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International Centre for Theoretical Physics

News from ICTP

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Action Urged to Narrow Science Gap

Courtesy of
South Letter,
No. 5, December 1989.

The Nobel physicist Professor Abdus Salam – a member of the South Commission – chaired a panel of eminent persons convened by the UN Secretary-General to discuss issues related to peace, development and the role of science and technology on 25 and 26 October at the United Nations in New York. The meeting was held in the context of the UN General Assembly's commemoration of the tenth anniversary of the Vienna Programme of Action on Science and Technology for Development adopted at a special UN conference held in 1979.

In a statement presented to the General Assembly session – at which Professor Salam was a keynote speaker – Professor Salam was a keynote speaker – the panel put forward a programme of action for the 1990s and beyond designed to ensure that developing countries are able to use science and technology to achieve adequate rates of economic growth while protecting the environment.

The panel noted that while revolutionary progress in many scientific fields had opened new opportunities in agriculture, industry, medicine, communication and materials, the gap in technology development and application between industrialized and developing countries was widening. The life support systems of the planet were also being placed under increasing stress. As the Brundtland Commission had warned, unless environmental degradation and biological impoverishment were arrested, the future of humankind would be in jeopardy.

At the same time, increasing population and the prevalence of chronic hunger, absolute poverty and widespread unemployment made faster economic growth essential in most developing countries. The panel's statement said:

"The challenge thus lies in harnessing modern science and technology to achieve the desired economic growth rates based on sound ecological ground rules. The nineties will be a critical decade in our ecological and scientific evolution. Unless steps are taken to promote sustainable and equitable development, it will be difficult to achieve a better common future. This realisation has provided an opportunity for promoting a new global solidarity among all members of the solidarity among all members of the human family. The climate of peace now gathering strength has provided a unique opportunity for rechannelling substantial scientific, managerial and financial resources for launching a bold Planet Assurance Programme which will help us to avoid the adverse changes associated with phenomena such as desertification, loss of biological diversity, ozone layer depletion, global warming and rise in sea levels".

Five-point action plan

The statement went on to call for a five-point plan of action:

"First, the prevailing political will for sustainable development should be converted into political action to avert our planet from experiencing the effects of a nuclear winter without a nuclear war. This will call for a new rationale for international co-operation, manifesting itself in a meaningful manner at the local, regional and global levels. We urge member states to

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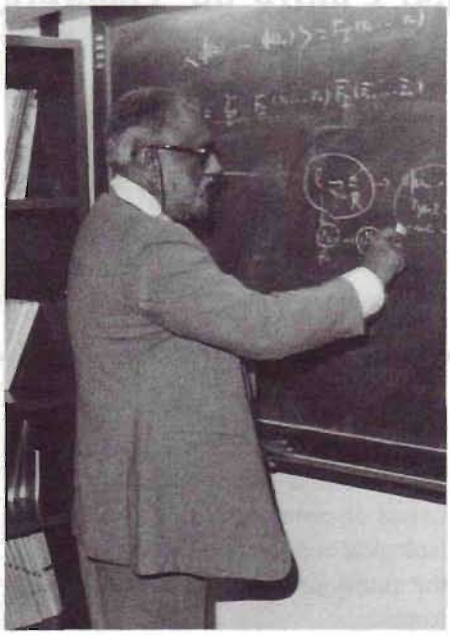
include in the Human Rights Declaration the right of access to technology for all people and to give concrete shape to this concept at the ongoing Uruguay Round of GATT negotiations.

Secondly, we appeal for a new deal for the lowest income billion of humankind, by launching a special programme designed to extend the benefits of science and technology to the economically disadvantaged sections of the human family worldwide. For this purpose it will be essential to associate grassroot-level people's organizations in both the planning and implementation of training and technology dissemination programmes. What is needed is low-cost but high quality and socially compatible methods of technology sharing.

Thirdly, we emphasize the urgent need for strengthening and expanding the science and technology infrastructure in developing countries, in view of the growing gap in endogenous capacity between industrialized and developing countries. For this purpose, we request the Secretary-General to convene a meeting of interested governments, foundations and industries for the establishment of a Consultative Group on Science and Technology for Sustainable Development. Such and initiative could result in a coalition of resources and their optimum utilisation. In particular, the proposed Consultative Group could support a network of Centres on the lines outlined by Prof. Abdus Salam. Sustainable development to become real will need the support of location specific technologies, tailored to suit the needs of local ecological, socio-cultural and economic conditions. This will call for a massive programme of education and training. Mass media can play a valuable role in the dissemination of new technologies. Recent advances in communication technology provide opportunities for easy access to relevant information. We recommend the establishment of a network of media resources centres to provide professionally credible software for the media.

Centres on the lines outlined by Prof. Abdus Salam. Sustainable development



Professor Abdus Salam is often very busy travelling and devising new projects, yet he organizes his time so that the greatest part of it is devoted to research. Here he is portrailed at the blackboard in his office at ICTP.

Industrialised countries should also take steps to develop and adopt environmentally sound technologies and strengthen R&D efforts in the area of sustainable development. This will call for a reappraisal of growth patterns, lifestyles and technology options. The experience gained under the proposed consultative Group will be equally valuable for industrialised countries.

Fourthly, the conservation and sustainable management of biological diversity are essential for achieving continuous improvements in biological productivity. Unfortunately, many habitats rich in biological diversity are under threat of extinction. Also, gene patenting procedures are resulting in conflicts regarding ownership and patterns of utilization of plant, animal and microbial genetic resources. The time is therefore ripe for the establishment of a United Nations Commission on Biological Diversity which will help to ensure both the conservation and sustainable utilization of our global genetic estate for the benefit of food and ecological security in all nations.

Finally, the unique opportunity now generated by recent developments in the UN General Assembly in the area of disarmament and strengthening of peace initiatives, have created opportunities for converting resources from defense to development. The scientific, managerial and financial resources which will become available in the process of conversion could be utilised for strengthening ecological and food security as well as the livelihood security of the poorest billion of the world. We urge the initiation under the United Nations system of case studies to highlight the opportunities for improving the quality of life on earth, if both industrialised and developing countries pursue vigorously the path of linking disarmament with fighting the battles against hunger and poverty.

It is our conviction that action on the lines recommended by us would help to transform the vision projected at Vienna ten years ago into reality".

A Sobering View of Vienna Ten Years After

Courtesy of
Update,
No. 38, Summer 1989.

The Intergovernmental Committee on Science and Technology for Development (IGC) will devote its 10th session in New York (21 August-1 September 1989) to a review of progress and the developing world's lack of it in the field of S&T since the Vienna Programme of Action (VPA) was drafted in 1979. Particular attention will also be paid to new ideas and approaches for the future.

The IGC will have before it evaluations from a vast and prestigious array of international experts from public and private sectors, scientific and other institutes and foundations, United Nations agencies and organizations, NGOs and universities. It will also have

behind it an extraordinary weight of human experience and social upheaval, captured in the conclusions of four regional meetings and one interregional meeting organized by CSTD between November 1988 and April 1989.

That experience has been a sobering one. The regional meetings have reported that while social awareness of the importance of S&T to development has grown remarkably since the 1979 Conference, the accomplishments of the VPA have fallen far short of its objectives.

Some blame for that has been apportioned to the global economic environment of the 1980s, but more important causes seem to lie in resistance to the sometimes drastic revisions in conceptual and institutional approaches which would have been necessary to achieve the four basic goals of the VPA, namely: the strengthening of endogenous capacity in the developing world; a restructuring of international scientific and technological relations; the strengthening of the role of the United Nations system in the field of S&T; and the mobilization of new financial resources in support of S&T for development.

The review of the VPA clearly spelled out the need for developing countries to:

- articulate priority demands in relation to specific socio-economic problems and available resources;
- promote participation by the various stakeholders in the economy through national policy dialogues which would determine priorities for the application of S&T;
- redirect development efforts not only to raise production, but to promote social equity;
- translate general assumptions about the role of S&T into specific actions at national and regional levels;
- participate in new and emerging areas of science and technology (NESTS) with a view to long-term social objectives.

Failed linkages

Ten years after Vienna, the vast majority of nations have failed to establish the linkages necessary to identify the social needs (demand) for S&T, or to bring the various stakeholders in their economies into an active partnership for progress. Very few have developed the capacity to undertake policy analysis and technology assessments which relate to their particular situations; and in many countries, even when progress has been made towards the development of S&T capacity, there has been little inclination to deal with problems of social equity.

International support for the development of S&T capacity in the Third World has been largely through bilateral channels and official development aid, and both national and regional experiences point to the need for greater coherence and effectiveness of development support; a balanced approach to demands for assistance; complementarity in the programmes of different bilateral and multilateral agencies; and reinforcement of the concept of endogenous capacity-building, not merely in terms of equipment, infrastructure of isolated projects, but as a process which builds nations' capacity for autonomous decision-making.

Institutional arrangements for S&T in the UN system were also of major concern in the VPA, as a means of underscoring the value of S&T in socio-economic development. But the potentials of these institutions, namely, the IGC, the ACC Task Force, ACSTD, FSSTD and CSTD, have not been fully realized and a redefinition of the scope of their functions is now considered necessary.

It is felt that these institutions should primarily be responsible for activities to:

- assess the implications of technological change on areas of interest to the UN General Assembly debate;
- promote the development of endogenous capacity and help nations define priority actions through policy dialogues among stakeholders in their economies;
- catalyse S&T linkages among the agencies of the UN system, other development agencies, the S&T community and other stakeholders at national level.

Meanwhile, the development of new sciences and technologies continues at an unprecedented pace, accompanied by euphoria or panic according to their impact on processes, products and profits globally. Whereas the NESTS of the 70s were largely employed in the developed world, their impact, for better or worse, has been felt in the markets of almost every developing nation during the 1980s. They have fundamentally changed a range of economic activities in agriculture, manufacturing and services – creating new techniques, products and skills, which have influenced modes of work and leisure.

Human values

Accordingly, the end-of-decade review will also look to the 1990s and beyond, addressing the fears that human values will be sacrificed, nature's processes damaged, social inequalities widened, privacy and freedom of thought eroded.

What has become obvious during the past decade, and remains certain for the future, is that the impact of NESTS will not necessarily be the same in developing countries, or from one developing country to the next, as it was in the developed world. Nations, individually and collectively, will find that they must scan the horizon and engage in some serious, independent assessments of the potential consequences in the context of local conditions, needs and circumstances. As the papers placed before the IGC will make clear, the major issues and answers produced by the VPA remain as valid today as they were a decade ago.

East-West and North-South

by A.M. Hamende,
Scientific Information Officer,
ICTP.

The course of history which, in Europe, appeared immutable for the last forty-five years has taken a sudden turn just a few months ago. The pace of the changes in Eastern Europe and in the East-West relations is such that every day brings us new hope. A better future is in sight with fewer weapons and people at arms, democracy, more equity, better life and freedom for individuals. The political world is not the only one to be very active in these days, also the economic scene is already in march with new proposals for East-West collaboration. With time, old Europe – East and West and the rest of OECD countries – might become a group of 1 billion people liberated from the threat of war and with their huge potential of human skills and knowledge, living in prosperity. However, the other 4 billion inhabitants of this globe should not be ignored by the new course of history. The rich fifth of mankind cannot live in an island of prosperity if the rest of the world is left out of this process. That is why the Third World should get opportunities and support to improve their economics, the standard of living of their people and enjoy democracy with peace. To achieve that, the Third World should get a better share in the pursuit of scientific knowledge and better opportunities to contribute to the utilization of Science and Technology, and the human and natural resources.

As a matter of fact, the scientific community, which has always been at the forefront for free and democratic relations between the peoples, knows no frontiers. Collaboration between South and North, East and West has always existed in the domain of science, even during the cold war. This collaboration is taken as a mission by the ICTP. Already in 1966-67, Salam succeeded in bringing to Trieste European, Soviet and American specialists in fusion physics who worked together for nearly two years. The ICTP is a truly international institution. In twenty-five years, it has welcomed 19,000 scientists from the industrialized world and 23,000 from developing countries. These figures also include 5,800 scientists from Eastern Europe. However, the recent changes in East-West relations open up new possibilities for more efficient collaboration in the field of science between East and West and South and North which must be explored carefully.

These issues will be discussed in a conference at the ICTP on 26 and 27 March 1990. Abdus Salam has invited outstanding scientists, chairmen and presidents of academies of science, ministers for Science and Technology and high officials from Eastern European countries and representatives from international organizations to take part in the debate. Key representatives from the major Italian research institutions and leading scientists from Italy and Austria will also attend. It is expected that the Italian Government will be represented in the Conference at a very high level.

Edoardo Amaldi

The great Italian physicist Edoardo Amaldi passed away on 5 December 1989. Only a few weeks before he had chaired a session at the 25th Anniversary Conference of the ICTP. Edoardo Amaldi had been in the past the distinguished guest of the Centre on several occasions. In 1960, he informed Paolo Budinich of the intention of the International Atomic Energy Agency to study the possibility of setting up a centre for theoretical physics upon a proposal submitted by Abdus Salam on behalf of the Delegation of Pakistan at the IAEA's General Conference. This information prompted Paolo Budinich to contact Abdus Salam and this started the collaboration between the two physicists which led to the establishment of the ICTP in Trieste.

We reproduce hereunder a commemoration of Prof. Edoardo Amaldi by F. Pagan which was published in Trieste's newspaper "Il Piccolo".

Prof. E. Amaldi

If, sixty years ago, Enrico Fermi was called the "pope" on account of his infallibility and Emilio Segrè the "basilisk" for his sharp tongue, in the halls of the Institute of Physics in Rome, in Via Panisperna, Edoardo Amaldi was known as "the little boy" because of his frail aspect and rosy face. Edoardo remained frail and rosy until his magnificent old days full of lucidity and passion during which he never renounced to say his ideas clearly and never ceased "to fight a duel" with whomever did not think the same way as he did.

The life and works of Amaldi who passed away suddenly on 5 December 1989 in the Accademia dei Lincei of which he was the President, coincide with the somewhat romantic epopee of the years from 1927 to 1938 during which the Fermi "boys" laid down, without realizing it, the foundations of much of the contemporary nuclear physics. With limited financial

resources but methodically and with great enthusiasm, they used the gold-fish pond which was in front of the Institute for their experiments on neutron slow-down, an indispensable step to control a nuclear chain reaction.

The group to which Amaldi belonged is perhaps the first example of high-level team work in modern physics. In addition to the future Nobel Laureates Fermi and Segrè, there were also the mysterious figure of Ettore Majorana (who disappeared during a trip from Palermo to Naples) and those enigmatic of Bruno Pontecorvo (who later took refuge in the Soviet Union) and of Franco Rasetti who after the Second World Was abandoned physics in order to release his conscience from the anguish of the atomic bomb, for another of his passions: paleontology and botany. After the death of Segrè and Amaldi in a span of time of eight months, Pontecorvo and Rasetti are now the only ones who survived a fabulous epoch for physics and science in Italy: the first is still engaged in the study of cosmic neutrinos despite the Parkinson disease which afflicts him. The second is in his nineties and very ill in his voluntary exile in Waremme, near Liège in Belgium.

The years of activity in Rome were abruptly interrupted due to the racial laws which caused the diaspora of Fermi and Segrè to the United States. A gloomy prelude to the Second World War. One day Amaldi said: "It was perhaps naïve to build such a fragile house on the slopes of a volcano which was near to explode. It may be that we illusioned ourselves, as we were young and presumptuous. But we believed that what we were doing was more durable than the political regime of those days. He further recalled the bombing on the Institute of Physics: "We carried with a cart the instruments which had not been damaged through Via Nazionale and Corso Vittorio. We left them in the Liceo Virgilio near the Vatican – we thought they would have been in a safer place there". After the war, the Institute of Physics moved within the university complex. Amaldi was its Director from 1949 to 1960, shaping the renaissance of the Italian School of Physics – from nuclear to elementary particle physics, from cosmology to space research – and providing his experience to Euratom, ENEA (the Italian national Committee for research and development of nuclear and alternative energies) and to the INFN (the Italian National Institute of Nuclear Physics). It was him who brought Italian physicists back to Europe contributing to creation of CERN in Geneva of which he became Secretary General first and then Deputy Director – the highest position ever held by an Italian at the European Centre for Nuclear Research before the appointment of Carlo Rubbia in January 1989 as Director General. His son Ugo continues the prestigious scientific tradition of the family and is in charge of one of the four experiments with the new LEP superaccelerator.

As an experimental researcher in addition to radioactivity and neutrons, Amaldi studied atomic and molecular spectroscopy, antiprotons produced by accelerators, mesons in cosmic rays. For many year, he held positions of high responsibility in the Pugwash Movement, a group of scientist formed in the fifties under the impulsion of Albert Einstein and Bertrand Russel to throw a bridge during the cold war between East and West in order to create a confidential channel for proposing solutions to the disputes in nuclear armament matters.

Freed from his academic duties in these last ten years, Amaldi was still fascinated by the evanescent gravitational waves produced for instance by stars exploding in the far-away space. But he never ceased his acting as a polyvalent "scientific ambassador". Last year's spring, in his capacity of representative of the Space Commission of the Italian Ministry for Research, he attended the launching in Kenya of a "San Marco" satellite from the Italian equatorial launching platform. This year he visited several research centres. Together with other scientists he met Gorbachev during his visit in Rome.

He told me in an interview, a few years ago: *"Physics is now witnessing a period which in several senses is comparable to that which saw the birth of the nuclear era. Astrophysics, plasma physics, condensed matter physics, high-energy physics with its large accelerators. If fifty years ago scientists had known the cost of a particle accelerator, they would have turned mad. Nevertheless, governments support this research and unite for facing the costs. For this, such international scientific structure that we succeeded to set up like the CERN in Geneva, should serve as a model for so many other initiatives on the Old Continent".*

Andrey Dmietriyevich Sakharov

Courtesy of
TWAS Newsletter,
Vol. 2, No. 1,
October-December 1989.

Andrey Dmietriyevich Sakharov, one of the greatest Russian scientists of the present century, passed away on 14 December 1989 in Moscow. He was known as the father of the Soviet H-bomb, but he was more famous for his crusading spirit for human rights and all that does along with it. No wonder he is the first Russian to have earned the Nobel Peace Prize.

Sakharov had an indomitable spirit, and its image persists more than his other qualities and achievements. For his views, he was exiled to Gorky for many years and returned to normal life only in 1986.

Sakharov was an extremely humane man who hated the idea that science be used for the destruction of man. being the father of the Russian H-bomb, he sent a request to Nikita Khrushchev in 1961 that nuclear tests not be resumed. Unfortunately, the request was turned

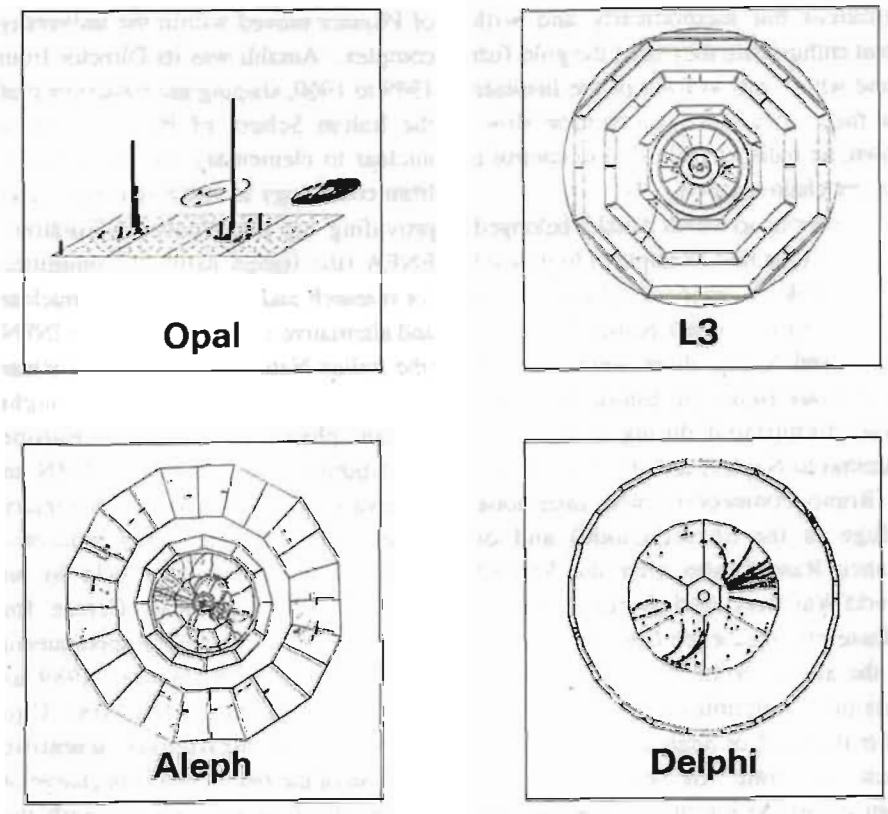
down.

The prestigious journal *Nature* of London, among other tributes, had the following to say: *"The image of the contentious academician will persist in people's memory. A brilliant physicist-theoretician, he became an academician at 32, the youngest in the Soviet Union. His work on the hydrogen bomb, pioneer ideas on thermo-nuclear synthesis and a number of discoveries in other fields brought him recognition as an outstanding scientist.*

He was decorated with the Lenin Order, three Stars of the Hero of Socialist Labour, and given the Stalin Prize – and prohibited from leaving the Soviet Union for reasons of state secrecy."

The Director of the ICTP and President of the Third World Academy of Sciences, Professor Abdus Salam, sent his message of condolence to the USSR Academy of Sciences and to the bereaved family on behalf of the Academy and the ICTP.

The telex read: *"We are deeply sorrowful at the death of Sakharov. Kindly send my condolences to his family and to the Academy of Sciences. His work in gravity theory is deeply appreciated by everyone here, and his moral courage was legendary."*



Initial Zs in LEP, as seen by the four detectors.

LEP There Be LeptonZ!

Courtesy of
CERN Courier,
Vol 29, No. 7, September 1989.

On 14 July, as all France celebrated the bicentenary of its revolution, CERN was the scene of a revolution of a very different kind. At 16:30 hrs, a 20 GeV positron beam went round the 27 kilometres (most of which is under French territory) of CERN's new LEP electron-positron storage ring. After more than a decade of careful planning and preparation, almost six years after groundbreaking, and two years after the start of equipment installation, the LEP team delivered on the day they had told people to mark five years ago.

Following this first injection of positrons, priority was to commission the beam observation monitors. After the firs measurements of the beam trajectory, the machine physicists were making the first corrections. Several days later first particles were captured with the radiofrequency system.

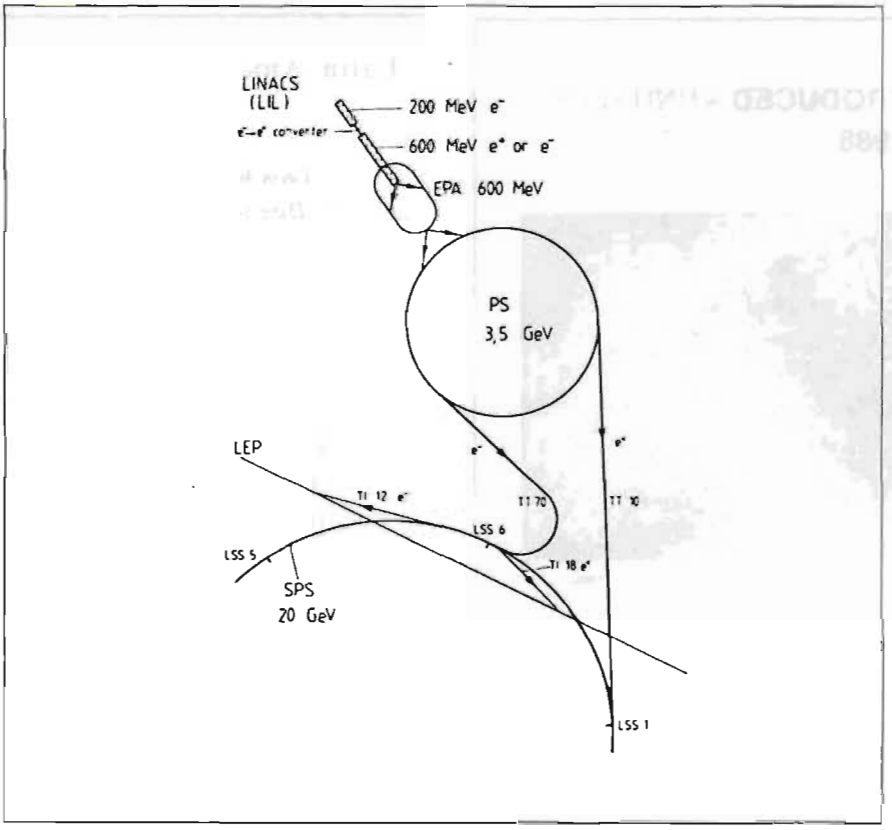
Injection from the SPS had initially encountered some difficulties in the standing-wave radiofrequency cavities used for accelerating particles for LEP, but this was soon fixed and there was a steady beam of positrons. Both electrons and positrons were accelerated and extracted on the four lepton cycles, and the transfer line feeding electrons to LEP was commissioned, although no particles were injected at first. Circulating electrons made their appearance in LEP on 25 July.

On 27 July positrons were accumulated and stored, the intensity of the stored LEP beam increasing over the following days from 20 to 250 microamps. On 3 August, attention turned to electrons once more, with particles being stored. Later that day, positrons were accelerated from 20 to 47.5 GeV without loss.

Beam currents built up steadily, with positron beam reaching 700 and electrons 300 microamps over the next few days. On 11 August the low beta system came into action to squeeze the beam in the collision points, and there was enough confidence to go for a pilot physics run with 45.5 GeV colliding beams. By 14 August each of the four big experiments – L3 Aleph, Opal and Delphi – had seen their first Z particles*. LEP was in business.

During this time, the faithful SPS, using subtle interleaving of acceleration cycles, continued to supply protons for a

* Z is the particle the existence of which was predicted by the electroweak unification theory of Abdus Salam, S. Glashow and S. Weinberg.



Electrons and positrons for LEP are provided by CERN's complex of interconnected accelerators.

full programme of fixed target physics at the same time as providing LEP with its electrons and positrons.

Before arriving in LEP, the electrons and positrons have already come a long way, having transited CERN's unique complex of interconnected accelerators. The particles are manufactured by the LIL injector – positrons from an initial 200 MeV high current electron linac providing electron-positron pairs from photon conversion, with a second linac taking electrons and positrons to 600 MeV. They are then stored in the EPA accumulator before being passed to the PS synchrotron for acceleration of 3.5 GeV. Using the same beamlines as the proton-antiproton collider scheme, the particles are then fed into the SPS for acceleration to 20 GeV, ready for injection into LEP.

The commissioning featured regularly updated computer news bulletins. With accurate and up-to-date information readily available, enthusiastic LEP followers could monitor progress without having to pester colleagues who had their hands full.

Science's Go-Go Growth: Has It Started to Slow?

by
David Pendlebury
David Pendlebury

From "The Scientist",
7 August, 1989.

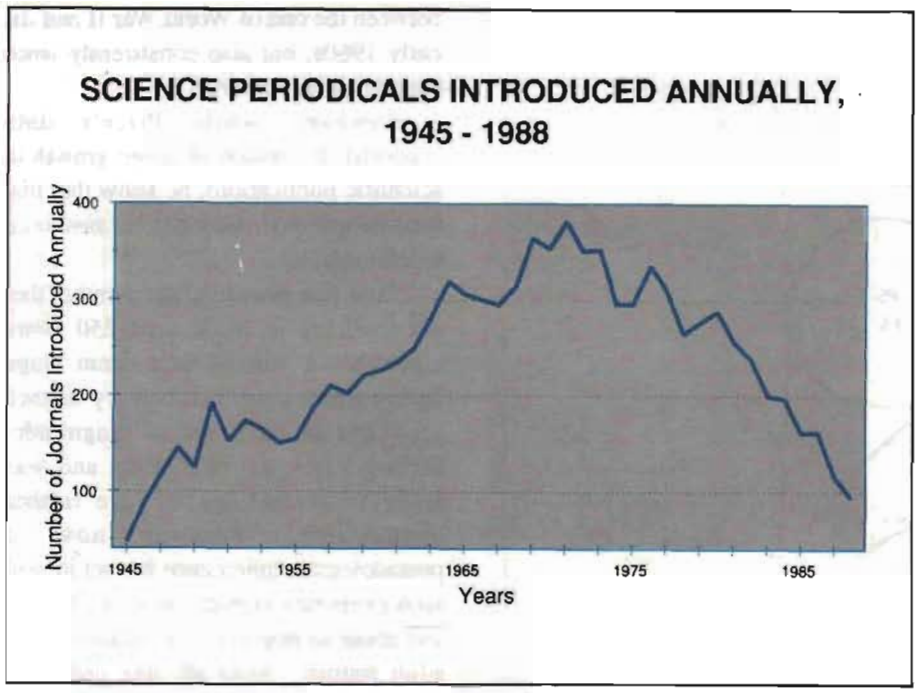
The size of science as measured by the number of journals being published "tends to double within a period of 10 to 15 years," Derek J. de Solla Price observed in his 1963 classic book *Little Science, Big Science* (New York: Columbia University Press). Price found that this "fundamental law," as he called it, held true not only for the period between the end of World War II and the early 1960s, but also consistently since the early 18th century.

However, while Price's data supported the notion of go-go growth in scientific publications, he knew that that kind of growth could not be sustained indefinitely.

"It is just possible," he wrote, "that the tradition of more than 250 years represents a sort of adolescent stage during which every half century science grew out of its order of magnitude, donned a new set of clothes, and was ready to expand again." He further speculated: "Perhaps now a postadolescent quiescence has set in, and such exuberant growth has slowed down and about to stop upon the attainment of adult stature. After all, five orders of magnitude is rather a lot...It is clear that we cannot go up another two orders of magnitude as we had climbed the last five. If we did, we should have two scientists for every man, woman, child, and dog in the population, and we should spend twice as much money as we had.

Since Price wrote that 26 years ago, at least one trend has appeared that does in fact point to the inevitable slowing down that he foresaw: the number of new scientific journals introduced each year.

Price had charted the number of new scientific journals from the founding of the *Philosophical Transactions of the Royal Society* and the *Journal des Sçavans* in the late 17th century up to the early 1960s and observed an exponential increase. With the exception of more gradual growth in the first 50 years, he observed a doubling in scientific journals every 15 years or so. Price noted in 1963 that there were then some 30,000 scientific journals being published. If the growth rate had held up since, we should now be nearing, at minimum, some 100,000 journals. Even using the broadest definitions of what makes for a scientific journal, there are perhaps only one-half that number being published today. In fact, the growth that Price observed and predicted



Source: *Ulrich's International Periodicals Directory.*

could not be sustained seems to be slowing.

The accompanying chart records the number of science journals introduced annually since 1945. The data are derived from *Ulrich's International Periodicals Directory*, one of the most comprehensive source of information on periodicals published both in the United States and throughout the world.

For science journals, *Ulrich's* lists, for example, 152 new titles in 1950. In 1965, the number was 306 – a reflection 1965, the number was 306 – a reflection of the doubling phenomena Price had observed for the total population. But in 1980, the number of new science periodicals was only 288, and the number since then has declined.

What this data set does not reveal is the growth in the number of scientific journal *articles* over time and the phenomenon of fatter journals. Nor does it reveal the changing economic conditions for publishers over this period. Nonetheless, it is hard to see how these or other variables would account for such a dramatic decline in the annual introduction of new scientific journals.

Price ventured to state what the characteristics would be of the period in which the exponential growth of science begins to level off. "Clearly there will be rapidly increasing concern over ... problems of manpower, literature, and expenditure that demand solution by reorganization," he predicted.

In many ways, that scenario is descriptive of the scientific enterprise in the 1980s.

It is evident to all involved in science today that the scientific literature is today that the scientific literature is continuing to grow, in new journals, in total number of articles, an in number of investigators. And the cry of "too many papers" and "can't keep up" is real enough for many working scientists.

Nonetheless, in a broader view, the growth rate of the scientific literature does seem to have crested – at least for the moment.

David Pendlebury is an analyst in the corporate research department at the Institute for Scientific Information, Philadelphia.

Latin American Science

by
Leon M. Lederman
Director Emeritus
and
Roy Rubinstein
Assistant Director,
Fermi National Accelerator Laboratory,
Batavia, Ill., USA.

From "The Scientist",
11 December, 1989.

The Oct. 30, 1989, issue of *The Scientist* contained a report in the University Briefs section [page 6] about the creation of a Western Hemisphere sister institute to the International Centre for Theoretical Physics in Trieste, Italy. We at Fermilab have had a similar program of cooperation with developing nations of Latin America. However, we put major stress on experimental science and technology, with the thought that collaboration here would be more relevant to the needs of development. Our motivation was to advance world science and especially physics, in which human resources are still the most important ingredient.

The attention that we feel should be given to helping science in given to helping science in underdeveloped nations is due in part to the financial difficulties of most of these countries and in part to recognition that a strong scientific infrastructure is a necessity for a country's technologic advancement, which in turn is the basis for its economic development. Also, as scientists, we believe that science should strive to use the talents of all having the abilities to contribute to its advancement.

One element of the Fermilab program has involved the administration of grants to aid Latin American physics, an effort arising from discussions at the Second Symposium on Pan American

Collaboration in Experimental Physics, held in Rio de Janeiro in July 1983. At the symposium, many participants expressed concern at the effects of the economic crisis on the growing scientific infrastructure of the most developed countries in Latin America. It was realized that a relatively small amount of money would be enormously helpful in tiding the physicists in those countries over the difficulties caused by the hard-currency shortages.

The eventual result was a $300,000 grant in 1984 from NSF (partially funded by the Department of Energy) to the American Physical Society, with principal investigators Leon Lederman (Fermilab) and Leo Falicov (University of California, Berkeley). The grant was for assistance to physics in Argentina, Brazil, Chile, Mexico, and Venezuela; it was to be used for library subscriptions to U.S. journals, payment of page charges for articles in U.S. journals, per diem support for Latin American physicists on short visits to the U.S., and spare parts and small equipment items for Latin American physics laboratories. Note that all grant funds were to be expended in the U.S.

The funds were all used by the end of 1986; after much letter writing and pleading, Fermilab was awarded another $100,000 grant in 1987, this time from DOE; this grant, whose purpose and method of administration was identical to the first one, is currently almost all spent.

to the first one, is currently almost all spent.

The grants were administered essentially by Falicov and Fermilab's Roy Rubinstein, with all activities carried out at Fermilab; no overhead was charged to the grants. In each recipient Latin American country, two representatives were chosen to ascertain, in a fair manner, the most critical needs for that country; a strong effort was made to select outstanding members of the physics community in each country, often involving that country's physicists' organization. The U.S. administrators, as far as possible, respected the choices of a country's representatives, although items were rejected if judged to be not for physics research.

Administering the grants was not without incident; much work was involved but it has led to some understanding of the problems of undertaking research in underdeveloped countries, and also to lasting friendships with many of the other people involved in this undertaking, who all were taking part not for material reward but for the satisfaction of assisting their fellow physicists. We have many anecdotes (including visitors to the U.S. with no money, phoning and expecting us to instantly supply funds), and have acquired a healthy respect for the often almost incomprehensible and time-dependent regulations for getting scientific equipment past customs departments in the various countries. Dealing with some U.S. companies and persuading them to ship equipment to Latin America was often interesting, to say the least. The reader can perhaps appreciate the labor involved in administering $400,000 worth of grant monies in which the typical transaction is about $600; it was truly a labor of love.

It is obviously of interest to verify the success of these grants in helping to facilitate physics research in Latin America. It is difficult to be quantitative, but we have had many conversations with Latin American physicists describing how their work became possible because of the grants.

physicists describing how their work became possible because of the grants.

In addition, when the first grant ran out we reviewed more than 30 letters pleading with us to try and obtain a renewal.

Some quotes from these are as follows:

- "In a country like Chile ... scientific isolation is one of the main problems..."
- "The funds were used to buy pure metals for evaporating purposes, materials which were not available in my country."

Our opinion is that the grants have been very valuable in allowing physics research in Latin America that would otherwise not be possible. We hope that our experiences can be useful to others involved in similar projects. The needs for such assistance in Latin America (and presumably in other less-developed countries around the world) is large. The mind boggles at the benefits, long-term to science but short-term in so far as international amity, that would follow from a 100-fold multiplication of this project, spread to all scientific disciplines. The cost could soar to 0.2% of our foreign aid.

Applied Mathematics in the Andean Region

by

Roberto Semenzato

University of Padua, Italy.

The First Latin American Workshop on Industrial Mathematics took place last year in Mar del Plata, Argentina (see SIAM News, November 1988). Lima, Peru, in June was the venue for the second Workshop. This event was organized in the framework of "Multiciencias", a program of activities sponsored by the International Centre for Theoretical Physics of Trieste, and aimed at the scientific development of the Andean Region (which includes Peru, Venezuela, Colombia, Ecuador and Bolivia) with an emphasis on the

Venezuela, Colombia, Ecuador and Bolivia) with an emphasis on the

problems which may be relevant for this area. The Director of "Multiciencias" is Dr. Victor Latorre, a distinguished Peruvian physicist, former professor at the Universidad Nacional de Ingeniería in Lima and former President of the Peruvian Institute of Nuclear Energy, who has been successfully running the program for eight years with much enthusiasm and dedication, despite the innumerable organizational difficulties which one has always to face in Peru. A few words are in order about the International Centre for Theoretical Physics, a research institute based in

Trieste, Italy, financed mainly by the Italian Government, through the Department of Cooperation of the Ministry of Foreign Affairs, and connected to UNESCO and the International Atomic Energy Agency in Vienna. Its Director, Nobel Laureate in Physics Professor Abdus Salam, supports science in Third World countries as one of the Centre's main activities, and "Multiciencias" was proposed by him during a visit at the University of Cuzco. Additionally this event had also the support of Concytech (the Peruvian Research Council).

The Workshop took place in the beautiful setting of the Country Club "El Bosque", some 20 miles east of Lima, from June 19 to 28, 1989. It was attended by about 30 people from Peru, Colombia, Ecuador, Bolivia and Argentina. The first four countries have little tradition in mathematical research, either pure or applied. Despite this, there seems to be a growing interest in applied mathematics, viewed as an opportunity for mathematicians to get involved in helping to solve some of the countries' problems, and therefore as a way of justifying their role. In addition, universities in Latin America have a strong projection towards the outside world, in an attempt to use their resources, both technological and intellectual, to the benefit of the whole population. This role is greatly emphasized in universities and explains the strong appeal of applied mathematics not only to mathematicians, who use to consider themselves just as teachers at the service of other careers, but also to engineers, who were well represented among the participants.

Activity in applied mathematics, in a wide sense, is already being developed in some universities, and this came out during the panel discussion held in the last morning of the workshop. In Peru, at the University of San Marcos in Lima, statisticians help industries and public institutions. Interestingly, they charge their clients not in cash but in supplies which are badly needed, such as computer diskettes, writing paper, etc. At San Marcos an Institute of Biomathematics has been established where emphasis is on the interaction among mathematicians, statisticians and biologists. At the Universidad Nacional de Ingenieria, in Lima, a group led by Dr. E. Blum, a Swiss-born mathematician, is working in optimization and actively seeking contacts with industry. Finally, at the Universidad Católica in Lima, a privately-run academic institution with a reputation of being one of the most prestigious in the whole country, has set up a Laboratory of Statistics, run by Prof. L. Gasco, which helps other departments, like geology, archaeology, geography, psychology. Almost nothing is being done in the provinces outside Lima, with the exception of the University of Trujillo, a city some 300 miles north of the capital, from where Prof. E. Vergara brought some problems taken from his experience of collaboration with the sugar cane industry. Ecuador (Escuela Politecnica Nacional, Quito) has some activity in the area of biomathematics and operational research, and in Bolivia (Universidad Mayor de S. Andrés, La Paz), mathematicians give support to projects with industry developed by other university departments. More activity seems to be going on in Colombia; people working on simulation of dynamical systems and computer-aided design give assistance to industry, as reported by Prof. E. Ruiz, from the Universidad Nacional de Colombia in Bogota. We shall not speak of what is going on in Argentina – represented by Dr. V. de Spinadel, a mathematician from the University of Buenos Aires, – which stands, as far as its tradition in mathematical research is concerned, at a considerably higher level than the other countries represented here.

The talks presented at the workshop can be classified into three different groups. Two series of lectures were short courses on a specific subject "Mathematical Modeling Applied to Exploitation of Solar Energy", by Prof. P. Vestrucci, of the University of Bologna, Italy; "Computer Simulation of Industrial Problems", by myself. The lectures by Prof. E. Cumberbatch of The Claremont Colleges, USA, and of Dr. S. Howison of Oxford University, England, were similar in character in the sense that both lecturers presented a variety of case studies, derived from their experiences, respectively, with the Claremont Mathematics Clinic and the Oxford Study Group With Industry. In their lectures Cumberbatch and Howison tried to focus on problems which might be of interest to developing countries. Finally, there were three lectures dealing with problems taken directly from the Peruvian reality.

Prof. E. Vergara, a young mathematician from the University of Trujillo, brought an operational research problem from the sugar cane industry, consisting in the optimal organization of the basic operations which precede the processing of the cane in the plant. These operations are burning of the cane (to take the leaves off), cutting, loading, trucking, unloading. The constraints are the following: the cane cannot be left unprocessed for more than fifteen days, otherwise it gets spoiled; the plant has a maximum daily processing capacity; there is a limited number of means to cut, load, truck, and unload the cane. The problem then is how to organize all the afore-mentioned operations in such a way that the minimum amount of cane (or possibly none) gets spoiled, and the plant can work steadily close to its maximum processing capacity. For a couple of years Prof. Vergara has stayed in contact with the factory technicians to collect information and data, and has shown, both in his exposition and informal conversations, to be well acquainted with all the details of the process. The preliminary search and modeling trials that he has done will surely be of help to a more systematic approach to the problem, which can possibly lead to original research work. There may be some doubt on how much

the organization of the sugar cane cooperative can take advantage of such modeling work. The Peruvian sugar cane cooperatives are badly in need of efficient management before any modeling type work is of usefulness. However the value that such type of work can have may be in the training it gives university people to do good quality research related to problems of local interest.

Prof. E. Blum discussed his collaboration with Electroperu, the National Electricity Company, consisting in minimizing the operational costs of a network made of hydroelectric and thermal power plants, given the power availability from each plant and the daily demand of electricity that has to be satisfied.

Finally, I, an adopted Peruvian, talked about some preliminary work carried out at the Servicio Nacional de Meteorología e Hydrología, the National Meteorology Institute (with Ing. C. Pinche an his collaborators) on modeling of very simple devices to catch the fog of the coastal hills of Peru and transform it into liquid water. The coast of Peru on the Pacific, from the southern border with Chile and north almost to the border with Ecuador, has one of the world's lowest average rainfalls. However it is often covered by thick banks of fog, especially during winter. Some simple experimental devices (made basically of framed nylon nets) convert the water from fog into liquid. Modeling based on fundamental fluid dynamics has been devised, which allows for and optimal spacing of the net, in order to maximize for collection. This mechanism is purely mechanical; it does not involve heat transfer, at least in a first approximation, nor condensation, which would make it a very complicated phenomenon to model. The problem is interesting and the modeling can be improved, for instance by considering the effect of the water drop size distribution in the fog on the collection rate. Cost will be a very strong constraint for developing sophisticated devices.

Dr. S. Howison brought some of the vast experience of the Oxford Study Group With Industry, which is well known worldwide in the applied mathematics environment, and has specialized in modeling problems dealing with ordinary/partial differential equations. Dr. Howison gave a clear-cut exposition of the steps that one has to follow when modeling by means of boundary value problems; the applications to thermistor design, to the prediction of the force exerted by a pantograph on the cable which carries electricity in an electric railway, and the problem of color vision in the use of fluorescent dyes were all very detailed, in such a way that an audience not very used to applying those techniques, but familiar with the basic concepts, could take the most advantage.

Prof. Cumberbatch in his series of lectures presented a variety of case studies taken from the Claremont Mathematics Clinic. There was a series of problems brought up by the Forest Service: predicting probability of fire ignition, optimal allocation of fire fighting equipment, prescribed burning of *chaparral*, temperature distribution in soil due to forest fire. To solve these problems a variety of techniques, pertaining to different areas of mathematics, had to be used. For other problems, like finding the flow past an aircraft or the distribution of nitrate content in the water table of Pomona Valley, given measurements at a discrete set of points, Prof. Cumberbatch stressed how original techniques can be found to solve apparently "trivial" problems (for instance the inversion of a matrix). In his final talks he gave a thorough account on modeling of "MOSFET" transistors for the computer industry.

In his topical series of lectures, Prof. Vestrucci presented applications of mathematical modeling and a simulation to the experimentation and construction of solar energy collectors; these more practically oriented lectures were preceded by a theoretical introduction on the derivation and application of the radiative transfer equations in the atmosphere. The topic of these lectures particularly suits the Peruvian reality, since the country has vast regions which are suitable for the exploitation of solar energy.

Finally, I gave a series of lectures intended as an introduction to discrete computer simulation, a technique that can be applied to a large variety of problems. The focus was mainly on basic concepts and practical procedures to set up simulation experiments. In the final lecture I presented a case study derived from my experience of collaboration with an Italian industry.

The material covered in the workshop had enough variety to give people a good idea of how mathematical techniques – including computational algorithms – can be applied to the analysis and solution of real world problems. However, the goal of "Multiciencias" is not just to give good introductions, but to open the route to more work in areas of local application. This has already been done with physics applied to archaeology and to the exploitation of mineral resources, and microelectronic for scientific laboratories. Of course to establish a line of work is a more difficult task than organizing a single event. Most of these countries, among them Peru, lack the basic infrastructure to do research work in mathematics, i.e. journals, books and computing resources. Even more, there is a lack at university level of good well-trained and motivated people who can engage in this type of work. To create this environment a large cooperative effort from culturally and scientifically more developed countries is badly needed.

Activities at ICTP June-December 1989

Title: RESEARCH WORKSHOP IN CONDENSED MATTER, ATOMIC AND MOLECULAR PHYSICS, 19 June - 29 September 1989.

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

Lectures: Solution of the phase problem in diffraction by multiple Bragg scattering. Self-generating oscillations in non linear waves with dispersion. Physics of immunology. Theoretical concepts for fractal growth. What is chaos – a colloquium for non-chaologists. Chaotic soliton in science and engineering. Quasicrystals. Hopping transport and localization in high electric fields. Quantum simulations: an overview. Antiferromagnetic resonance in triangular antiferromagnets. Self-organized behaviour of dislocations. The functional integral method in the problem of the lifetime of a metastable state. Nonlinear lattice statics, dynamics and statistical mechanics. Multifractal wave functions in one-dimensional systems. Chemical aspects of high-temperature superconductors. Damping of collective excitations in normal ^3He and other fermion liquids. The Cottrell-Stokes law and activation theory. Introduction to the interaction of bulk and surface modes in liquids. Electronic phase transitions in semiconductors with strong electron-phonon interaction. Electron and phonon structures and Raman effect in multiple quantum wells. Pressure induced superconductivity in elemental solids. Phonon-drag thermopower in low-dimensional semiconductor systems. Light induced magnetisation in semiconductors. Magnetism and high T_c superconductivity: new perspectives. Static and dynamic properties of clouds of virtual quanta. Frustration and correlations in Ising systems. Wetting transitions. Theory of elementary excitations with damping in systems with strong correlations and complex spectrum. Self-avoiding walks (SAWs) and self-avoiding trails (SATs) on fractal lattices. Relaxed structure and structural phase transition in crystals with surfaces – a microscopic model. Developments in the theory of multiphoton absorption by molecules (bound-bound); applications of a chiroptical nature. High temperature superconductors: facts and fantasies. Inverse problem for obtaining phonon density of states. Cooling, bunching, velocity effects and localization of atoms in a light field. Dislocation theory of elastic twinning and related topics. Diabatic and adiabatic motion in periodically driven quantum systems. Quantum distinction between regular and chaotic, dissipative motion. Hot QED for free particles made easy. Rydberg atoms and quantum optics. Phase transition in aperiodic quantum spin chains. Lattice defects in the simplest metals: progress in the study of Li and Na. Algebraic analysis of dynamical models in condensed matter physics. Quantum ballistics in two-dimensions. Solution of some problems of electron kinetics beyond the relaxation time approximation. Atomic source field effects and the action of passive systems in quantum optics. Recent progress in Fermi liquid approaches to high T_c. Influence of a magnetic field on quasi-one-dimensional electron systems. Some arguments against the validity of Boltzmann's equation in narrow gap II-IV semiconductors. Non-adiabatic effects in the electron and phonon spectra of a Peierls insulator. The localisation length of electrons in one- and quasi-one-dimensional systems. Physical modelling of electrochemical interfaces. An introduction to fractal objects. Surface first order transition in a Heisenberg ferromagnet with competing interactions. Resonatorless, dissipative optical bistability in semiconductors. Magnetoconductance in quasi-periodic superlattices. Effect of rotational constraint on lattice models. Electron cooling in strong electric fields. Dynamics of a driven and damped kink in a 1D chain. The thermopower in crystalline and amorphous semiconductors: energy transport and the role of the electron-phonon interaction. Dc and ac phonon-assisted hopping conductivity calculated from generalized master equations. Gauge theory of line defects in elastic continua and liquid crystals. Review of doping superlattices. Diffusion and thermal equilibrium defects in Si and Ge. Metal-enhanced crystallization and fractal formation. mathematical structural equivalence of TDLDA and RPAE in the calculation of atomic photoabsorption cross sections. Void lattice formation under particle irradiation – a phenomenon of self-organization. Hopping transport on deterministic aperiodic chains. Electronic properties of 2D quasicrystals. An experimental study on microstructure and annealing behaviour of rapidly quenched Al-Si alloys. Three-photon interband processes in solids. Hot electron properties in GaAs/AlGaAs heterojunction prepared by LPE. Bimetallic interfaces. Hard-core Yukawa fluid – some new results. Dynamical effects in electron tunneling. Development and characterization of device grade thin films of semiconductors. Vibrational spectra of quasicrystalline superlattices. Surface and interface electronic structure of alkali

halide crystals (LCAO slab calculations). Dislocation representation of a wall of elastic domains. Random site-bond percolation: application to high T_c superconductors. Experimental and theoretical study of Ge/Pd/n-GaAs and Si/Pd/n-GaAs ohmic contacts. Simulation studies of low-dimensional classical spin systems with long-range interactions. Computer modelling of coherence effects in the excitation transfer in photosynthetic units. Semiconductor epitaxial layers characterization by persistent photoconductivity measurements. Swendsen-Wang algorithm and critical behaviour of the dilute Ising model. Diagram technique for non-orthogonal group functions. Self-interaction in Hopfield model.

The Workshop was attended by 310 lecturers and participants (257 from developing countries).

Title: TOPICAL MEETING ON VARIATIONAL PROBLEMS IN ANALYSIS, 28 August - 8 September 1989.

Organizers: Professors A. Ambrosetti (Scuola Normale Superiore, Pisa, Italy) and D.G. de Figuereido (Universidade Estadual de Campinas, Brazil).

Lectures: New contexts and old theories. Some semilinear elliptic problems. Variational aspects of hydrodynamic problems. Semilinear elliptic equations with nonlinearity crossing all eigenvalues but a finite number. Approximation methods for some nonlinear problems. The Palais-Smale condition versus coercivity. Morse theory for Harmonic maps. Relative category and Hamiltonian systems with periodic Hamiltonian. On the exact number of solutions for an ODE through Morse index computation. Simplicity and isolation of the first eigenvalue of the p-Laplacian. On the singular set of the Ambrosetti-Prodi problem. Existence of solutions for resonant elliptic problems. Bifurcation from infinity in nonlinear elliptic equations involving the critical Sobolev exponent. Variational problems: topology and physics. Elliptic problems. Periodic solutions for Hamiltonian systems in a nonconvex potential well. Multiple solutions for superlinear elliptic equations. A strong resonance problem. Shape optimization for Dirichelet problems: relaxed solutions and optimality conditions. Plateau problem of minimal surfaces in Riemann manifolds. Periodic solutions of the first order dynamical system. Ordinary differential equations with impulses: a control theory applications. Crystal microstructure, Young measures, and variational problems of elasticity theory. Variational identities and elementary applications. Periodic solutions of superquadratic Hamiltonian systems. Nontrivial solutions and eigenvalue problems for Monge-Ampère type equations. Critical exponents and critical dimensions for semilinear equations. Nonlinear elliptic equations at a critical exponent. The Graetz problem – a variational treatment of a non self-adjoint equation. Asymptotic behaviour for nonlinear ordinary differential equations. Mathematical theory of stationary miscible filtration. On the Grad-Shafranov equation. A note of eigenvalue problems of elliptic equations of high order. On the generalized Arnold conjecture for ($\mathbb{C}P^n$, $\mathbb{R}P^n$) and ($\mathbb{C}P^n$ x $\mathbb{C}P^n$, $\mathbb{R}P^n$).

The Topical Meeting was attended by 90 lecturers and participants (50 from developing countries).

Title: COMPUTATIONS IN PHYSICS AND PHYSICS IN COMPUTATION (Anniversary Adriatico Research Conference, 5 - 9 September 1989.

Organizers: Professors R. Car (International School for Advanced Studies, ISAS-SISSA, Trieste, Italy), B.A. Huberman (Xerox Palo Alto Research Center, Palo Alto, USA) and A. Sadiq (Pakistan Institute of Nuclear Science and Technology, Islamabad, Pakistan), with the co-sponsorship of the European Research Office of the U.S. Army, IBM-Italy and SISSA.

Lectures: Complex ordering phenomena in simple systems. Fundamental limits to information. Molecular dynamics studies of structural slowing down and the glass transition in simple systems. Decomposition of information with respect to scale and correlation length. Entropy and complexity of cellular automata. Special purpose processors for statistical mechanical simulations. The ecology of computation. Metastability in distributed computation. An overview of computations in material physics. Simulation spectroscopy and vibrational localization in amorphous glasses. First-principles molecular dynamics. A polarizable charge site model for water using and extended Lagrangian. Recent advances in quantum mechanical reactive scattering. Path integral treatments of static and dynamic processes in liquids. The use of neural networks for finding structure in chemical languages. Hyphenation in natural languages by neural networks. Doing physics on the connection machine. Quantum dynamics by numerical simulation. Numerical simulation of many-fermion models in condensed matter physics. Computational methods in quantum field theory. Neural nets. Quantum Monte Carlo for chemical systems: a new pseudo-Hamiltonian technique. Ground-state fermion Monte Carlo simulations. Numerical simulation of models for the high T_c materials. Dynamical properties of the two-dimensional Hubbard model. Concluding remarks.

The Conference was attended by 90 lecturers and participants (53 from developing countries).

Title: ADRIATICO WORKING PARTY ON CONDENSED MATTER PROPERTIES OF NEUTRON STARS, 11 - 29 September 1989.

Organizers: Professors H.A.

Cerdeira (Brazil/ICTP) and G. Srinivasan (Raman Research Institute, Bangalore, India).

Lectures: What are the stars? The nature of pulsars. Theory of superconductivity. Equation of state of neutron star matter. Superfluidity and superconductivity in neutron stars. Neutron star crust and cooling. The structure of flux tubes in neutron stars. Vortex pinning, post-glitch relaxation and crystal heating. The role of the magnetic fields of neutron stars – an overview. Do pulsar magnetic fields decay? The evolution of the magnetic field of pulsars. The dynamics of vortex lines and the decay of pulsar magnetic fields. Electrical resistivity of magnetized cores of neutron stars. Ohmic decay of the core field. Equation of state – the moral of millisecond pulsars. High energy gamma-ray stars. Thermal growth of neutron star magnetic field. Growth of pulsar magnetic fields: observational constraints. Thermal radiation from neutron stars: role of the magnetic field. Electrical resistivity of neutron star crust. A mechanism for the decay of pulsar magnetic fields. On the structure of neutron star crust. Electrohydrodynamic instability of the surface of neutron stars. Electrodynamics of the polar cap region: some effects of general relativity. Spin-up of a new-born neutron star.

The Working Party was attended by 31 lecturers and participants (16 from developing countries).

Title: WORKSHOP ON MATERIALS SCIENCE AND PHYSICS OF NON-CONVENTIONAL ENERGY SOURCES, 11 - 29 September 1989.

Organizers: Professors D. Nobili (Laboratorio di chimica e tecnologia dei materiali e componenti elettroniche, LAMEL, Bologna, Italy), A.A.M. Sayigh (Engineering Department, University of Reading, UK) B.O. Seraphin (University of Arizona, Tucson, USA) and G. Furlan (University of Trieste and ICTP, Italy), with the co-sponsorship of the Direzione Generale per la Cooperazione allo Sviluppo (Italian Ministry of Foreign Affairs, Rome, Italy) and Consiglio Nazionale delle Ricerche, CNR (Rome, Italy).

Lectures: Devices and optics for P.V. conversion. Materials for energy-efficient windows: survey. Large-area chromogenics for transmittance control. Activities at the ENEA Laboratory. Mono/poly-crystalline Si-cells. Fundamentals of amorphous silicon semiconductors. Transparent insulation materials and their application in solar thermal energy conversion. Basic physics of amorphous silicon solar cells. Design and matching for P.V. systems. Present research activities at Conphoebus (Catania, Italy). Amorphous silicon cells – production technology. The Portici Laboratories (Naples, Italy). The Delphos Project (ENEA, Rome, Italy). An overview of P.V. technologies. Amorphous semiconductors: silicon-based alloys. Towards a network of centres of international scope on NRSE. Electromicroscopy of semiconductor materials. Solar cell performance characterization. Economic aspects of P.V.: costs of production of P.V. modules. Microanalysis of P.V. devices. Mini-hydropower. State of the art of wind energy. Thin films for S.E. conversion. Tandem amorphous solar cells. An overview of activities in P.V. Cells. An overview of activities in P.V. Economic aspects of P.V.: economics of P.V. applications. Research activities in P.V. Adaptation control techniques for optimized management of P.V. systems. Chemistry and technology of MOVPE for semiconductor devices. Storage. The mechanism and efficiency of photosynthesis. Telecommunication systems and sources of energy for TLC. Standards and qualifications for P.V. sources. P.V. stand alone systems and P.V. hybrid systems – examples. Review of the activity in biogas and anaerobic digestion. Biomass as an energy resource. Solid liquid junction for solar energy conversion. Electrochemical energetics. Characterization of solid electrolytes. Solar energy activities in Arab countries. Highlights from the Tokyo conference. Materials for nonconventional electrochemical energy sources and optical displays. Amorphous and polycrystalline semiconducting electrodes for photoelectrochemical solar cells.

The Workshop was attended by 205 lecturers and participants (163 from developing countries).

Title: WORKSHOP ON INTERACTION BETWEEN PHYSICS AND ARCHITECTURE IN ENVIRONMENT CONSCIOUS DESIGN, 25 - 29 September 1989.

Organizers: Professors F. Butera (University of Palermo, Italy), O. Corbella (Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil) and A. De Carli (Comitato Nazionale per la Ricerca e per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative, ENEA, Rome, Italy), with the co-sponsorship of the Direzione Generale per la Cooperazione allo Sviluppo (Italian Ministry of Foreign Affairs, Rome, Italy) and ENEA.

Lectures: Principles of thermal comfort and cooling strategies. Physical principles involved in natural cooling. Natural cooling in traditional and modern architecture. Instrumentation and measurement methods. Monitored measurement methods. Monitored bioclimatic buildings. Introduction to monitored bioclimatic buildings in Latisana (Italy). Computer aided learning in bioclimatic architecture. TRNSYS code for bioclimatic building simulation. Computer simulations of bioclimatic buildings visited in Latisana and comparison with measured data. Computer aided design and cooling issues: recent advances in simulation and in artificial intelligence applications. Cooling for outdoor spaces. Architectural issues and design options: pilot experiment EXPO '92 in Seville. Simulation, monitoring and evaluation of Project EXPO '92. Cooling

technologies and techniques by means of renewable energy sources. Lighting loads and new transparent materials. Passive design concepts in Arab countries.

The Workshop was attended by 46 lecturers and participants (29 from developing countries).

Title: TRIESTE CONFERENCE ON RECENT DEVELOPMENTS IN CONFORMAL FIELD THEORIES, 2 - 4 October 1989.

Organizers: Drs. E. Gava (Istituto Nazionale di Fisica Nucleare/ICTP), K.S. Narain (CERN, Geneva, Switzerland/ICTP), S. Randjbar-Daemi (Iran/ICTP), E. Sezgin (Turkey/ICTP) and J.B. Zuber (Commissariat à l'Energie Atomique, Saclay, France).

Lectures: Twisted conformal field theories. Extended chiral algebras, modular invariants, and fixed points in conformal field theories. Feigin-Fuchs representation on Riemann surfaces. Fusion algebras and differential equations approach to RCFT. A coset construction for classical integrable hierarchies. S-matrix bootstrap and rational integrable models. Conformal field theories and lattice integrable models. Unitarity of superstring theory. Quantum groups in conformal field theories and integrable systems. Correlation function for SU(2) parafermions on the torus. An expanding universe in string theory. Renormalization of higher spin conserved currents. Generalized Toda field theories and S-matrices. Temperley-Lieb algebras. Rings of invariants for finite groups. W-algebras and parafields. The quantum group structure of 2D gravity and minimal models. Aspects of the connection between Chern-Simons-Witten Lagrangians and conformal field theories. Aspects of topological gauge theory in 2+1 dimensions and its relation to integrable lattice models. Affine characters and modular transformations. BRST quantization of conformal field theory on a random surface. Chiral bosonization of superconformal ghosts on Riemann surface and path-integral measures.

The Conference was attended by 48 lecturers and participants (15 from developing countries).

Title: FIFTH COLLEGE ON MICROPROCESSORS: TECHNOLOGY AND APPLICATIONS IN PHYSICS, 2 - 27 October 1989.

Organizer: Mr. C. Verkerk (CERN, Geneva, Switzerland). Dr. A. Colavita (Argentina/ICTP) acted as Head of the Laboratory. Co-sponsorship of the Direzione Generale per la Cooperazione allo Sviluppo (Ministry of Foreign Affairs, Rome, Italy) and of the United Nations University (Tokyo, Japan).

Lectures: Introduction to Logic. Introduction to (Micro)computers. Characteristics of the 6809. Assembly language programming. ROSY + FLEX. Microprocessor interfacing. The Colombo '84 board. Personal computers in the USSR. Software tools and techniques. A/D, D/A and V/F conversion. The Colombo '84 Kernel software. Bus basics. Software tools and techniques. Transputers. Introduction to projects. Array logic. Maintenance. Other microprocessors. Real time systems. Introducing the Microprocessors Laboratory and ROSY Junior. Computer modelling of computer elements. Floating point. DSPs. Multichannel analysis.

Laboratory Sessions: Logidules, AND, OR, majority, full adder, flip flop. Shift register, latch, counter, ALU. Rosy, demo hands-on, commands, debugging. Hand-coding. FLEX introduction, commands, file system, editor, assembler. Flow of control, if...then...else, while...do..., repeat...until..., case. Subroutines principals, parameter passing. I/O logidules on Rosy, decoding, read/write registers. PIA basics, display on ICTP board. PIA control lines, counters. Repetition, finish previous exercises, free programming. Interrupts logidules on Rosy, interfacing to IRQ. D to A, DAC on logidules, voltage supply, function generator. A to D simple DVM, successive approx. V/F, V/F conversion on ICTP board. Projects.

The College was attended by 114 lecturers and participants (100 from developing countries).

Title: COLLEGE ON SOIL PHYSICS, 9 - 27 October 1989.

Organizers: Dr. D. Gabriels (State University of Ghent, Belgium), Prof. I. Pla Sentis (Universidad Central de Venezuela, Maracay, Venezuela), Dr. E. Skidmore (U.S. Department of Agriculture, Manhattan, Kansas, USA), and Prof. G. Ghirardi (University of Trieste and ICTP, Trieste, Italy), with the co-sponsorship of the Direzione Generale per la Cooperazione allo Sviluppo (Italian Ministry of Foreign Affairs, Rome, Italy)

Lectures: The soil resources: classification of the soils of the world with reference to the soil physical aspects. Soil composition. Soil structure formation. Soil mechanical aspects. Water erosion processes: parameters. Modelling water erosion processes. Soil conservation techniques. Soil management principles. Rainfall, infiltration, crusting. Magnetic soils on Earth and Mars. Examples: soil erosion, soil conservation. Measurement of soil physical properties. Soil water potential – tensiometers. Soil imagery techniques: some results. Soil water potential – tensiometers: practical applications. Unsaturated waterflow. Wind erosion. Water balance: principles. Theoretical basis of neutron and gamma density gauges. Methods of calibration. Field applications. Introduction to the infiltration process. Evaluation of field infiltration tests. Water balance studies. Analytical solutions for flow of water in unsaturated soils: transient one-dimensional flows and steady multi-dimensional flows. Physical aspects of growth and functioning of plant roots. Movement of solutes. Movement of solutes: practical aspects. Spatial

variability of soil physical properties: theory and sampling. Scaling. Spatial variability of soil physical properties: modelling. Spatial variability: practical examples. Water balance studies.

The College was attended by 99 lecturers and participants (70 from developing countries).

Title: COLLEGE ON DIFFERENTIAL GEOMETRY, 30 October - 1 December 1989.

Organizers: Professors J.P. Bourguignon (Ecole Polytechnique, Palaiseau, France), M. do Carmo (Instituto de Matematica Pura e Aplicada, IMPA, Rio de Janeiro, Brazil), H.B. Lawson Jr. (State University of New York at Stony Brook, USA) and R. Tribuzy (University of Manaus, Brazil).

Lectures: Basic Riemannian geometry. A historic overview of the programme. Function theory and minimal surfaces. A theory for turbulent dynamics. Spaces of Riemannian manifolds. Linear analysis for the geometer. Toponogov theorem with applications. Differential forms and applications. Topology and geometry of minimal surfaces. A report on the classification of complete manifolds with non-negative curvature operators. Generic minimal surfaces. Pseudospherical surface equations and Bäcklund transformations. Isoparametric submanifolds in semi-Riemannian spaces. On the existence of minimal submanifolds in semi-Riemannian spaces. On the existence of minimal surface with free boundary. Nonlinear analysis for the geometer. Examples of minimal surfaces. Kähler submanifolds of the Euclidean space. Weierstrass' representations for superminimal surfaces in S^4. Lower bounds for the Morse index of a minimal surface in R^3. Constant mean curvature foliations of Riemannian manifolds. Moduli of genus zero superminimal surfaces in S^4. Escaping harmonic maps: an example. Constant mean curvature tori. Multiple solutions to Plateau and Douglas problem in Riemannian manifolds. Minimal submanifolds and generalizations of the Cauchy-Riemann equations. Some geometric models in the natural sciences. Some new results in surface theory. Minimal hyperspheres in symmetric spaces. Harmonic maps heat flow in dimension two. Real isometric immersions of Kähler manifolds. On the existence of minimal surfaces supported by thin obstacles. Variational techniques in geometry. Isoperimetric inequalities: an introduction. Invariant tensors and homogeneous spaces. Spherical-type hypersurfaces in a Riemannian manifold. Inner type isometries on Lie groups. Manifolds of negative curvature. An intrinsic multidimensional geometric generalization of the wave and sine-Gordon equations. Mean curvature functions for codimension-one foliations. Curvature properties of twistor spaces. Geometric invariants associated to the space of flat connections. Harmonic morphisms and three-dimensional geometry. What is a twistor? A class of totally geodesic foliations of Lie groups. Regularity theory on p-harmonic obstacle problems. The normal connection and isoparametric submanifolds. De Rham's theorem for singular varieties. Convergence of metrics. Einstein metrics. Geometric quantization of homogeneous symplectic manifolds. Construction of harmonic maps between pseudo-Riemannian manifolds. The geometry of R-spaces. Isotropy irreducible Riemannian manifolds. Cheeger-Gromov convergence under Ricci curvature bounds. Removable singularities of Einstein metrics. Einstein metrics on principal torus bundles. Cohomogeneity one Riemannian manifolds. The Futaki invariant. Hermite-Einstein metrics and stability of bundles. Algebraic construction for Hermite-Einstein metrics and compactification of the moduli spaces. On the second fundamental form of an Einstein 4-submanifolds in E^6. Kähler-Einstein metrics and stability of the tangent bundle. Moduli of Einstein metrics. Inequalities for the sectional curvature and the Ricci curvature of submanifolds. Geodesic sprays and universality. G_2-stable bundles and algebraic completely integrable systems. Calabi-Yau metrics on the Fermat surface. Isometries and totally geodesic submanifolds.

The College was attended by 180 lecturers and participants (109 from developing countries).

Title: SECOND WORKSHOP ON TELEMATICS, 6 - 24 November 1989.

Organizers: Professors G. Perrucca (Centro Studi e Laboratori Telecomunicazioni, CSELT, Turin, Italy) and M. Pitke (Centre for Development of Telematics, Bombay, India), with the sponsorship of the Italian Direzione Generale per la Cooperazione allo Sviluppo (Ministry for Foreign Affairs, Rome, Italy).

Lectures: Telecommunications and informatics. Telematics and developing countries. Telephony basics. Wide band network. Data transmission protocols. Digital transmission. Switching. Packet switching. Digital signal processing. Telecommunication network. Telematics and developing countries. LANS and WANS. Packet switching: practical aspects. Automatic speech recognition. Introduction and speech synthesis. Satellite communication. Optical transmission systems. Communication software. Cambridge HSLANs. Real-time applications on high speed packet networks. VLSI.

Laboratory work: Electronic telephone. Speech Codec. Digital switching. Digital signal processing. Digital tone generation. Telephony software. Data communication. Bit synchronisation. PABX demonstration. Optical fibre kit demonstration.

The Workshop was attended by 92 lecturers and participants (85 from developing countries).

Title: ICTP-INFN COURSE IN BASIC VLSI (Very Large Scale Integration) DESIGN TECHNIQUES, 6

November - 1 December 1989.

Organizer: Professor A.A. Colavita (Argentina/ICTP and INFN). Dr. S. Turrini (ICTP) acted as Head of practical exercises. Co-sponsorship of the United Nations University (Tokyo, Japan) and the Italian Direzione Generale per la Cooperazione allo Sviluppo (Italian Ministry of Foreign Affairs, Rome, Italy). Co-operation of ES2 – European Silicon Structures which provided the software used during the Course.

Lectures: Course overview. Digital design: Boolean algebra; realizing logic in hardware; building blocks for digital design; sequential machines; practicing design. Introduction to the design of optimized arrays: overview; schematic capture; model language; simulation; analogue cells; wave and physical design; generators and synthesis; requirements for tests; WDL language; Solo 20XX presentation. VLSI technology: introduction to VLSI technologies; MOS physics and design; CMOS processing technology and layout; logic and circuit design; system design and design methods; CMOS subsystem design; new approaches for VLSI. Present and future fabrication techniques: general overview of fabrication illustrated by means of the 7 mask NMOS process; basic fabrication steps, viz. patterning (lithography), layering, etching and doping; new technological trends, e.g. in situ process and nanometer technology.

Laboratory: Two-four line decoder. Basics of Unix: some basic commands and edit. Model code and symbol editing. Bus construction and four-sixteen decoder. Ignition regulator. Window detector. RAM module. Seven-segment BCD decoder.

The Course was attended by 47 lecturers and participants (36 from developing countries).

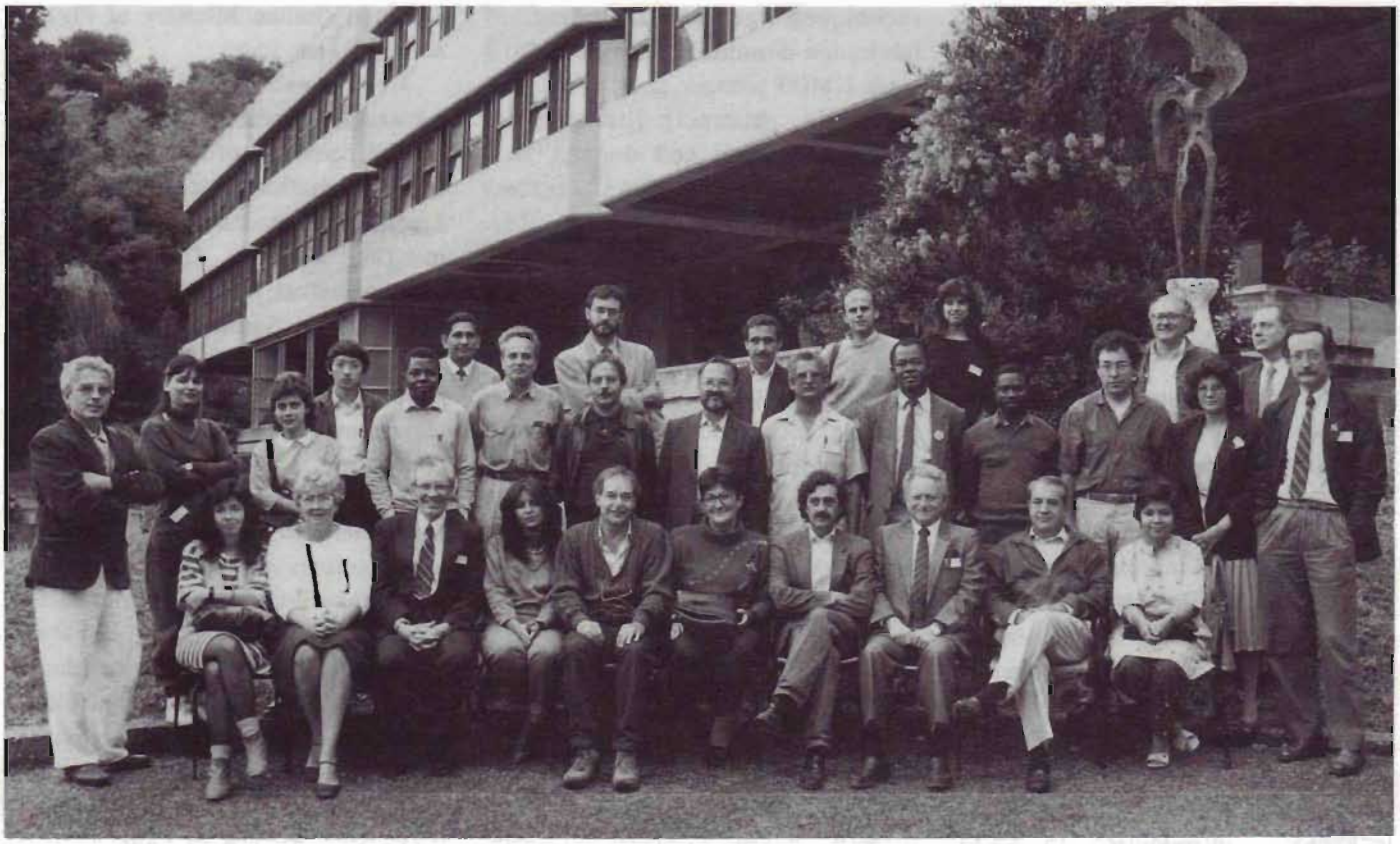
Title: THIRD AUTUMN WORKSHOP ON ATMOSPHERIC RADIATION AND CLOUD PHYSICS, 27 November - 15 December 1989.

Organizers: Professors E.E. Balogun (Obafemi Awolowo University, Ile-Ife, Nigeria), J. Latham (University of Manchester, UK), R. Rizzi (University of Bologna, Italy) and F. Stravisi (University of Trieste, Italy), with the co-sponsorship of the Direzione Generale per la Cooperazione allo Sviluppo (Italian Ministry of Foreign Affairs, Rome, Italy)

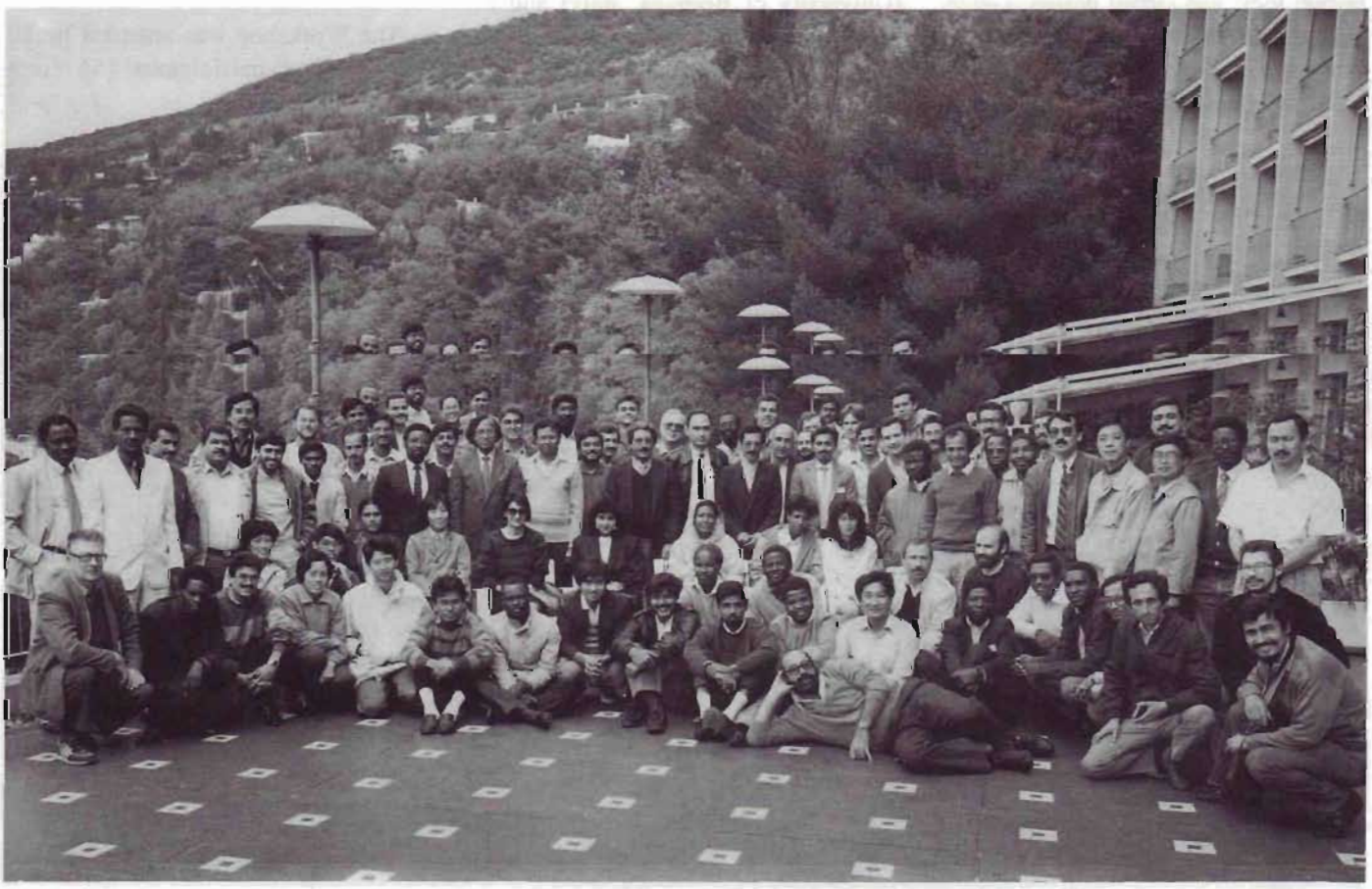
Lectures: Could physics and microphysical processes. Principles and general equations of radiative transfer. Cloud radiation interaction. Cloud dynamics and models. Radiative transfer in the visible. Cloud physics instrumentation. Interaction of radiation and clouds. Satellite meteorology. Parameterization of cloud effects on radiation in GCM. Radiation schemes in climate models. Radiation budget of the atmosphere. Cloud structures in space and time. Measurement of cloud parameters from the ground. Cloud radiative forcing of climate. Trace gases and climate problems. Measurement of cloud parameters using AVHRR. Radiative properties of cirrus clouds. Cloud radiation interaction. Principles of remote sensing of atmospheric parameters from space (RSA). Effects of clouds on remote sensing of atmospheric parameters. Review of cloud clearing techniques. 3-step decoding. Cloud identification and declouding at L.M.D.

The Workshop was attended by 80 lecturers and participants (56 from developing countries).

Workshop on Materials Science and Physics of Non-Conventional Energy Sources, 11 - 29 September.



Workshop on Interaction between Physics and Architecture in Environment-Conscious Design, 25 - 29 September.



Fifth College on Microprocessors: Technology and Applications in Physics, 2 - 27 October.

College on Soil Physics, 9 - 27 October.

Second Workshop on Telematics, 6 - 24 November.

Activities at ICTP in 1990

Winter college on high resolution spectroscopy	8 January - 2 February
Workshop on composite media and homogeneization theory	15 - 26 January
Second college on variational problems in analysis	29 January - 16 February
Training college on physics and characterization of lasers and optical fibres	5 February - 2 March
Workshop on reactor physics calculations for applications in nuclear technology	2 February - 16 March
Fourier optics and holography	6 - 9 March
Experimental workshop on high temperature superconductors and related materials (basic activities)	12 - 30 March
Workshop on group theory from a geometrical viewpoint	26 March - 6 April
Spring school on string theory and quantum gravity and workshop on string theory	23 April - 4 May
Spring college in condensed matter on: Physics of low-dimensional semiconductor structures	23 April - 15 June
College on recent developments and applications in mathematics and computer science	7 May - 1 June
First ICFA school on beam dynamics and engineering of synchrotron light sources	7 - 18 May
College on atmospheric boundary layer physics: I – "Modelling of the atmospheric flow fields" II – "Air pollution modelling for environmental impact assessment"	21 May - 15 June 21 May - 1 June 4 - 15 June
Miniworkshop on quantum chaos	4 June - 6 July
Adriatico Research Conference on Quantum chaos	5 - 8 June
Conference on lasers in chemistry	11 - 15 June
Trieste conference on topological methods in quantum field theory	11 - 15 June
Miniworkshop on strongly correlated electron systems	18 June - 27 July
Research workshop in condensed matter, atomic and molecular physics	18 June - 28 September
Summer school in high energy physics and cosmology	18 June - 28 July
Adriatico Research Conference on Quantum fluctuations in mesoscopic and macroscopic systems	3 - 6 July
Adriatico Research Conference on "Physics of strongly correlated systems"	10 - 13 July
Adriatico Research Conference on Defects in HCP crystals	14 - 17 August
6th Trieste IUPAP Semiconductor Symposium on "Hydrogen and semiconductors: Bulk and surface properties"	27 - 31 August
Working party on electrochemistry – Condensed matter aspects	27 August - 7 September
International conference on medical physics	3 - 7 September
College on medical physics	10 - 28 September
School on qualitative aspects and applications of nonlinear evolution equations	10 September - 5 October
College on neurophysics: "Neural correlates of behaviour, development, plasticity and memory"	1 - 19 October
College on "The design of real time control systems"	1 - 26 October
Workshop on atmospheric limited area modelling	15 October - 3 November
Third autumn course on mathematical ecology	29 October - 16 November
Workshop on earthquake sources and regional litospheric structures	
Third autumn course on mathematical ecology	29 October - 16 November
Workshop on earthquake sources and regional litospheric structures from seismic wave data	19 - 30 November
Experimental workshop on high-temperature superconductors and related materials (advanced activities)	26 November - 7 December

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

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