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Visit of the President of Italy Oscar Luigi Scalfaro to the ICTP

While on a two-day visit to Trieste city, the President of Italy Mr. Oscar Luigi Scalfaro met the scientific community of Trieste at the Adriatico Guest House conference room on Thursday 11th February 1993. A long applause greeted the President when he entered the conference hall of the Adriatico Guest House at 4:15 p.m. accompanied by Mr. Alessandro Fontana, Minister of Science, Mr. Sergio Vitiello, Govenor of Trieste, and Mr. Giacomo Borruso, Rector of Trieste University. This is the first time in the history of the ICTP after nearly 30 years that a President of the Italian Republic visits the Centre and that the scientists from the Third World have an opportunity to express their gratitude to the highest authority of the country for having made Trieste a second home for training of research.

The President and the other eminents were received by Professor Abdus Salam, Director of the ICTP.

Professor Abdus Salam delivered the opening address on behalf of the ICTP and the scientific community of Trieste. He said,

"Mr. President, Authorities, Ladies and Gentlemen,

I am grateful to you for having agreed to meet the Trieste scientific community here at the International Centre for Theoretical Physics. I consider this as a sign of recognition to the first International Scientific Institution in Trieste, whose presence in this city has stimulated the growth of so many new scientific initiatives.

Professor Abdus Salam, Director of the ICTP and President of TWAS, receiving the President of Italy, Mr. Oscar Luigi Scalfaro.

You are here today in a Centre which is, thanks to the generosity of the Italian Government, the home of the scientists from the Third World. This Centre was founded almost 30 years ago, in 1964, with the basic idea that people like myself, when working in their home countries, could come to a scientifically exciting place in Europe or America with fair regularity and then go back to their home countries after spending a few months in company of their peers. The Centre was indeed founded to cope with this need.

In spite of the initial lack of commitment of most of the industrialized countries, this Centre became a reality with the support of the developing countries, but mainly thanks to the most generous support of Italy and of the town of Trieste, which secured the necessary financial and logistic support.

Now, 30 years after, the Centre has grown so much that it covers all the aspects of pure and applied physics and mathematics and related sciences; the Centre is at the same time a research Centre, devoted to the advancement of pure science, and a place for high level training, where every year more than 30 training courses are held, which range from fundamental physics to technology, from the physics of the earth to the

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physics of the living state, from mathematics to the physics of energy.

The Centre welcomes every year between 4,000 and 5,000 scientists, mainly from developing countries, but not from developing countries alone. We had decided right at the outset that the Centre was to be a truly international Centre. This is reflected in the number of scientists who have been here from the industrialized Western countries and Eastern Europe. In the almost 30 years of operation, out of the 51,000 scientists who have visited the Centre, we have welcomed 24,000 scientists from developed countries (including over 7,000 from Italy). Those from developing countries have numbered 27,000.

The active participation and support of so many scientists from the industrialized countries in our activities has clearly demonstrated how wrong, 30 years ago, was the initial policy of the great powers.

What are the reasons for the success of the Centre?

First and foremost, a reason for our success is the fact that the Centre filled a need for developing countries.

Second, is the magnificent response of the World Physics community to the Centre's existence. Just to quote an example, 37 Nobel laureates have visited and worked at the Centre.

Third, for the Centre's existence, the fact that it is part of the United Nations system has been crucial. Officially, the Centre belongs to two of the Specialised Agencies of the UN — the IAEA and UNESCO — who have signed a Seat Agreement with the Italian Government.

Finally, but most important, the success of the Centre is due to the Italian support, in many ways: through the support of the Italian scientific community, who has participated in a very active way in the scientific life of the Centre; through the support of the local Trieste authorities, who have provided enthusiasm and logistic facilities; and through the support of the Italian Government and Parliament, which have provided very generously to the Centre the financial means for its existence. I must here pay a tribute to the far-sighting of the Italian policy, who has realized that the International Cooperation should not limit itself to the immediate needs of food and health, but that for the ultimate development the scientific progress is an essential tool. The scientific progress goes through the creation of a class of modern scientists, and this is exactly what the Centre is doing.

Prof. Luciano Bertocchi (left), Deputy Director, ICTP, talking with President Mr. Oscar Luigi Scalfaro.

Thanks to this policy, the names of Trieste and Italy are known in all the scientific institutes of the Third World; and we are proud to present to you, the President of Italy, this result.

This Italian support to the international scientific activities in Trieste has been later extended to many other initiatives. You will hear about these from the next speakers. I will limit myself to mentioning two other international activities which have been supported by the Italian Government here in the Miramare Area.

The first is the Third World Academy of Sciences, TWAS; the Third World Academy of Sciences is the collection of the finest of the Third World's first rate scientists of proven ability who belong to some of the most prestigious Academies in their own personal rights (including all of the nine Nobel prize winners born in the developing countries). It was inaugurated in 1985 by the Secretary General of the United Nations, at Trieste, and comprises now 311 members. The latest meeting of the Academy was held in Kuwait from 23 to 26 November 1992. The Amir, with his personal welcome, gave us a magnificent reception.

The second is the proposed International Centre for Science and High Technology — comprising three Institutes, of High Technology and New Materials, of Earth, Environment and Marine Sciences, and of Pure and Applied Chemistry. This new Centre will therefore extend and complement, here in Trieste, the activity of ICTP. Also for this Centre a new law is in preparation, and again the Italian support will be essential.

I should also like to mention here the network of twenty centres of excellence in science, high technology and the environment which the Third World Academy of Sciences is planning to set up in the South. We are requesting help from the World Bank of the order of US$ 250 million a year for the running of these centres. Once again, we will need Italy's support for this new initiative.

Why the Italian Government is so helpful is because, without patronising those from the Third World, the Italian Government happens to be one of the few which is deeply interested in Science as well as in Learning. This mirrors the feelings of a society which venerates scholarship. An example of this is the fact that, on the occasion of your visit to Trieste, you have included, Mr. President, a meeting with the representatives of science in the city which can be rightly named "Trieste, City of Science".

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Address by Prof. Paolo Budinich, former Deputy Director of the ICTP

Mr. President, Ladies and Gentlemen,

Many people have often wondered why Trieste, historically famous as a transit and trading point, has recently begun to acquire fame as a city of science.

The answer is, this is one of the few good consequences of last World War which left Trieste in a difficult geo-political situation. In fact, the city was only a few miles away from a border line, the so-called iron curtain which was source of harmful forms of nationalism. At that time, we in the science faculties saw clearly that it was absolutely necessary for the newly-born local university to become big, not in the number of students, but in quality, and this because good-quality culture crosses borders easily and can mitigate the most excessive forms of nationalism, thus becoming a vehicle for peace.

Establishing prestigious faculties in a short time was almost a loosing battle for us in Trieste, in a corner of Italy and without university traditions. Therefore we thought we should exploit our geographical position — at the border of Italy, but in the centre of Europe. We started immediately to tie international scientific co-operation links. These links, with some luck but also thanks to far-sighted political national and local authorities, brought here in Miramare the International Centre for Theoretical Physics in 1964. Moreover, the Centre was under the flag of the United Nations — something precious for us.

The Centre was an institute of scientific excellence, proven by the awarding of the Nobel Prize to its promoter and director Abdus Salam. But the Centre first of all had the noble task of transferring scientific culture, a privilege of rich countries, to poor countries which had and still have the urgent need of such culture in order to become emancipated. Because of this social action, which also affected the countries of Eastern Europe, the Centre soon became famous in the world and made Trieste famous and our University prestigious, as was intended originally.

Great culture never remains isolated, and the success of the Centre generated new culture and attracted to Trieste new institutions to back-up the university which was then developing and from which prestigious institutes such as the geophysical and astronomical observatories, and other institutions, were deriving. Thus, the Research Area and the Synchrotron Light Laboratory — about which Prof. L. Fonda and Prof. D. Romeo, respectively, will speak — were established.

Some time later, the International School for Advanced Studies was founded. It is considered a model within the university system, and complements the Centre's activities in new fields of research. The School has attained so much prestige in a short time that its faculty now consists of eminent Italian and foreign scientists coming from research institutions famous all over the world such as Oxford and Geneva (from where its current director Daniele Amati comes). In its turn, the School generated the Interdisciplinary Laboratory, a unique tool in Italy to explore new ways to fill the gap between scientific and humanistic culture and which, upon the initiative of its director Stefano Fantoni and of Claudio Magris, proposes very interesting projects, also for Eastern Europe.

The International Foundation was also established, which baptized the Third World Academy of Sciences — an institute of great potentiality which has not been completely exploited yet. Mr. President, allow me to draw your attention on just one project of this Academy, the great value of which I am sure you will not fail to appreciate. Such scheme envisages to endow each Third World country with at least one complete library — an indispensable basic tool for any future development. An Italian version of such project has been proposed, namely to donate a full library to each of seven selected countries in the Mediterranean area which need them and would greatly benefit from them. This gesture would hold a highly symbolic value, especially if we think that Africa, where the majority of the selected countries (among them, Egypt) is situated, has a long-standing credit with Italians and Europeans, in that it was the famous library of Alexandria of Egypt that was one of the paramount ancient sources of our western civilization.

The International Foundation also contributed to bringing to Trieste the excellent International Centre for Genetic Engineering and Biotechnology of UNIDO. The Foundation now manages the Laboratorio dell'Immaginario Scientifico which is devoted to the dissemination of scientific culture among people at large and which has become renown all over Europe. The Foundation has also been the promoter of promising projects which would take too long even to list and which we hope will materialize in the near future.

Professor Abdus Salam addressing the scientific community of Trieste. On the left: Prof. Paolo Budinich, former Deputy Director of the ICTP. On the right, Prof. Domenico Romeo, President of Area di Ricerca.

But the story is not finished. We are only half-way. Trieste is becoming again a city of trading, but especially of exchange of knowledge and ideas which are bound to have — and, in fact, are having now — effects which favour economic recovery. We hope and are confident that Trieste as a city of science, open to the near as well as Third World countries, will render again a good service to Italy for its pioneering social action.

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Address by Prof. Domenico Romeo, President of Area di Ricerca

Mr. President,

The "AREA di Ricerca" in Trieste is the first Italian science and technology park. It was established upon the initiative of a group of scientists of the University of Trieste and of the International Centre for Theoretical Physics. It has been operative since June 1982.

The main aim of AREA is to stimulate and disseminate innovation through the offer of high-level research services, training, consulting and assistance to the establishment of business concerns. In materializing this aim, particular care is taken to favour the economic and cultural development of Trieste and its region, as well as the growth of international relations, in particular with near countries.

About twenty companies and centres have been set up within the AREA, including high-technology firms, laboratories set up by pools of universities or by university-industry consortia, laboratories belonging to national research institutes such as the Istituto Nazionale di Fisica Nucleare (Italian National Institute for Nuclear Physics) and the Consiglio Nazionale delle Ricerche (Italian National Research Council), as well as international centres such as the one for Genetic Engineering and Biotechnology of UNIDO. Over forty countries, accounting for much more than half the global population, co-operate in the latter Centre which co-ordinates a network of seventeen laboratories all over the world, besides the one in Trieste.

By now over seven hundred people work at the AREA, coming mainly from this region and holding high-school diplomas or university degrees. But there is also the significative presence of foreign researchers and experts from twenty-five nations. Research activities, headed not only towards the fundamental aspects of science but also to the development of products and services, are carried out in key sectors such as biotechnology, informatics, surface physics, science and technology of natural polymers, microelectronics, neurosciences, environmental sciences, advanced instrumentation for space and terrestrial optics and for biomedical uses. Over ten years of activity, the centres and firms of AREA have developed fruitful co-operation links with organizations of the United Nations, the European Community, the Italian, European and American space agencies, CERN in Geneva, the national health system, public governing bodies, as well as with numerous, small-, medium- and large-sized industries, in particular in the sectors of chemistry, pharmaceutics, informatics and electronics.

When the synchrotron laboratory (which you saw this morning) starts its operation, our Science Park will be able to put at the disposal of university-level researchers and chemical, mechanical, pharmaceutical and electronics industries a new fantastic tool for investigating matter. "Elettra" will be one of the most advanced laboratories in the world, something the national scientific and technological community shall be proud of.

Particular care has been taken by AREA in keeping very good alliances with the scientific and high-level-training institutions of the city, first of all the University and the International Centre for Theoretical Physics. Many young graduates follow-up their training in the laboratories and establishments of AREA, and university teachers utilize at best all their scientific culture and capabilities as entrepreneurs in promoting high-level initiatives.

Over the years, the science park has maintained significative links with the Osservatorio Geofisico Sperimentale (Geophysical Experimental Observatory) which carries out an intense activity of applied research and technological development in the field of seismology and in the study of the sea-bottom, and which has played a determinant role in carrying out the national plan in Antartica. Stimulating links have also been tied with the Laboratorio di Biologia Marina (Marine Biology Laboratory) — which envigilates on the state of health of the Adriatic Sea and makes proposals of high economic value for the development of business set-ups related to fishing and mariculture — as well as with the Osservatorio Astronomico (Astronomical Observatory) which has shown remarkable capabilities of developing informatic technologies applied to astronomy and astrophysics and has played and important role in co-ordinating research programmes carried

Eminent scientists of Trieste attending the conference.

out with the national telescope "Galileo" and international projects carried out with other space telescopes.

The quality of our programmes is well-known at both national and international level. About a year ago, an article in a popular economic magazine read "Surprises in Italy — Islands of Excellence". The article dealt with that part of Italy which works smoothly and, in an obviously journalistic style, stated that "the good part of Italy shows at least thirty different facets". In the list of thirty islands, Mr. President, the science park of Trieste was counted.

I conclude with a promise and a wish. The scientists, experts and all the staff of the research, high-level-training and innovation centres in Trieste re-affirm their determination to contribute to the growth of the "Nation-System", at this time when it is more and more evident that the Italian crisis also derives from a decade in which investments were made more for recovering productivity than for improving the technological sector. Mr. President, the AREA together with the Association of Italian Science and Technology Parks which the AREA itself helped to found, believe that the time has come to concentrate on the formulation of a new policy centered on research, technology, on the will to innovate, on the development of collaboration within greater Europe, also with the aim of raising the level of competitiveness of business establishments. By formulating and, subsequently, implementing such policy we shall avoid the risk of turning into "performers" of foreign technologies and we shall be able to overcome the difficulties of a more and more competitive market, thus determining our future of industrialized nation.

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Address by Prof. L. Fonda Dean of the Faculty of Science, University of Trieste

Mr. President, Authorities, Ladies and Gentlemen,

In order to become a true City of Science, Trieste needed a large scientific experimental laboratory involving both pure and applied industrial research. Such laboratory was missing in the constellation of scientific set-ups in the Trieste area.

At the end of the 1960s, the city of Trieste proposed Doberdò del Lago, on the karst plateau near Monfalcone, as the objectively most suitable site in Europe for the installation of the European SuperProtonSynchrotron. Expectations were disappointed, due to political reasons, and the accelerator was built at CERN in Geneva.

Starting in 1980, Trieste thought that an accelerator of electrons, a source of synchrotron light, was actually more suited for its Research Area. So Trieste ran as a candidate for the installation of the European light machine, but also in this case she lost the race, this time in favour of Grenoble.

After all these failures at the European level, we thought of planning an all-Italian 1.5 GeV synchrotron light machine. Driven by the Nobel Laureate Carlo Rubbia, the company "Sincrotrone Trieste" was then established in November 1986 with the aim to plan, build and operate ELETTRA, the light machine which you, Mr. President, saw this morning, on the way to completion, on the karst plateau near Basovizza.

ELETTRA, and its twin in Berkeley (California), will have the world record of brilliance in the wavelength interval of soft X-rays. The Italian scientific and technological community — in particular in the sectors of biology, chemistry, physics, medicine and science and structure of materials — will finally have at its disposal in Italy itself an extremely advanced tool, envied by the rest of Europe, and suitable for studying the electronic structure of any sort of material and complex molecular system. The increase in brilliance with respect to presently operating machines, will allow a big qualitative jump forward in all experimental disciplines with the opening of new frontiers, for the greater benefit of our society. Many experiments technically not feasible today will in fact be possible with this machine with discoveries now unforeseeable. Besides, the experiments will be performed in extremely short times. Just as an example, consider the discovery of the structure of haemoglobin which kept Perrutz busy for fourteen years — with ELETTRA such research will be carried out in a few days !

With ELETTRA, Italian researchers expect to be able to experiment numerous applications and, consequently, to attain many discoveries. I am going to mention just a few, Mr. President.

Through the techniques of photoemission and photoabsorption, high-temperature superconductors will be studied, thus contributing to the comprehension of this fascinating, so far unsolved, problem which could have a strong inflence on our society (transportation of electric power over long distances, magnetic-levitation trains, etc.). Through these techniques, it will be possible to study the structure of molecules and macromolecules of any sort. In studying the surface of a material, we will understand the cause of corrosion, the reason why a catalyst gets "poisoned", or we will follow every step of the evolution of a very important chemical reaction (such as, for example, the chemical processes occurring in a catalytic muffler).

As far as biology and medicine are concerned, I can mention that by means of X-ray microscopy, which is now developing at a fast rate, important results in the study of cell structure will be obtained. By means of crystallography, it will be possible to define the spacial geometry and the chemical composition of new proteins and viruses. We foresee that this research will be far-reaching in contributing to eliminate the most serious viral diseases which afflict humanity. Other, more direct, applications in medicine, such as mammography, are now being explored.

By means of photoelectronic spectroscopy, more advanced semiconductor devices will be developed. Such progress will boost the industry related to data storage (computers, videotapes etc.). ELETTRA will contribute to producing smaller and more compact computers, thus enabling our industry to compete with the American and Japanese industries. Metal industry will be greatly helped in diagnosing structural defects, materials fatigue etc.

In the field of ecology, by means of X-ray fluorescence, it will be possible to detect traces of highly polluting agents in tissues, food, water etc., thus contributing to the understanding of the noxiousness of fumes (from chimneys) and acid rains.

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TWAS Holds Fourth General Conference in Kuwait

The Third World Academy of Sciences has honoured the invitation of His Highness The Amir of Kuwait, Jaber Al Ahmad Al Jaber Al Sabah, to hold its Fourth General Conference in Kuwait City from 23 to 26 November 1992. More than two hundred participants from 64 countries took part in the various sessions. Among them, there were eighteen ministers of science and technology and of higher education from the countries of the South, in addition to heads of research councils and other scientific institutions, and to distinguished Fellows of the Academy. The Conference was organized in collaboration with the Kuwait Foundation for the Advancement of Sciences (KFAS) which not only made its facilities available to the meeting but also covered the local expenses of all participants as well as travel costs of invitees from the developing countries.

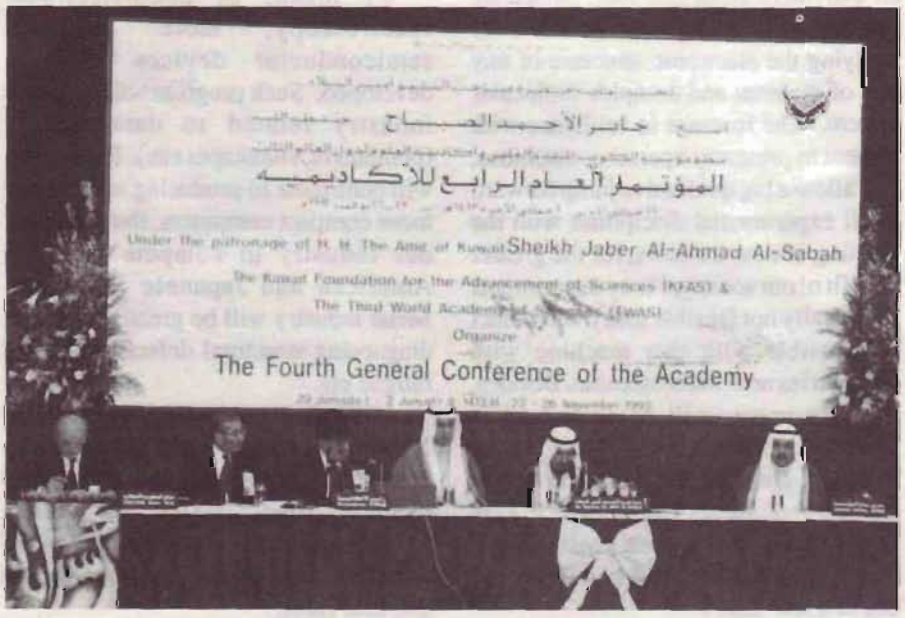
While working sessions were held at the KFAS headquarters, the opening ceremony, presided over by His Highness The Amir, took place at the University of Kuwait. Over one thousand personalities including government officials and ambassadors from several countries attended part of the Conference. The opening addresses by His Highness The Amir, the President of TWAS and the Director General of KFAS were followed by speeches by the representatives of the three organizations co-sponsoring the TWAS programmes, i.e. the Government of Italy, the Canadian International Development Agency (CIDA) and the OPEC Fund for International Development.

In conclusion to the ceremony, His Highness The Amir presented to the recipients the ten TWAS Awards in Basic Sciences for the years 1990 and 1991 and two TWNSO Awards on Agriculture and Technology for 1991. He received from the TWAS President, Professor Abdus Salam, the Special Medal of the Third World Academy of Sciences for his distinguished service to Third World Science. This Special medal was the third ever presented to distinguished personalities and the first to an Arab Head of State.

The programme of the Conference was very dense. In addition to the sessions on science in the Arab countries and its role in solving environmental problems in the region, there were several panels on specific topics and, most important, special meetings involving ministers of science and technology and of higher education. The first of these, which took place on 23 November in the early afternoon, was chaired by H.E. E. Inönü, Deputy Prime Minister and Minister of Science and Technology of Turkey. This session was devoted to "Research and Training Centres for Sustainable Development in the South" and more specifically to the discussion of the proposal voiced by the Third World Network of Scientific Organizations (TWNSO) and TWAS to establish a network of twenty research and training centres for science, technology and environment in the Third World. The concept was illustrated by the President of TWAS, Prof. Abdus Salam, the President of the International Commission for Scientific Unions (ICSU), Prof. R. Menon, the Director General of the United Nations Industrial Organization (UNIDO), Mr. D. Siazon, and the Director General of the OPEC Fund for International Development, Dr. Y. Seyyid-Abdan.

Ten Ministers (from Bangladesh, the Islamic Republic of Iran, Malaysia, Nigeria, Pakistan, Sierra Leone, Sri Lanka, Syria, Tanzania and Turkey) presented proposals for the upgrading of already existing scientific institutes in their countries to international or regional level and expressed the commitment of their governments to this end. The Ministerial Group assembled in the late afternoon of the same day and again in the morning of Tuesday 24 November under the chairmanship of Dr. R.M. Hossain, Minister of Energy and Mineral Resources of Bangladesh. The group resolved to support the TWNSO/TWAS proposed network of research and training centres and provided the President of TWNSO/TWAS with the mandate of establishing a ministerial-level committee for guiding the implementation of the project, of appointment of a Committee for reviewing proposals from governments and to carry out a feasibility study of the whole project. The Ministers have agreed to secure funds from their governments for the feasibility study.

The agenda of the TWAS Fourth General Conference included the Symposium on Environmental Pollution in the (Gulf) Region, held on Tuesday 24 November, during which scientists from Kuwait and from the region illustrated



Opening ceremony of TWAS Fourth General Conference at Kuwait University on 23 November 1992.

the consequences of the environmental catastrophe caused during the Gulf war and the measures to counteract it. The points under discussion were (a) the impact of oil pollution on marine and coastal environment, (b) the impact of oil fires on air quality and health, (c) the impact of the region's environmental disaster on the terrestrial ecosystem and (d) the moral, legal and economic aspects of the region's environmental disaster. The Conference expressed its deep concern and disapproval for the damage caused in the region and noted with admiration the remarkable efforts of the governments and of the scientists of Kuwait and in the region to check their consequences on the marine and coastal environment and upon the desert ecosystem.

Holding the TWAS General Conference in Kuwait also provided the opportunity for reviewing the status of science in the Arab countries. This review and critique was done in several sessions on Monday 23 November and Wednesday 25 in the afternoon and the following areas were covered: science and engineering education and research, research networks and cooperative programmes in physics and geology, agricultural sciences and land degradation, as well as biological, chemical, medical, physical and mathematical sciences. From the lectures and debates, participants concluded that there is a need for intensifying cooperative efforts within the region as well for increased communications in, essentially, all fields. In chemistry, the establishment of an Arab Institute for Chemical Technology was recommended while geologists called the attention on the necessity of using remote sensing and space photography in arid land research.

The remainder of the Conference timetable was devoted to discussions in four panels on science and technology for sustainable development in the South, technology and industry development in the South and the role of the private sector, international cooperation for promoting basic research in the South and on the role of academies in promoting scientific excellence in the South.

Once more, the TWAS General Conference was a forum for scientists, policy makers and administrators to confront their ideas on the future of science and technology in the South and of the welfare of the people living in these countries, and to take appropriate measures to improve the present situation which, though some progress has been accomplished during the last two years, requires a constant attention and a permanent mobilization of all those involved in the process despite other pressing priorities. Scientists of the South are aware that they must unite their efforts and increase their cooperative activities between the regions of the Third World if they wish to narrow the scientific and technological gap between the industrial world and themselves. It was encouraging to note that several ministers indicated the willingness of their governments to support the programme of TWAS. In his concluding statement, Professor Abdus Salam stressed the importance of raising an endowment fund of US$10-20 million from the governments of the South in order to secure the functioning of the Academy. During his visit to the palace, His Highness The Amir had promised him to continue his support to TWAS.

The Conference has been a great success for all. Its organization was perfect thanks to the efficiency of the KFAS Staff. Not a single minute was wasted. TWAS thanks the Government of Kuwait and KFAS for this unique event.

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Opening address of His Highness the Amir of the State of Kuwait, Jaber Al Ahmad Al Jaber Al Sabah.

Opening Address of His Highness the Amir of the State of Kuwait

In the Name of Allah, the Most Compassionate, the Most Merciful.

Dear Brothers and Sisters,

Peace be upon you and the Mercy and Blessings of Allah — Assalam Alaykom.

We cordially welcome you in Kuwait and among its people. We extend our greetings to you and to your blessed gathering and to what it symbolizes of noble significance for science and the scientists. Our Sacred Book, the Glorious Quraan, has pronounced the meritorious and honourable status of science and the scientists, and has bestowed upon them epithets and titles so virtuous that they are placed in the highest ranks. They were described as people of intellect and compassion, of thought and insight. They investigate the creations of Allah and become witnesses that everything in nature attests to the Oneness of Allah and His firm stand on justice. To them one has to refer in the crisis. Because of their knowledge, they are the ones who truly fear Allah. There are many verses in the Quraan pertinent to this point.

But at the same time, Allah — Glory be to Him — has cautioned against rendering science as a means for digression, corrupt creeds, transgression and predomination. This misuse of science happens when it is mated with vagaries and made subject to evil propensities, favouring vanity to

Professor Abdus Salam giving his opening address.

essence, the transient to the eternal.

I am confident that your gathering, in consistence with its objectives and areas of research, is a convention for truth and goodness, God willing (...) where your researches and discussions will encompass the environmental destruction caused by the aggression that targeted Kuwait, but went far beyond it to envenom the environment and kill life on the land and in the sea.

The list of objectives and researches which I looked into and which your Conference aspires to, involve a testimony and a methodology.

This testimony is to an era of Arab and human history which demonstrates that the good will ultimately triumph, no matter how long the evil deeds had prevailed. Man with his pure instinct will always uphold what is right and oppose what is wrong.

As to the methodology traced by your researches, it is the scientific and the intellectual channels that suggest various remedies for the different aspects of environmental, economic and psychological destruction.

In our view, the most important aspect in this matter, is to consolidate these researches and give them a sort of universality in order for them to become general frameworks for an interconnected and continuous plan that looks up to the future, which opens its arms only to those who work in the light of science, supported by their faith, and who never surrender to indolence, lassitude and the abominations of self-indulgence and extravagance.

It is the future that awaits us all, the seats of honour are reserved for those who know and act while others have to occupy back seats and content themselves with marginal status. But you — Allah is willing — are looking forward to the ranks of honours most appropriate for the dignity of your nations.

Once again and with great pleasure, Kuwait, the land of freedom and cordiality, embraces you, wishing you a pleasant stay and every success in your endeavours.

Peace be upon you and God bless you.

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Opening Address by Professor Abdus Salam

Your Highness Jaber Al Ahmad Al Jaber Al Sabah, Amir of Kuwait, Excellencies, Ladies and Gentlemen,

On behalf of the Third World Academy of Sciences and the Third World Network of Scientific Organizations, I first wish to express our sincere thanks and appreciation to His Highness the Amir of Kuwait for hosting the Fourth General Conference of the Third World Academy of Sciences and the Third General Meeting of the Third World Network of Scientific Organizations. Our first conference was held at our headquarters in Trieste, Italy, in 1985 at which the Academy was officially launched by the Secretary General of the United Nations. The second conference was held in China in 1987 at the invitation of Chairman Deng, and the third in Venezuela in 1990 at the invitation of President Perez.

It was at our second General Conference in China that we first received the kind invitation from His Highness the Amir of Kuwait to host the Fourth General Conference of the Academy. We are indeed very grateful to you, Your Highness, that despite the catastrophic events that have besieged your country during the last two years, you have kept your promise and are now honouring us with your presence at this opening. This is the first time that such a conference is being held in the Arab region which clearly shows your support to the Academy and the Network and your commitment to promote science and technology for sustainable development in your country and in the Arab region.

Your Excellencies, Ladies and Gentlemen,

We have gathered here today with four main objectives in mind; first to honour scientists from the South who have made considerable contributions to the development of science and technology; secondly to discuss the major environmental challenges facing the region; thirdly to review the status and future prospects of science and technology in the region and finally to discuss and adopt action plans for building science and technology capacity and scientific excellence for sustainable development in the South.

Regarding the first objective, we are greatly honoured that His Highness will present this morning on our behalf ten TWAS Awards in Basic Sciences for the years 1990 and 1991, and two TWNSO Awards in Agriculture and Technology. I am pleased, Your Highness, to announce that the TWNSO Award Committee for Agricultural Sciences chaired by Prof. M.S. Swaminathan (one of the most eminent agricultural scientists in the world) has unanimously decided to award the 1991 prize in Agriculture to the Kuwait Institute of Scientific Research for its significant contributions to the development of mariculture.

With regard to the second and third objectives, our colleagues from Kuwait

and the Arab region will describe to us in detail the environmental problems of major concern to the region, and the contributions made so far by the scientists in resolving these problems. In addition, our colleagues from the region will also describe to us the present status and prospects of scientific research and teaching in the region.

Let us not forget that about 1,200 years ago this part of the World made a remarkable contribution to Science, Mathematics and Medicine. A Commonwealth of Science was truly developed and had dominated scientific thinking in the World for nearly 600 years. The question to ask now is, can we turn the wheel back and re-establish this Commonwealth of Science again? Can we hope to plant during this week the first seed towards the realization of this goal?

Turning now to our fourth objective, we hope that this distinguished gathering and especially the Ministers of Science and technology who will meet this afternoon will endorse and implement our proposal to set up a Network of Research and Training Centres in Science and High Technology in the South. These Centres will play a crucial role in building science and technology capacity for sustainable development in the South, as recommended by Agenda 21 of the Earth Summit last June. The idea of setting up this Network was first presented and endorsed at the 1989 Summit of Non-Aligned Countries. It has subsequently been backed by a number of Heads of Governments and leading scientists in the South. TWAS and TWNSO, in collaboration with UNIDO, have recently been developing a feasibility study for this project, as a result of which we shall present at the Ministerial Meeting this afternoon 12 comprehensive proposals for upgrading existing competent institutions in 12 developing countries to international and regional levels. We hope to select from these 12 proposals the first nodes of the Network.

Furthermore, in order to provide the necessary political and financial impetus to this important initiative, a Commission on Science and Technology for Sustainable Development in the South (COMSATS) has been established under the Chairmanship of the Prime Minister of Pakistan with the membership of seven Heads of State from the South, and the Government of Pakistan is planning to hold the first meeting of this Commission in 1993.

Your Highness,

As I mentioned before, it is nearly seven years since the Third World Academy of Sciences was formally launched. During this period the Academy has established itself as the leading scientific organization promoting the development of science and technology and scientific excellence in the South. This would never have been achieved without the generosity of two major donors, the Italian Government and the Canadian International Development Agency, whose financial support have made it possible for the Academy to support the scientific work of young scientists working and living in over ninety Third World countries. Fortunately, two more donors, the Swedish Agency for Research Cooperation with Developing Countries (SAREC), and the OPEC Fund for International Development have recently decided to support certain programmes of the Academy.

The Academy is currently operating with a small budget of approximately two million dollars per year (1,5 million is derived from the Italian Government, and the rest from CIDA, SAREC, and the OPEC Fund). This small budget is not even guaranteed for a long period, and new requests have to be made every one or two years to the donors.

It is therefore extremely important for the credibility and continuity of the Third World Academy of Sciences, that additional and more stable financial support be provided by countries in the South. This support is not only crucial for the undertaking of new and more substantial programmes like the Network of Centres, but also for the long-term survival of the Academy itself. Time and again I pleaded — without much success — for an endowment of 10-20 million dollars to secure the running of the Academy forever. I pray to Allah that I live to see this being fulfilled.

It is very pleasing to see that Your Highness has taken the lead in this direction by generously supporting this Conference. We very much hope that you and your Government will continue to support the Academy and that other leaders in the region will soon join you.

Let young scientists from countries in the South like Bangladesh, Peru and Uganda take pride in knowing that it is not only Italy, Canada and Sweden that are supporting their scientific endeavours, but also Kuwait and others.

Finally, Your Highness, I would like to thank you once again for your kindness and generosity for hosting us here in this beautiful City of Kuwait. I would also like to extend my thanks and appreciation to the local organizing committee, the Kuwait Foundation for the Advancement of Sciences and its Director General Dr. A.A. Al-Shamlan, for their tireless efforts to make this meeting possible. I thank you all for being here, and I hope you will have a very productive meeting.

***

Conclusions and Recommendations

(1) The Ministerial Working Group unanimously adopted a resolution endorsing the proposal to establish a South Network of International/ Regional Science and Technology Centres, and mandated the President of TWAS/TWNSO to (i) set up a ministerial-level Committee to guide and facilitate the implementation of the proposal; (ii) to appoint a technical committee to review proposals for centres received from Governments so as to report the outcome to the ministerial steering committee by 1st May 1993; and (iii) to carry out comprehensive feasibility studies for the project in time for the Pakistan Summit of Heads of State/Government to be held in 1993. The Ministers agreed to help secure the necessary funding for the feasibility studies.

(2) The need to upgrade a number of existing competent institutions in the South to international or regional levels to form the first nodes of the proposed Network of Centres was recognized throughout the Conference as a more realistic and economic initial step towards building capacity, excellence and relevance in science and technology for sustainable development in the South. The selection criteria for the centres to be upgraded should be based on scientific merit and relevance to the regions. Public and private industry in the South should be encouraged to participate in the upgrading of these centres, to ensure that they contribute significantly to the

industrial and economic development of the societies.

(3) The need for a strong political will to back up national and regional programmes for building indigenous high-level science and technology capacity for sustainable development in the South was emphasized in a number of the Conference Sessions. The establishment of a Commission on Science and Technology for Sustainable Development in the South (COMSATS) under the chairmanship of the Prime Minister of Pakistan and with the membership of seven Heads of Governments from the South is an important step towards the sensitization of the political leadership in the South to science-led development. The Conference enthusiastically welcomed the announcement made on behalf of the Government of Pakistan to hold a Summit Meeting of the Commission in Lahore in 1993.

(4) Deep concern and disapproval of the environmental disaster created during the Gulf war were expressed by the participants. The remarkable efforts made by Governments and scientists in Kuwait and other countries in the region to combat the serious damage caused to the marine and coastal environment and to the desert ecosystem were noted with admiration.

The need for further regional and international cooperation to monitor the long-term impact of the environmental damage and to develop the appropriate technology for restoring the fishing industry, the desert ecosystem and coastal habitats was stressed. In particular, increased efforts should be made to implement the rehabilitation plans established by the Regional Organization for the Protection of the Marine Environment (ROPME), in cooperation with UNEP and other UN bodies.

(5) Increased efforts should be made to intensify inter-Arab cooperation and communication in science teaching, scientific research and training. High-quality regional research and training programmes and networks in areas of science and technology of critical importance to the region's development such as remote sensing, arid lands and water resources were specifically mentioned. The establishment of regional institutes of common interest to the Arab countries such as an Arab institute for chemical technology was also recommended. Books, equipment, journals, maintenance of instrumentation were considered to be vital.

(6) Regional and inter-regional cooperation between scientists and institutions in the South should be further intensified. In particular, existing scientific competence and infrastructure in the South should be fully utilized to provide research and training opportunities to scientists from institutions with poorer facilities. The inventory of competent research and training centres in the South to be published by TWNSO and the South Centre should be distributed widely in the South. Annual programmes of these centres should also be regularly communicated to scientists in the South.

(7) Major efforts should be made to enhance the involvement of the international scientific community in research and training activities in the South. The need to expand the ICSU-TWAS-UNESCO-CSC joint lectureship programme to allow for longer and more frequent visits by internationally renowned scientists to institutions in the South was recognized as an important step in that direction. Twinning arrangements between institutions in the North and the South should also be encouraged to allow for long-term cooperation and institutional links. It was also recommended that TWAS, in collaboration with Academies in the North, should convene high-level study groups involving scientists from the South and the North to provide authoritative studies on the implications of modern science and technology to developmental and environmental problems impeding economic progress in the South.

(8) The important role of national academies in popularizing and promoting scientific excellence in the South was stressed. National academies should, in particular, constantly encourage their Governments to significantly increase expenditure on science education and scientific research, and to improve the conditions of service of talented scientists so as to reduce the brain-drain to the North. National academies should also play an advisory role to Governments on science and technology issues and encourage Governments to formulate proper science and technology policies and assist in the implementation of these policies.

(9) Technology, training and trade were considered as prime movers of economic growth and rural prosperity. The scientific community in the South should devote greater attention to the application of technologies to rural development. Major efforts should be made to engage the very best scientists and engineers in solving problems of poverty and sustainable development. Increased emphasis should be given to promoting indigenous knowledge systems and location-specific

Dignitaries attending the Conference.

technologies. They should be developed in response to local needs and through participatory research involving rural populations.

(10) High priority should be given to building national capacity in science and technology in the South at the highest possible international level to enable countries in the South to participate fully in the implementation of AGENDA 21 of the United Nations Conference on Environment and Development (UNCED).

Efforts should also be made to ensure that TWAS becomes an adviser on scientific matters to the International Commission on Sustainable Development and to ensure that high-level scientists and technologists from the Third World be involved in setting the agenda for the Commission. ____ ♦

American Physical Society Creates Rahman Prize

During the 1960s and 1970s, Aneesur Rahman was one of the first to make use of computers for solving problems in molecular spectroscopy. In honor of his pioneering work, the American Physical Society has established the Aneesur Rahman Prize, which will recognize contributions to computational physics.

A native of India, Rahman earned a DSc in physics at Louvain University in Belgium in 1953. He then returned to India, where he worked at Osmania University and the Tata Institute for Fundamental Research. In 1960 he moved to Argonne National Laboratory, where he remained for the next 25 years. In 1985 he became a physics professor at the University of Minnesota and a Fellow of the Supercomputer Institute there. Rahman died in June 1987.

The annual prize, sponsored by IBM, consists of $5000 and a travel allowance. It is open to scientists of any nationality. The first Rahman Prize will be awarded in June 1993 during the annual meeting of the APS division of computational physics in Albuquerque, New Mexico. The chair of the nominating committee is Jay Boris of the Naval Research Laboratory. _____ ♦

ICTP Workshop on High T_c Superconductors, San Carlos de Bariloche, Argentina

The Seventh Experimental Workshop on High T_c Superconductors and Related Materials (Advanced Activities) took place at the Comisión Nacional de Energía Atómica (CNEA)-Centro Atómico Bariloche (CAB), San Carlos de Bariloche, Argentina, from 11th to 29th January 1993. The activity was attended by 69 participants of which 40 were local, 15 Latin-Americans, 14 from other Third World countries and East-European countries, and 8 invited lecturers. Given the advanced character of the activity, the participants were chosen, among the many applicants, following the criterion that they had to show a proven working experience in the specific fields listed in the workshop announcement.

The workshop programme was divided into two parts: during the first week it mainly consisted of a series of specialized lectures given by a very selected faculty. About half of the talks were centered on the problem of the magnetic phase diagram of the HTS materials. A large part of the remaining time was spent on informal talks between the lecturers and participants which turned to be very stimulating because of the common ground of experience. A series of seminars on the many activities of HTS at the CAB was given by senior CAB scientists. This section of the programme was aimed at introducing the foreign participants to the research activities of the second part of the course.

Some participants gave 20-minute evening seminars on the research activities and a poster session was also organized to allow more people to present their recent results. The poster session proved to be more interesting and efficient in promoting information exchange.

The intensive work performed during the last two weeks permitted to obtain original results that were intensively discussed in a four-hour poster session at the end of the workshop. The titles and the authors of the posters presented give a good idea of the areas covered by the participants:

Application of Lanczos method to diagonalize a generalized one-dimensional Hubbard model
L.d.C. Arrachea*, K. Hallberg**, A. Aligia**, and C. Balseiro**
*Universidad Nacional de La Plata, Argentina. **CNEA-CAB, Argentina.

Spectral density of the extended Hubbard model
M. Di Stasio*, C. Balseiro**, and J. Lorenzana*
*SISSA, Trieste, Italy. ** CNEA-CAB, Argentina.

Characterization of the carbocuprates $Ba_{2-x}Sr_xCuO_2CO_3$ *and* $B_{2-x}Ca_{3x}Cu_{1-2x}O_2CO_3$
C. Acha*, P. Guptasarma**, and F. Matacotta†
*CNEA, Div. Fis. Sol., Buenos Aires, Argentina. **Tata Institute of Fundamental Research, Bombay, India. †ICTP, Trieste, Italy.

MaMMa in NdCeCuO compounds.
C. Ramos*, A. Fernandes**, J. Briático*, V.V. Srinivasu†, A. Caneiro*, and F. Prado*
*CNEA-CAB, Argentina. **Instituto Militar da Engenharia, Rio de Janeiro, Brazil. †Indian Institute of Science, Bangalore, India.

Magnetic defects in $Nd_{2-x}Sr_xNiO_y$*: an EPR study*
Magnetic defects in $Nd_{2-x}Sr_xNiO_y$*: an EPR study*
A. Elzubair*, G. Goya**, M.T. Causa†, R. Sánchez†, J. Alonso‡, M. Vallet Regi‡, and J.M. González Calbet‡
*CBPQ, Rio de Janeiro, Brazil. **Universidad Nacional de La Plata, Argentina. †CNEA-CAB, Argentina. ‡Universidad Complutense de Madrid, Spain.

Preparation and properties of AmGdCeCuO
G. Nieva*, H. Simanjuntak**, V. Skumryev†, A. Butera*, H. Salva*, M. Servin*, and J. Briático*
*CNEA-CAB, Argentina. **University of Indonesia, Indonesia. †University of Sofia, Bulgaria.

Relationship between microstructure, oxygen content, and ac susceptibility of $La_{1.84}Sr_{0.16}CuO_y$

H. Ferrari*, A. Jiménez**, A. Caneiro†, F. Prado†, J. Abriata†, and D. Serafini†
*Universidad de Buenos Aires, Argentina. **Universidad Nacional de Colombia, Colombia. †CNEA-CAB, Argentina.

Determination of the intergranular magnetic field in $Ga_1Ba_2Cu_3O_{7-\delta}$ *using I-V characteristics*

J. Barroso*, N. Ayoub**, F. Pardo†, and D. López†
*University of Havana, Cuba. **Yarmouk University, Irbid, Jordan. †CNEA-CAB, Argentina.

Dissipation and stiffness of the vortex lattice in NbZr: mechanical oscillator studies

L. Miu*, J.L. Zhang**, J. Luzuriaga†, E. Rodriguez†, and D. Rodriguez†
*Institute of Physics, Bucharest, Romania. **Chinese Academy of Sciences, Beijing, China. †CNEA-CAB, Argentina.

Determination of $H_{c1}(T)$ *in* $Bi_2Sr_2Ca_1Cu_2O_8$ *single crystal with H parallel to c*

K. Abbes*, J. Ossandon**, G. Panaitov†, E. Fernández Righi‡, and H. Pastoriza‡
*University of Annaba, Algeria. **Universidad de Talca, Chile. †Institute of Applied Physics, Kishinev, Moldavia. ‡CNEA-CAB, Argentina.

Decoration of the flux lattice in the superconducting compound $NbSe_2$

M. Prester* and C. Bolle**
*University of Zagreb, Croatia. **CNEA-CAB, Argentina.

Excitation field dependence of the susceptibility in $Bi_2Sr_2Ca_1Cu_2O_8$ *single crystal with an applied dc field*

R. Andrade*, E. Altshuler**, A. Bellorin†, M. Goffman‡, and A. Arribere‡
*UNICAMP, Campinas, Brazil. **University of Havana, Cuba. †IVIC, Caracas, Venezuela. ‡CNEA-CAB, Argentina.

Specific heat measurements in $ZrNb_{9\%}$ *alloys*

A. Castellanos*, P. Levy**, O. Trovarelli†, and J. Sereni†
*CIF, Colombia. **CNEA Div. Fis. Sol., Buenos Aires, Argentina. †CNEA-CAB, Argentina.

The organization of an experimental workshop outside Trieste was successful and paid back the extra effort required by the preliminary work. In fact, the benefits of such a training activity went to foreign and local participants thus, in a way, doubling the efficiency of the course.

The experiments were carried out using an impressive number of good-quality facilities normally used for state-of-the-art research and having the continuous assistance of expert personnel. This turned out in an immediate possibility for the foreign participants to get to work on real scientific problems.

The participants lived in campus and had access to all the facilities available. They also had the opportunity to interact with the local scientists on a true "24-hours-a-day" cooperation.

Bariloche, 29 January 1993.

Dr. F. de la Cruz
Dr. F.C. Matacotta
Course Directors

♦

Conferences and Lectures

Dr. M. Kirane, a Post-doctoral student of the ICTP Mathematics Research Group, lectured on "Some reaction diffusion systems: results and reaction diffusion systems: results and open problems" at the University of Granada, Spain, on 12 January. He then gave a seminar on "A reaction-diffusion system describing the spread of infectious diseases" at the Universidad Complutense in Madrid, Spain, on 26 January.

*

Prof. S.J. Abbasi from Karachi, a Post-doctoral student in the Mathematics Research Group, has been invited to attend and to present a talk at the Conference on Near-Rings and Near-Fields to be held at the University of New Brunswick, Fredericton, N.B., Canada, from 18 to 24 July 1993. ♦

Visits to ICTP

Twenty students from the Scientific High School "E. Torricelli" in Maniago (Italy) visited the ICTP on 22 February. As is customary, the visit was tailored for them on the basis of their particular interests — in their case, computers. In fact, they attend a special course in informatics at their School, and therefore a visit at the ICTP Microprocessors Laboratory was a must. ♦

continued from Page 5

We foresee that 1500 to 2000 researchers per year will work at ELETTRA, once it has become fully operational. A good share of the visitors will come from Eastern Europe. By means of its universal scientific language, ELETTRA will then also be an instrument of international collaboration, a catalyst of good relations with the nations of *Mitteleuropa* — finally, an instrument of peace.

Mr. President, allow me to express our thanks for your personal interest in this initiative. The Government has been far-sighted in letting it take off on Italian territory, because — as Germany and Japan have proven after the second world war — it is just in moments of crisis that investment in the scientific and technological research produces technological and economic progress for technological and economic progress for the country.

Thank you, Mr. President! ♦

Corrigendum

Please read "Top Scorer in the ICTP Diploma Course Programme, 1991-92 in the High Energy Group of 10 participants" instead of "scored the top position among 20 participants", on Page 5 of the November/December issue of *News from ICTP*. ♦

Klaus Von Klitzing *(Germany), 1985*
"for the discovery of the quantised Hall effect".
Dates of visits:
1984, June 17 – 20
1988, December
1990, August 10 – 12.

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

Leon M. Lederman *(USA), 1988*
"for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino".
Date of visit:
1987, June 29 – August 7.

Heinrich Rohrer *(Switzerland), 1986*
"for the design of the scanning tunnelling microscope".
Dates of visits:
1987, July 28 – 31
1990, August 11 – 13.

Karl Alex Müller *(Switzerland), 1987*
"for the discovery of high-temperature superconductivity in copper oxide ceramic materials".
Dates of visits:
1987, July 5 – 8
1988, July 26 – 29
1988, December 6 – 7
1989, October 31 – November 4.

Kenneth Geddes Wilson *(USA), 1982*
"for his theory of critical phenomena in connection with phase transitions".
Date of visit:
1986, October 6 – 31.

Synergetics: Pattern Formation and Pattern Recognition

H. Haken
Guest Scientist, ICTP

Abstract

After a brief definition of synergetics, its microscopic, macroscopic and phenomenological approaches are described. In particular, an outline of the microscopic approach is given, where the fundamental role played by generalized Ginzburg-Landau equations as developed by the present author is stressed. Using the idea that pattern recognition by machines or humans is nothing but pattern formation, an outline of the synergetic computer for pattern recognition is given.

1. What is synergetics about?

Synergetics is an interdisciplinary field of research that I initiated some twenty years ago. This field is concerned with the spontaneous formation of spatial, temporal or functional structures (or patterns) from a unifying point of view. While such an approach is a common place today as is witnessed by numerous conferences dealing with these problems, at that time asking for general principles underlying these processes of self-organization was a rather daring enterprise. Indeed, why should systems as diverse as lasers, fluids, chemical reactions, morphogenesis, evolution, formation of public opinion, a.s.o. be governed by the same underlying principles? Over the past twenty years, however, it turned out that the question for general principles underlying self-organization could be answered in the positive for a great variety of systems.

The spontaneous formation of patterns in condensed matter physics, i.e. in particular in solid state physics and in fluid dynamics, has become a large and important research subject in its own right and the field is exploding. At the same time this field has become an important test ground for the application of general concepts and mathematical tools of synergetics because of the detailed and accurate experimental data that have been obtained over the recent years.

In this paper I wish to remind the reader of some of the underlying general concepts of synergetics and of its recent applications to the problem of pattern recognition.

2. Basic approaches of synergetics

Depending on the kind of tasks, synergetics uses three different methods:

a) *The microscopic approach* (Haken 1983, 1987). In it is assumed that the individual variables of the subsystems and the laws for their temporal evolution are known. Then, close to instability points, when new patterns emerge, the theory shows that the dynamics of the whole system is governed by few variables, the so-called order parameters, which enslave the subsystems. This approach is also valid in the mesoscopic case, e.g. in fluid motion, where again the basic equations are known though not for the molecules explicitly, but for the volume elements.

b) *The macroscopic approach based on the maximum information (entropy) principle* (Haken 1988). In this approach it becomes possible to determine the distribution function of a system far from equilibrium by means of special moments, or to derive a Fokker-Planck equation starting from specific correlation functions.

c) *The phenomenological approach.* If the microscopic or mesoscopic laws are not known, one may nevertheless try to describe a system by means of adequate macroscopic quantities, namely the order parameters.

3. The microscopic approach

3.1 *Order parameters and the slaving principle*

In order to make the profound analogies between the formation of patterns by quite different systems visible and to prepare the ground for establishing an important analogy between pattern formation and pattern recognition, we have to adopt a rather abstract level of formulation. To describe a system at the microscopic or mesoscopic level, we introduce the state vector

$$q = (q_1, q_2, \ldots, q_n) \ . \qquad (1)$$

In fluids, q_j may denote the components of the velocity field and the temperature field. In this case the components are both space- and time-dependent. In models of chemical reactions, q_j may stand for the concentration of a chemical of kind j. In all these cases and many others, the state vector develops in the course of time. This time evolution is described by so-called evolution equations which are of the form

$$\dot{q} = N(q, \nabla, \alpha) + F(t) \ . \qquad (2)$$

$$\dot{q} = N(q, \nabla, \alpha) + F(t) \ . \qquad (2)$$

The left-hand side is the temporal derivative of the state vector q. N is a nonlinear function of the state vector. The state vector may be subjected to differential operations ∇, and the system may be controlled from the outside by so-called control parameters α. $F(t)$ represents random forces which may still be specified, e.g. as δ-correlated in time ("white noise") and Gaussian. In chemical reactions the typical reaction-diffusion equations are of the form

$$\dot{q} = N(q, \alpha) + D\Delta q \qquad (3)$$

where D is a diffusion matrix and Δ the Laplace operator.

The general form of the equations (2) covers an enormous range of phenomena and it appears impossible to devise a general method of solution. From the experimental point of view, however, we are quite often confronted with the following sit-

uation. For instance, in a fluid layer heated from below at a certain temperature difference ΔT below the lower and upper surface, the fluid is quiescent, whereas above a critical value of ΔT it acquires a specific macroscopic motion. In other words, at a critical value of a control parameter α (here identical with ΔT) the former state has become unstable and is then substituted by a new state. This suggests to follow up the following strategy: We assume that for a given control parameter value α_0 a solution q_0 of equation

$$\dot{q} = N(q, \alpha) + F(t) \tag{4}$$

is known. We just mention that our general procedure allows us to treat all kinds of q_0 as such an initial state; it may be time-independent (representing a fixed point), it may be time-periodic (representing a limit cycle), it may be time-quasi-periodic (forming a torus), or it may be even time-chaotic (forming a chaotic attractor). When we change the control parameter, the state vector q_0 may become unstable. Quite generally, therefore, under the assumption that we have changed the control parameter $\alpha_0 \to \alpha$, we make the hypothesis

$$\alpha_0 \to \alpha : q = q_0 + w(x, t) \; . \tag{5}$$

Since w is assumed to be a small quantity, we may insert (5) into (4) and linearize the resulting equation for w

$$\dot{w} = L(q_0) w \; . \tag{6}$$

It can be shown quite generally in all the above mentioned cases of q_0 that w can be written in the form

$$w(x,t) = \begin{cases} e^{\lambda t} v_u(x,t), \; \mathrm{Re}\, \lambda \geq 0 \\ e^{\lambda t} v_s(x,t), \; \mathrm{Re}\, \lambda < 0 \end{cases} \tag{7}$$

where v depends on t in a way that is weaker than an exponential growth or decay. The λs are the eigenvalues of equation (6). In what follows, we have to distinguish between those eigenvalues whose real part is positive and those whose real part is negative. In the former case, we shall speak of unstable, in the latter case of stable modes. It is our goal to solve the nonlinear stochastic equations (2) exactly, i.e. not only in a linear approximation. To this end, we expand the unknown function q into a superposition of the individual modes.

$$q(x,t) = q_0 + \sum_u \xi_u(t) v_u(x) + \sum_s \xi_s(t) v_s(x) \; . \tag{8}$$

In the mathematical sense, this is a complete superposition, where the amplitudes ξ_u and ξ_s are still unknown functions of time. Inserting (8) into

$$\dot{q} = N(q, \alpha) + F(t) \tag{9}$$

and projecting on the modes v, we obtain the following two sets of equations:

$$\dot{\xi}_u = \lambda_u \xi_u + \hat{N}_u(\xi_u, \xi_s) + \hat{F}_u(t) \tag{10}$$

and

$$\dot{\xi}_s = \lambda_s \xi_s + \hat{N}_s(\xi_u, \xi_s) + \hat{F}_s(t) \; . \tag{11}$$

These equations are entirely equivalent to the former equations (9). However, provided the inequality

$$|\mathrm{Re}\, \xi_s| \gg |\mathrm{Re}\, \xi_u| \tag{12}$$

holds, the slaving principle of synergetics may be applied. According to this principle, the mode amplitudes ξ_s can be expressed by the amplitudes of the unstable modes ξ_u

$$\xi_s(t) = f_s(\xi_u(t), t) \; . \tag{13}$$

The explicit dependence of f_s on t stems from the time-dependence of the fluctuating forces, but not from that of the amplitudes ξ_u. Provided λ_u and λ_s are real, the slaving principle takes a very simple form in its lowest approximation. It is nothing but the adiabatic elimination procedure that I had introduced into laser theory some thirty years ago and which consists in putting $\dot{\xi}_s = 0$ in equation (11). Then equation (11) reduces to an algebraic equation which can be resolved with respect to ξ_s so that ξ_s is represented in the former form of (13).

In practically all cases that have been treated in the literature the systems are of a very high dimension, but in contrast the number of unstable mode amplitudes ξ_u is very small. The amplitudes ξ_u are called order parameters, whereas the variables ξ_s will be called enslaved variables. The order parameter concept allows for an enormous reduction of the degrees of freedom.

Once we have expressed the enslaved modes by means of the order parameters ξ_u via (13), we may insert (13) into (10) and thus find equations for the order parameters alone

$$\dot{\xi}_u = \lambda_u \xi_u + \hat{N}_u(\xi_u, f_s(\xi_u, t)) + \hat{F}_u(t) \; . \tag{14}$$

In a number of cases these equations can be put into universality classes describing similar behavior of otherwise quite different systems. For instance the formation of a roll pattern in a fluid, a single mode laser, or the formation of a stripe pattern in chemical reactions obey the same basic order parameter equation. Such universality classes can be established because of the following facts:

a) When we are dealing with a soft transition of the order parameters, they are small close to the instability point. This allows us to expand $\hat{N}_u$ into a power series with respect to the order parameters where we may keep only a few leading terms.

b) Furthermore, we may exploit symmetries, for instance when there is a term $\beta \xi_u^2$, and there is an inversion symmetry of the system, it follows that $\beta = 0$. Symmetries lead also in a number of cases to relationships between coefficients.

c) Finally, we may invoke normal form theory to simplify the nonlinear functions on the right-hand side of (14).

3.2 Some examples for the formation of spatial patterns

In the case of a single order parameter with inversion symmetry, the order parameter equation reads

$$\dot{\xi}_u = \lambda \xi_u - \beta \xi_u^3 + F(t) \; . \tag{15}$$

In the case of a single mode laser, ξ_u may be identified with the slowly varying time-dependent field strength. In this case, λ is the unsaturated gain minus cavity losses, whereas the cubic term stems from gain saturation. We further assume that ξ is

real. Equation (15) holds for many other systems also.

Let us consider the general case. The state vector may be written as

$$q(x,t) = q_0 + \xi_u(t)v_u(x) + \sum_s \xi_s(t)v_s(x) \,, \qquad (16)$$

where the sum over the enslaved modes is in general small so that the evolving pattern is determined by the second term on the right-hand side which is called the mode skeleton. While v_u determines the spatial variation of q, ξ_u determines the temporal rise and saturation (see Fig. 1). In the case of two order parameters, the basic equations read

$$\dot{\xi}_1 = \lambda\xi_1 + \beta_1\xi_1^2 + \beta_{12}\xi_1\xi_2 + \beta_2\xi_2^2 + \ldots + F_1(t) \qquad (17)$$

and

$$\dot{\xi}_2 = \lambda\xi_2 + \beta_1^1\xi_1^2 + \beta_{12}^1\xi_1\xi_2 + \beta_2^1\xi_2^2 + \ldots + F_2(t) \qquad (18)$$

and the total state vector is determined by

$$q(x,t) = q_0 + \xi_1(t)v_1(x) + \xi_2(t)v_2(x) \qquad (19)$$

Depending on the coefficients in (17) and (18), modes may either coexist or compete. In the case of competition, either ξ_1 or ξ_2 vanish. In the case of coexistence, both are nonvanishing so that the total pattern becomes a superposition of the patterns v_1 and v_2 (Fig. 2).

Let us consider finally the case of three order parameters where the modes are represented by plane waves

$$\begin{aligned} v_1(x) &= A\exp\{ik_1x\} \\ v_2(x) &= A\exp\{ik_2x\} \quad + \text{C.C.} \\ v_3(x) &= A\exp\{ik_3x\} \end{aligned} \qquad (20)$$

When hexagons are formed, k_1, k_2, k_3 must form a triangle and the coexistence of the corresponding three order parameters is guaranteed by quadratic terms in the equations (14). In some fluids the coexistence of three order parameters may get lost and give way to competition if the energy input into the system is enhanced. Also the possibility of regimes of coexistence and competition is given.

fluids the coexistence of three order parameters may get lost and give way to competition if the energy input into the system is enhanced. Also the possibility of regimes of coexistence and competition is given.

3.3 *Continuous spectrum. Generalized Ginzburg Landau equations (Haken 1975)*

In a number of cases the intrinsic length of a pattern may be much smaller than the extension of the whole pattern ("large aspect ratio systems"). In such a case, the eigenmodes v may be represented as plane waves in the plane of large extension (and a more complicated function in the third dimension). Correspondingly the indices u (and s) must be replaced by pairs of indices, say k, j, where k is a continuously changing wavevector. When the system passes through an instability point, a whole band of wave vectors is connected with a positive eigenvalue (Fig. 3). Under such conditions the inequality (12) is no longer fulfilled. However, a way out can be found by discretizing the k

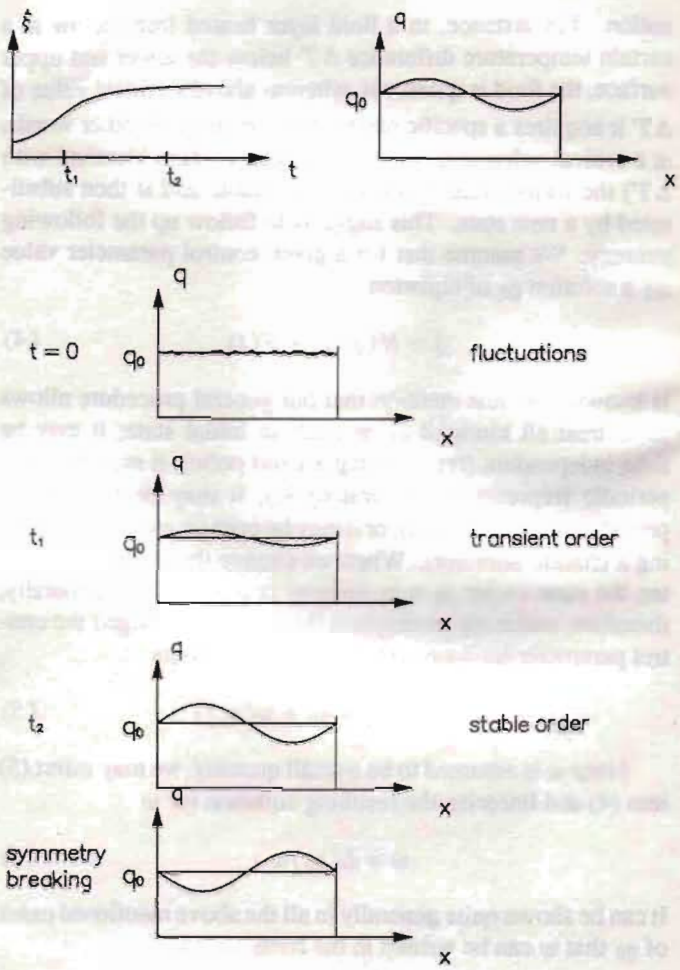

Figure 1

Upper part, l.h.s.: Temporal evolution of the order parameter ξ. It grows from a fluctuation and, eventually, saturates; R.h.s.: Example of the spatial variation of the unstable mode v_u; Lower part, from top to bottom: The evolution of the pattern $q(x,t)$ in the course of time. From an initial spatio-temporal fluctuation a pattern evolves.

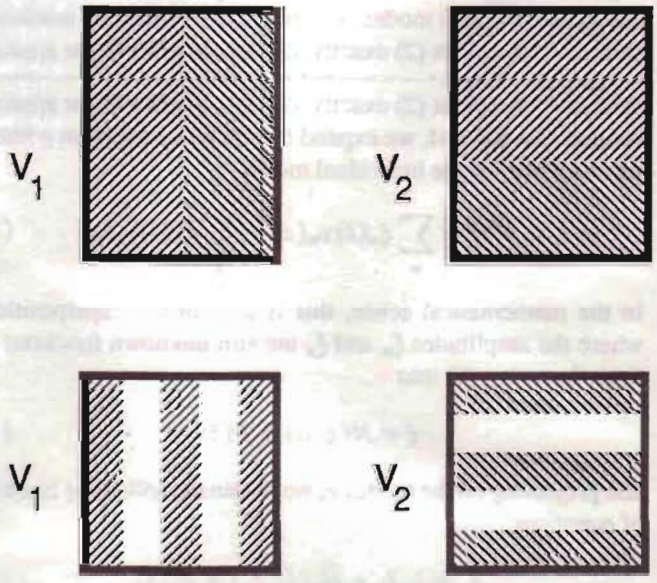

Figure 2

Examples for v_1 and v_2; Lower part: In the case of coexistence a superposition of the patterns v_1 and v_2 is observed.

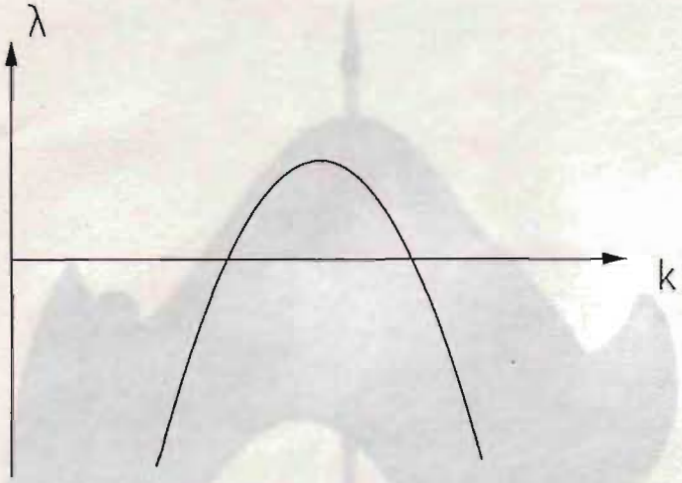

Figure 3
Example of a continuous spectrum in which the eigenvectors become unstable for a full range of k values.

values and forming wave packets around these discrete values. Thus, in (8) we replace sums of the form $\sum_u$ or $\sum_s$ by

$$\int d^2k \sum_j \xi_{k,j}(t) e^{ikx} u_{k,j}(z) .$$

Then we replace $\int d^2k$ by

$$\sum_{k_c} \int_{k_c-\delta}^{k_c+\delta} d^2k .$$

This leads us to the introduction of wavepackets

$$\xi_{k_c}(x,t) = \int_{k_c-\delta}^{k_c+\delta} \xi_k(t) e^{ikx} d^2k \qquad (21)$$

which become new slowly *space-dependent* amplitudes. It then becomes possible to derive equations for the new order parameters, where the eigenvalues λ_{kj} become operators $\lambda_j(k_c, \nabla)$ (cf. H. Haken 1975, 1987). These equations are of the form

$$\dot{\xi}_{k_c j}(x,t) = \lambda_j(k_c, \nabla)$$

$$+ \sum_{k_c', k_c'' j' j''} A_{k_c, k_c', k_c'' j j' j''}(\nabla) \xi_{k_c' j'} \xi_{k_c'' j''} \qquad (22)$$

$$+ \text{higher order terms} .$$

Now the slaving principle can be applied and thus equations for the order parameters derived. The resulting equations are again of the form (22) but with newly defined A's and indices that refer only to the unstable modes. These equations are somewhat reminiscent of Ginzburg-Landau equations known from superconductivity. This is why I have called these new equations "generalized Ginzburg-Landau equations". Under suitable approximations a number of equations known in the literature can then be derived, e.g. the Swift-Hohenberg equations (Swift and Hohenberg 1977)

$$\dot{\xi}(x,t) = \lambda(\nabla)\xi - B\xi^3 \qquad (23)$$

and others.

4. The macroscopic approach

Here it is assumed that certain observables can be measured and their correlation functions - or moments - determined. When a distribution function close to an instability point must be determined, moments from the first till the fourth order must be used, or in specific cases, still higher order moments. In the case of the derivation of a time-dependent Fokker-Planck equation, it is assumed that the underlying process is Markovian. Then correlation functions of specific types must be used. This method has recently been used by Lisa Borland and the present author to recover the Brownian motion in a nonlinear potential from experimental data. But the method can be applied to more complicated cases, too.

5. Phenomenological synergetics

As an example we study the modelling of the following experiment done by Kelso on humans (Haken, Kelso and Bunz, 1985). He told test persons to move their fingers in parallel, first at a slow speed, later at an enhanced speed. To the surprise of the test persons, they changed quite involuntarily their mode of finger movement from parallel to antiparallel, i.e. symmetric, when the finger movement exceeded a specific typical speed. In these experiments the relative phase was identified as an order parameter. Its motion can be described by that of a ball in a potential landscape which is depicted in Fig. 4. From top left to bottom right, the speed is enhanced which leads, as can be shown in more detail, to a flattening of the upper potential valley.

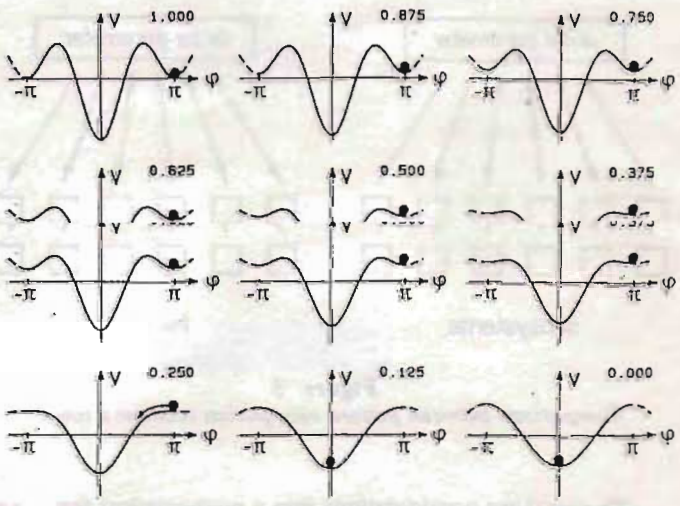

Figure 4
The landscape describing the behavior of the relative phase of the finger experiment. In the upper left corner, the finger movement is still slow, and the system is in a stable state in the upper right valley, as indicated by the ball. With increasing speed of the finger movements, the landscape is deformed until in the middle row, r.h.s., the unstable situation is reached and a little push now can cause the ball to fall down to the absolute minimum corresponding to the antiparallel finger movement. With still higher speed of finger movement, the lower minimum is the only minimum available.

The predictions following from this model, namely hysteresis, critical slowing down, and critical fluctuations could be observed by Kelso and co-workers. In this way, a number of movement patterns connected with a single order parameter in the form of a phase could be modelled.

6. Pattern recognition

In this section I want to show how the results of the foregoing chapters allow us to construct a device (a computer) for pattern recognition (Haken, 1990). To this end we use three ingredients:

a) Pattern recognition is achieved by an associative memory. An example for an associative memory is provided by a telephone book. When we look up the name Alex Miller, the telephone book tells us his telephone number. In a more abstract way, an associative memory complements a set of data to a full set depending on the initially given data.

b) Pattern recognition is a dynamic process in which fixed point attractors are approached.

c) Pattern recognition can be considered as pattern formation. Consider to this end the left-hand side of Fig.5. Its lower part symbolizes the individual parts of a system, e.g. a fluid, where a part of that system is already in an ordered state. This ordered state generates its order parameter which competes with the other possible order parameters. It wins the competition and finally forces the system into the specific ordered state. The right-hand side of Fig. 5 shows a process of pattern recognition. Here some features of a pattern are given. These features generate the order parameter which, in turn, reacts on the recognizing system and forces it into a fully ordered state, i.e. the state related to the initially given features.

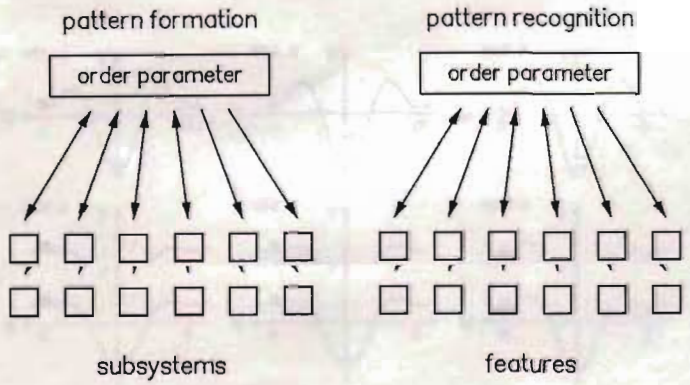

Figure 5
Comparison between pattern recognition (compare text).

To cast these considerations into a mathematical form, we first introduce the so-called prototype vectors and consider as an example the recognition of faces. We photograph faces of some persons and digitize them. The grey value of each pixel then constitutes a component of the prototype vector. If an incomplete pattern is offered, it is described by a state vector q. The idea of our approach to pattern recognition is now to subject the state vector (test pattern vector) q to a dynamics through which q is, eventually, moved into a final attracting state which is identical with one of the stored prototype vectors, specifically to the one to which q had been closest. The dynamics is

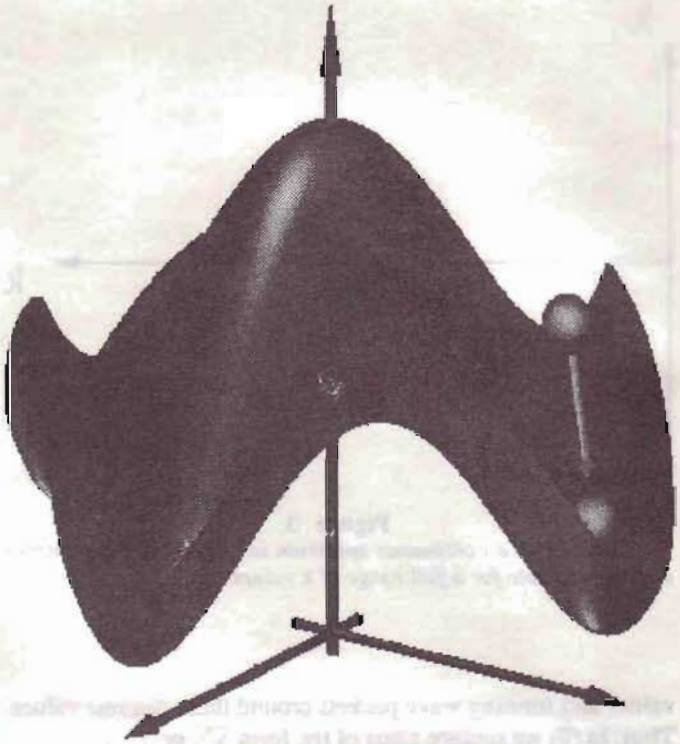

Figure 6
Visualization of the behaviour of the test pattern vector q determined by the evolution equation by means of a two-dimensional example. The two prototype patterns are supposed to lie along the axes q_1 and q_2. The dynamics is determined by that of a ball moving in a potential landscape. If the test pattern vector that is initially given does not coincide with the valleys corresponding to the prototype patterns, it is pulled into one of them by means of the dynamics.

described by the equation (for a visualization cf. Fig.6)

$$\dot{q} = \sum_u \lambda_u v_u v^u \cdot q - \sum_{u' \neq u} (v^{u'} q)^2 v_u (v^u q) - |q|^2 q + F \,. \quad (24)$$

v^u are the adjoint vectors belonging to v_u, brackets indicate scalar products between vectors. Equations (24) can be solved on a serial computer. Examples for stored prototype vectors and the recognition procedure are shown in Figs. 7 and 8. The recognition procedure can be made invariant against rotation, scaling and orientation. A computer can then recognize scenes, e.g. that of Fig. 9. It recognizes first the lady in the foreground and then, when the corresponding attention parameter equation (24) is set equal to zero and the pattern is shown again to the computer, it recognizes the man in the rear. In this way, scenes composed of up to five faces were recognized.

I wish to mention that we developed a learning procedure, where, for instance, the computer learns prototype patterns from a set of offered noisy patterns (Haken, Haas, Banzhaf 1989). I believe that pattern recognition (and the corresponding learning algorithms) will play an important role in future studies in fluid dynamics where complicated patterns will be classified, their frequency of occurrence determined and recognized by computers.

Figure 7
Examples of stored prototype patterns jointly with letters encoding for the names.

Figure 8
Example for the action of the synergetic computer when an initial test pattern vector is offered. Upper row: The computer reconstructs out of the name encoded by D the face (plus name); Lower row: It reconstructs from part of a face the full face (plus name). Note that these completions are done in the presence of all prototype patterns, i.e. the pattern recognition procedure is performed fully in parallel.

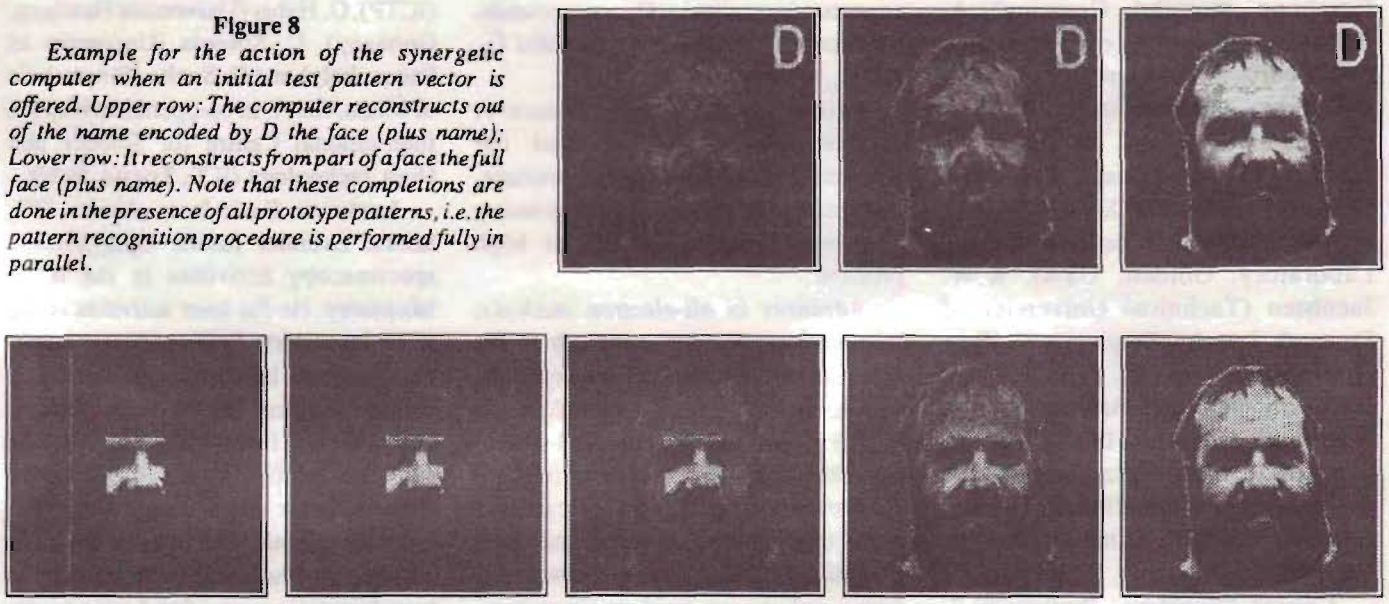

Figure 9
Example of a scene recognized by the synergetic computer.

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Activities at ICTP in January-February 1993

Title: SIXTH INTERNATIONAL WORKSHOP ON COMPUTATIONAL CONDENSED MATTER PHYSICS, 11 – 13 January.

International Programme Committee: Professors O.K. Andersen (Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany), A. Baldereschi (University of Trieste, Italy, and Ecole Polytechnique Fédéral, Lausanne, Switzerland), R. Car (International School for Advanced Studies, SISSA, Trieste, Italy, and University of Geneva, Switzerland), S. Froyen (National Renewable Energy Laboratory, Golden, USA), K.W. Jacobsen (Technical University of Denmark, Lyngby, Denmark), K. Kunc (Université de Paris VI, Paris, France), R. Resta (International School for Advanced Studies, SISSA, Trieste, Italy), M. Scheffler (Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany) and E. Wimmer (Biosym Technologies, Suresnes, France).

Course Directors: Professors S. Baroni (International School for Advanced Studies, SISSA, Trieste, Italy), S.G. Louie (University of California, Berkeley, USA) and R.J. Needs (Cavendish Laboratory, Cambridge, UK).

Lectures: *Many body calculations:* Auxiliary-field quantum Monte Carlo for systems with long-range repulsive interactions. Update on quantum Monte Carlo calculations on materials. Exchange correlation and magnetic field effects in two-dimensional Wigner crystals. Quasiparticle calculations for Si(111) and Si(100) surfaces. A perturbative approach to correlated electron systems: a model, the 3-d ferromagnets, UPt_3 and $La_{2-x}Sr_xCuO_4$.

Novel applications of band-structure methods: Accurate theoretical analysis of photonic band-gap materials. Density-functional theory for superconductors.

Applications of parallel computing & algorithmic developments: Massively parallel computation of electronic structure on the connection machine. Ab initio materials science on parallel computers. Running molecular dynamics code in parallel on a cluster of workstations: application to solid fullerenes. Electronic structure calculations in adaptive coordinates.

Panel discussion on O (N) methods.

Poster session.

C_{60} and related compounds: Coulomb pseudopotential and superconductivity in C_{60}. Electron-phonon coupling and superconductivity in doped C_{60}. Electronic structure and superconductivity in C_{60} compounds. Electronic structure of doped solid C_{60} and C_{84} clusters.

Solids under high pressure: Mechanical instabilities and the amorphization of solids under pressure. Phonon softening and low-symmetry phases of cesium halides at high pressure.

Advances in all-electron methods: Hartree-Fock FLAPW approach to the electronic properties of periodic systems. The surface embedded Green function (SEGF) method. Augmented-plane-wave based Car Parrinello method.

Forces and phonons: Forces and molecular dynamics using the full-potential LMTO method. Interatomic forces and phonon band structure in α-quartz.

Macroscopic electric polarization in solids: Theory of polarization of crystalline solids and relation to surface charges. The geometrical phase approach to spontaneous polarization in ferroelectrics.

Complex semiconductor structures: Some recent applications of the Car-Parrinello method to the study of the physical chemistry of small clusters. Can quantum wire effects explain visible luminescence in porous silicon? First-principles molecular dynamics simulations of disordered alloys. Electronic structure and dynamics of impurity reaction in wide-gap-semiconductors.

Surfaces: A step from fictitious to realistic surfaces. The adsorption and diffusion of adatoms on the Si(100) surface. Ab-initio calculation of structural and electronic properties of α-Ga surfaces. Dynamical calculations of Cl_2 dissociative chemisorption on Si(111)-2xl.

Tight-binding molecular dynamics: Tight-binding molecular dynamics study of silicon and carbon systems. Tight-binding molecular dynamics.

The Workshop was attended by 118 lecturers and participants (20 from developing countries).

Title: FOURTH TRAINING COLLEGE ON PHYSICS AND TECHNOLOGY OF LASERS AND OPTICAL FIBRES, 18 January – 5 February.

Organizers: Professors G. Denardo (ICTP), G. Huber (Universität Hamburg, Germany), C. Someda (University of Padua, Italy) and O. Svelto (Polytechnic of Milan, Italy), in co-operation with the International Centre for Science and High Technology (ICS, Trieste, Italy).

Lectures: Basic laser physics. CO_2 lasers. Excimer lasers. Optogalvanic spectroscopy activities in the ICTP laboratory. He-Ne laser activities in the ICTP laboratory. Semiconductor lasers. Femtosecond lasers. Single frequency semiconductor lasers with narrow spectral linewidth. Visible semiconductor lasers. Advanced semiconductor lasers. Single mode CO_2 laser. Fibre optics activities in the ICTP laboratory. Fluctuation suppression in laser beam geometry. Solid state lasers. Diode laser injection locking. Nonlinear optics. Laser diagnostics for medical problems. Laser diagnostics for environmental problems. Phase conjugation. Ultra-short-pulse high-power lasers and their applications. Advanced laser biomedical instrumentation. Fibre sensors. Stereolithography and other processes. Theory of propagation in waveguides and optical fibres. Fibre characterization. Quality control of optical fibres. Passive components in fibres and in planar optics. Solitons in optical fibres. Optical waveguides. Detectors, modulators, switches. Photodetectors.

Seminars.

Laboratory sessions: Operation and characterization of gas and solid state lasers. Axial mode structure of He-Ne lasers. Neon optogalvanic spectroscopy. Diode laser injection locking. Splicing, connecting optical cables. Use of Bit Error Rate system (BER) and Optical Time Domain Reflectometer (OTDR) for optical fibre communication

networks.

The College was attended by 83 lecturers and participants (61 from developing countries).

Title: SECOND WORKSHOP ON FUNCTIONAL-ANALYTIC METHODS IN COMPLEX ANALYSIS AND APPLICATIONS TO PARTIAL DIFFERENTIAL EQUATIONS, 25 – 29 January.

Organizers: Professors Le Hung Son (Polytechnical University of Hanoi, Viet Nam), G. Mandzhavidze (University of Tbilisi, Georgia), A.S.A. Mshimba (University of Dar-es-Salaam, Tanzania) and W. Tutschke (Technical University of Graz, Austria).

Lectures: Results and problems in the theory of generalized analytic functions and its influence on the present development of Mathematical Analysis. Unification of global and local existence theorems for holomorphic functions of several complex variables. Complex methods for second order systems. Introduction to computational versions of complex methods for partial differential equations. Weakly hyperbolic equations in Banach scales and applications to the Kirchhoff string equation. Review of results examined in the First Workshop on Functional-Analytic Methods in Complex Analysis (1988). Complex methods for boundary value problems with piecewise smooth boundary data. Conditions for holomorphy of L^1_{loc} functions. Oblique derivative problems for nonlinear elliptic complex equations of second order. Solution of initial value problems in associated spaces. The Vekua integral operators T_D Π_D in weighted Lebesgue spaces. Extensions theorems in Clifford Analysis and their applications. Analytic solutions to nonlinear hyperbolic equations. Regular quaternionic functions. Twistor spaces of Riemannian manifolds. The abstract Cauchy-Kowalewski theorem and some applications in Mathematical Physics. Discussion on mathematical education in developing countries. The Riemann boundary value problem with piecewise smooth data for elliptic partial differential equations in Sobolev spaces. Theorems of Cauchy-Kovalevsky and Holmgren type for abstract evolution equations in scales of locally convex spaces. Initial and nonlinear irregular oblique derivative problems for fully nonlinear parabolic complex equations. The new position of Complex Analysis in Mathematics as a whole, and its consequences in teaching Mathematical Analysis.

Seminars: The simple and the multiple layer potential approach in n-dimensional problems. On the construction of fundamental systems by superposition. Hypercomplex approach to the two-dimensional Complex Analysis. The operators Π_D and Π_D and two dimensional singular operators generated by them. Comparison on the solvability conditions for boundary value problems in the plane for different metrics. Riemann-Hilbert problem of certain n-th order equations. Fixed point theorems for nonlinear partial differential equations with the principal parts with Δu and $\Delta^2 U$ in a rectangle.

The Workshop was attended by 32

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

lecturers and participants (9 from developing countries).

Title: THIRD ICTP-URSI COLLEGE ON THEORETICAL AND EXPERIMENTAL RADIOPROPAGATION PHYSICS, 1 – 26 February.

Organizers: Professors S.M. Radicella (Programa Nacional de Radiopropagación, PRONARP, Buenos Aires, Argentina, and ICTP) and J. van Bladel (Union Radio-Scientifique Internationale, URSI, University of Ghent, Belgium), with the co-sponsorship of the International Telecommunications Union (ITU), the Telecommunications Development Bureau and the Italian National Institute of Geophysics.

Lectures: Electromagnetism. Computer techniques. Noise and interference in radiocommunications. Radiopropagation aspects of satellite communications. Radio spectrum management and electromagnetic compatibility. Ionospheric effects on modern telecommunications systems.

Open discussions.

Participants' contributions.

Visit to firm Telettra.

Free hours for library consultations.

The College was attended by 52 lecturers and participants (44 from developing countries).

Title: WINTER COLLEGE ON OPTICS, 8 – 26 February.

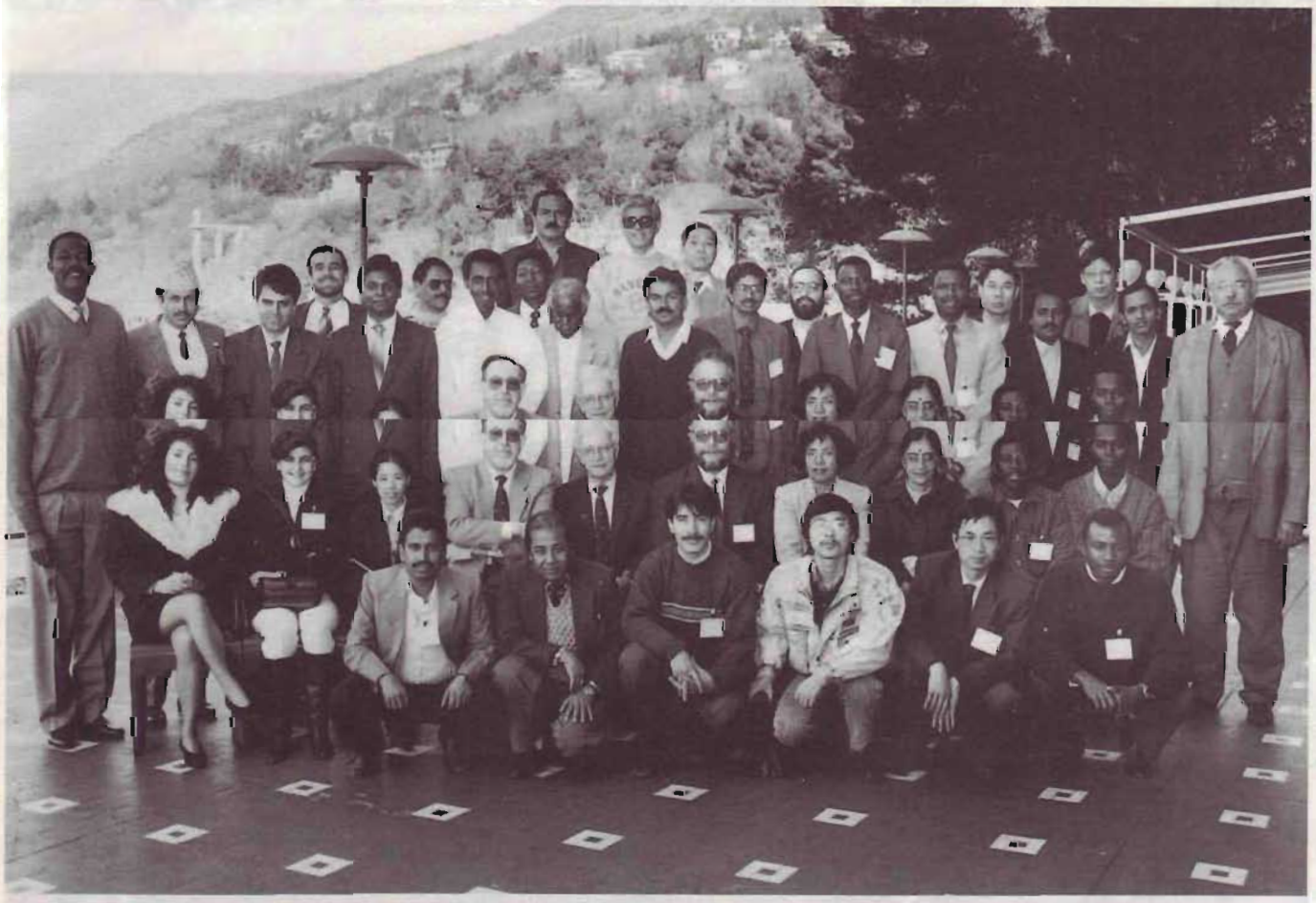
Organizers: Professors A. Consortini (University of Florence, Italy), C. Dainty (Imperial College of Science and Technology, London, UK), G. Denardo (ICTP), P. Hariharan (CSIRO, Lindfield, Australia, and University of Hyderabad, India) and H. Tiziani (University of Stuttgart, Germany), in collaboration with the International Centre for Science and High Technology (ICS, Trieste, Italy) and the International Commission for Optics (ICO).

Lectures: Fundamentals of geometrical optics. Adaptive optics and laser guide stars. Optical design. Diffraction and imaging. Fabrication and testing of optical components. Optical design laboratory. Optical instrumentation. Interferometry and metrology. A multisensor approach to optical industrial measurements: a European project. Thin film optics. An interferometer for operating on the geometric phase. Light detectors. Heterodyned Fourier transform spectroscopy in the field. Holography. Fourier optics. Applications of photorefractive crystals. Medical applications. Modern microscopy. Coherence of light. Optical computing.

Seminars.

Laboratory sessions and presentations.

The College was attended by 93 lecturers and participants (58 from developing countries). ♦



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

Calendar of Activities at ICTP in 1993

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[illegible] ..... [illegible]

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

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

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

including

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

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

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

Adriatico Research Conference on strong correlation phenomena at low carrier density ..... 22 – 25 June

continued on following page

Calendar of Activities at ICTP in 1992, contd.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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