860 Adriatico research conference on physics of sliding friction ..... 20 - 23 June
- 862 Workshop on quantitative biophysics at the molecular and macromolecular scales ..... 29 June - 7 July  
including
- 866 Adriatico research conference on biophysics at the molecular and mesoscopic scale ..... 4 - 7 July
- 857 Miniworkshop on "Quantum incoherence and quantum coherence in strongly correlated systems" ..... 3 - 21 July
- 863 4th School on non-accelerator particle astrophysics ..... 17 - 28 July
- 861 Adriatico research conference on chaos in atoms and molecules ..... 18 - 21 July
- 851 International symposium on African drought ..... 31 July - 4 August
- 892 African regional workshop on parallel processing and its applications,  
to be held in Yaoundé, Cameroon ..... 31 July - 11 August
- 889 Miniworkshop on Josephson junction arrays ..... 7 - 11 August
- 867 Workshop on nonlinearity: noise in nonlinear systems ..... 14 - 25 August
- ... Adriatico Research Conference on contemporary concepts in condensed matter physics,  
to be held in Gothenburg, Sweden ..... 18 - 22 August
- 869 Conference on partial differential equations and applications to geometry ..... 21 August - 1 September
- 868 Adriatico research conference on randomness, stochasticity and noise ..... 22 - 25 August
- 870 Adriatico research conference on information theory in classical and quantum physics ..... 29 August - 1 September
- 895 Trieste conference on chemical evolution IV: Physics of the origin and evolution of life  
"Cyril Ponnampuruma Memorial" ..... 4 - 8 September
- 871 Workshop on general theory of partial differential equations and microlocal analysis ..... 4 - 15 September
- 873 College on soil physics ..... 11 - 29 September
- 872 Workshop on materials science and physics of non-conventional energy sources ..... 18 September - 6 October
- 874 Autumn college on plasma physics ..... 18 September - 13 October
- 964 Regional college on microprocessor-based real-time control: Principles and applications in physics,  
to be held in Cape Coast, Ghana ..... 25 September - 13 October
- 875 Workshop on telematics ..... 2 - 20 October
- 876 Topical workshop on plasma physics: Collective processes in nonlinear media ..... 16 - 20 October
- 898 Topical workshop on plasma physics: Collective processes in nonlinear media: star formation ..... 16 - 20 October
- 888 Conference on Mediterranean Sea — Circulation, strait exchange and dense water formation  
processes (dedicated to Antonio Michelato) ..... 23 - 27 October
- 896 Summer school in radiophysics (diagnostic radiology) ..... 23 - 28 October
- 880 IX International symposium on ultrafast processes in spectroscopy ..... 30 October - 3 November
- 877 Third school on the use of synchrotron radiation in science and technology:  
"John Fuggle memorial" ..... 30 October - 1 December
- 879 Third workshop on non-linear dynamics and earthquake prediction ..... 6 - 17 November
- 878 Workshop on "Physics and chemistry of transitional metal oxide including high  $T_c$  superconductors,  
to be held in Bangalore, India ..... 19 November - 5 December
- 897 UN/ESA conference on optics in space science and technology ..... 20 - 25 November
- 898 Adriatico Research conference on trends in collider spin physics ..... 4 - 8 December



## CALENDAR OF ACTIVITIES AT ICTP IN 1996



### SMR

- 911 Workshop on atmospheric interactions ..... 5 - 16 February
- 912 First regional course on advanced VLSI design techniques (to be held in Havana, Cuba) ..... 5 February - 1 March
- 913 Winter college on quantum optics ..... 12 February - 1 March
- 914 ICTP-ICS-ITU (BDT) Workshop on economic quantification of the impact  
of telecommunication in development ..... 26 February - 1 March
- 915 Quantum interferometry II (Adriatico Research Conference) ..... 4 - 8 March
- 916 Seventh college on biophysics — Structure and functions of biopolymers:  
Experimental and theoretical techniques ..... 4 - 29 March
- 917 Second workshop on science and technology of thin films ..... 11 - 29 March
- 918 II Trieste conference on quantum field theory and condensed matter physics ..... 13 - 15 March
- 919 Spring school and Workshop on string theory, gauge theory and quantum gravity ..... 18 - 29 March
- 920 School on nonlinear functional analysis and applications to differential equations ..... 15 April - 3 May
- 921 Workshop on nuclear reaction data and nuclear reactors — Physics, design and safety ..... 15 April - 17 May
- 921 Workshop on nuclear reaction data and nuclear reactors — Physics, design and safety ..... 15 April - 17 May
- 922 College on oceanography ..... 22 April - 10 May
- 923 Spring college in condensed matter physics on “Disorder and chaos in quantum systems” ..... 6 May - 7 June
- 924 Workshop on dosimetry and dose reduction techniques in diagnostic radiology ..... 13 - 17 May
- 925 Workshop on biomass ..... 20 - 31 May
- 926 Disorder and chaos in microstructures (Adriatico Research Conference) ..... 11 - 14 June
- 959 Workshop on strongly correlated electron systems ..... 17 June - 5 July
- 927 Summer school on high energy physics and cosmology ..... 17 June - 2 August



928	Research workshop in condensed matter physics .....	17 June - 23 August
929	Controlling wave phenomena (Adriatico Research Conference) .....	2 - 5 July
960	Workshop on nonlinear control and control of chaos .....	8 - 19 July
930	Course on ENSO monsoon .....	15 - 26 July
961	Workshop on proteins, membranes and their interactions .....	22 July - 2 August
931	Tunneling and its implications (Adriatico Research Conference) .....	30 July - 2 August
962	Workshop on quantum dissipation and applications .....	5 - 16 August
932	School on algebraic groups and arithmetic groups .....	12 - 30 August
963	Workshop on dynamics of non-equilibrium systems .....	19 - 30 August
966	Electron and ion transfer in condensed matter (Adriatico Research Conference) .....	Summer (dates to be fixed)
967	Fluctuation phenomena in HTSC (Adriatico Research Conference) .....	Summer (dates to be fixed)
933	EFOMP - Giorgio Alberi Conference .....	2 - 6 September
934	School on numerical simulation of partial differential equations: methods, algorithms and applications .....	9 - 27 September
935	Second international workshop on parallel processing and its applications in physics, chemistry and materials science .....	9 - 27 September
936	College on medical physics .....	9 - 27 September
937	International conference on microelectronics for high energy physics .....	30 September - 4 October
937	International conference on microelectronics for high energy physics .....	30 September - 4 October
938	Trieste conference on quarks and leptons: Masses and mixings .....	7 - 11 October
939	College on microprocessor-based real-time control: Principles and applications in physics .....	7 October - 1 November
940	College on mathematical ecology .....	14 October - 8 November
941	Research workshop on LAM .....	21 October - 1 November
942	Workshop on three-dimensional modelling of seismic waves .....	4 - 15 November
943	Fourth course on basic VLSI design techniques .....	18 November - 13 December



## GETTING INFORMATION ON ICTP ACTIVITIES VIA COMPUTERS



Information on the various ICTP activities throughout the year can be retrieved via electronic mail, the Internet Gopher and WWW. The procedure is as follows.

### *Using Electronic Mail*

#### *(1) Scientific Program of ICTP Activities*

The complete Scientific Program can be obtained by sending an e-mail to **smr@ictp.trieste.it** using as Subject: **get calendar**

To get this year's calendar only use Subject: **get calendar 1995**

To get next year's calendar only use Subject: **get calendar 1996**

*Note:* The Scientific Program is constantly updated. So, please check the issue date.

To each activity listed in the Scientific Program there is an associated **smr-number** from which you can obtain more detailed information, when available.

#### *(2) Information on a specific ICTP activity*

To receive a list with the names of documents available for a particular activity, you should first identify the **smr###** code as indicated above. Then send an e-mail to **smr###@ictp.trieste.it** using as Subject: **get index**

If you send another mail to **smr###@ictp.trieste.it** using as Subject: **get document\_name** (e.g., *announcement*, etc.), you will receive detailed information on the topic *document\_name*

*Note:* If you wish more than one document of an activity then use Subject: **get doc1 doc2 ... etc.**

### *Using Gopher*

The ICTP Gopher server allows you to explore, search and retrieve general information regarding the many scientific activities carried out at ICTP. It is possible to access the Gopher space by issuing the gopher command and exploring the branch "*Other Gopher servers in the world*" pointing to the geographical region: Europe→Italy→ICTP.

To access directly to the ICTP Gopher server, you can issue the command **gopher gopher.ictp.trieste.it**

### *Using World-Wide Web (WWW)*

The ICTP WWW server allows you to obtain basically the same information available on the ICTP Gopher server, but through

The ICTP WWW server allows you to obtain basically the same information available on the ICTP Gopher server, but through the World-Wide Web protocol.

The ICTP WWW server URL (Uniform Resource Locator) is **http://www.ictp.trieste.it/**

*News from ICTP is also available on Gopher server*



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

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