



NEWS from ICTP

the
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international centre for theoretical physics

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Riccardo Zecchina
ICTP Condensed Matter Physics Group

WHAT'S NEW

Complex computational problems may undergo 'phase transitions,' moving abruptly from difficult to impossible to solve. That's the finding of a group of statistical physicists that includes ICTP research scientist Riccardo Zecchina.

When a Little Means a Lot

Computers are marvellous computational machines that have expanded our ability to analyse and solve 'number' problems that were once beyond our reach. Yet, even the most advanced computers are limited in their computational capabilities. In fact, ever since the dawn of the computer age, mathematicians and computer scientists have examined computational problems in relation to the time and memory resources that are available for their solution.

The issue, more simply stated, is how complex are complex computational problems, and at what point do the variables involved overwhelm the time and resources at hand, making a solution difficult, if not impossible, to compute. Scientists have placed such problems in a special category of analysis, which they have labelled 'nondeterministic polynomial time' (or 'NP-complete') problems.

Take the case of the 'travelling salesperson.' When a salesperson plans to visit three clients in a single business trip, devising the most efficient itinerary is a simple task. If the trip calls for five stops, devising the most efficient route becomes more difficult. And if it's a journey with 12 stops, more difficult still. Say you're a company with 200 travelling salespersons, each of whom is on the road an average of 150 days a year. Is it possible to devise a collective itinerary that provides the shortest route between these multiple destinations? At what point do the variables become too numerous for the problem to be solved?

Until recently, mathematicians and computer scientists have held court over so-called NP-complete problems. Now, a growing cadre of physicists skilled in statistics have entered the problem-solving fray drawing inspiration from both their knowledge of complex systems and the behaviour of materials during phase transitions from gases to liquids and liquids to solids.

In a recent article in *Nature*, which was subsequently discussed at length in *The New York Times*, my colleagues and I sought to shed new light on NP-complete problems in ways that would help other researchers—in computer science, mathematics and physics—understand the nature of multivariable computational problems.

Here's our conclusion: Such problems may not become increasingly complex with each new variable and condition, but instead may cross a solvable/unsolvable boundary—or, in the language of physicists, may experience a 'phase transition.' That means computational problems may remain solvable for extended periods regardless of the variables or conditions that are added, but at some point may become suddenly unsolvable—much like water remains a liquid despite falling temperatures until the thermometer reaches zero degrees centigrade, when the liquid then turns into ice.

Moreover, we concluded it's not the phase transition *per se,* but the nature of the transition that determines the level of complexity. A transition, for example, may be abrupt but simple (as in the case of water turning into ice), or abrupt but complex (as in the case of silicon turning into glass). The first transition is easy to understand; the second is not.

If our preliminary conclusions prove correct, more sophisticated understanding of NP-complete problems could have important implications for activities ranging from mathematicians' abstract understanding of algorithms to bottom-line efforts by airline executives to optimise their companies' flight schedules. It also may help physicists better understand the world in which we live by shedding new light on the behaviour of materials and complex systems.

When it comes to computational problems, our findings could help separate the analytical wheat from the chaff and, as a result, help scientists focus their attention on problems that are solvable instead of spinning their wheels on problems that are not. In the process, we hope to bring the worlds of mathematics, physics and computer science a bit closer to illustrate that at critical points in complex phase transitions, a little often can mean a lot. □

For additional information about computational complexity and phase transitions, see R. Monasson, R. Zecchina, S. Kirpatrick, B. Selman and L. Troyanksy, "Determining computational complexity from characteristic phase transitions," and Philip W. Anderson, "Solving problems in finite time," Nature *400 (8 July 1999). Also George Johnson, "Separating Insolvable and Difficult,"* The New York Times, *13 July 1999.*

News from ICTP *is delighted to report that for the second time in the past four months, the work of ICTP researchers has received coverage in* The New York Times *and other major international newspapers and journals. See the previous issue of* News from ICTP *(Summer 1999), p. 2.*

Faheem Hussain
Head of the ICTP Office of External Activities

COMMENTARY

Proud of their star-studded past in science, the nations of Central Asia hope to emerge from their present difficulties with strong scientific communities. The ICTP Office of External Activities plans to lend a helping hand in these efforts.

Science in Central Asia

Laced by the 'silk road,' the world's pre-eminent trade route at the beginning of this millennium, Central Asia was both an international crossroads and global intellectual centre.

This region—now home to the nations of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan—boasts some of the great names of Islamic science and culture: Al-Khwarazmi (780-850), whose book on mathematics gave birth to the name *algebra* and whose name is commemorated in the mathematical notion of *algorithm*; El-Farabi (878-950), the philosopher second only to Aristotle in the Islamic world; Ibn-Sina (980-1037), the renowned medical doctor and researcher who is known in the West as Avicenna; and Omar Khayyam (1048-1122), the mathematician and poet.

One thousand years later and 10 years after the collapse of the Soviet Union, the region faces enormous challenges. Although the scientific community has been rocked by what has taken place over the past decade, it still remains a vital enterprise drawing strength from its glorious tradition and the investments in basic science made by the Soviet Union during its rule.

As head of the Abdus Salam International Centre for Theoretical Physics (ICTP) Office of External Activities, I recently visited Uzbekistan to learn about the state of science within the region and to discuss how the Centre could work more closely with the physics and mathematics communities there.

During the second week in August, I attended the International Symposium on Experimental Gravitation in Samarkand, Uzbekistan, jointly organised by the Samarkand State University and the Uzbek Academy of Sciences' Institute of Nuclear Physics. This symposium, which received a grant from the ICTP Office of External Activities, was attended by some 40 scientists, including many of the world's leading experts. The field, which seeks to test Einstein's theory of gravitation and detect gravitational waves, remains on the cutting edge of explorations into the fundamental properties of matter.

In the 10th century, before its destruction by Chengiz Khan, Samarkand was one the world's leading centres of science. During the 15th century, it re-emerged as a pre-eminent science centre under the guidance of the great astronomer king Ulughbek, who built a state-of-the-art observatory that lead to the discovery of some 200 unknown stars. In Samarkand, I met with the physics and mathematics faculty from Samarkand University to learn more about their past and, even more importantly, about their hopes for the future.

During the last week in August, I attended in Bokhara the Third International Conference on Modern Problems of Nuclear Physics, co-sponsored by the Institute of Nuclear Physics in Tashkent, Uzbekistan, and Bokhara University, which drew more than 200 participants. Here I had extensive talks with the director of the institute, university authorities and a large number of physicists from Uzbekistan and the region.

The Institute of Nuclear Physics in Tashkent, created by the Soviet Union as its premiere nuclear physics institute in Central Asia, remains a place dedicated to high standards. Foreign physicists—for example, from Germany, Italy and the United States—attending the meeting had collaborated with scientists from the institute for many years. Yet, the hard times faced by the institute's scientists are reflected in their declining numbers—from a peak of 2000 during Soviet times to 800 today. Those who remain continue to do first-class research. In fact, some of the radioisotopes produced there are marketed in the West by a German-American company, which partly sponsored the event.

Central Asia boasts the scientific talent, will and enthusiasm to succeed. But its scientists face daunting problems. Since the economic collapse of the late 1980s, governments have drastically cut spending on education and scientific research. Laboratory equipment is ageing, money for books and journals is scarce, and investments in computer facilities and the internet are woefully inadequate. University salaries average US$20 a month.

Science, in short, has lost its appeal. As a result, fewer students are pursuing careers in the basic sciences, opting instead for careers in business and computer science. Despite the obstacles, Central Asian scientists continue to do good work. And in the face of enormous political and economic difficulties, scientific ties among the former Soviet republics, including Russia, remain strong.

That's where the ICTP Office of External Activities believes it can make a difference: by providing assistance to encourage local collaborations and networks that could prove instrumental in the future well-being of the scientific enterprise throughout the region. □

What will happen when an earthquake strikes? What measures can be taken to limit its damage? How far in advance can we predict such events? These are the questions shaping the research agenda of the ICTP SAND Group.

Shook Up

This summer's earthquake in western Turkey, which left 15,000 dead, hundreds of thousands injured and tens of billions of dollars in property damage in its wake, was a shocking event that generated untold misery and captured media attention around the world. In rapid succession, earthquakes in Taiwan and Mexico killed thousands more. Indeed three major tremors in less than three months have placed earthquakes high on the agenda of global concerns.

However startling the pictures and statistics have been, the fact remains that earthquakes are not uncommon. About 10,000 earthquakes with tremors strong enough to be felt occur each year, and about 100 of these tremors cause considerable damage. Moreover, every year or so, some place in the world experiences a super-catastrophic event on the scale of what took place in Turkey. Fortunately, these events often take place in unpopulated areas.

These numbers show that earthquakes can be expected, and experts agree that we had better be ready for them, especially in vulnerable, heavily populated areas. Shoddy construction, poor building codes, limited public awareness and inadequate disaster-response training make developing countries and their megacities particularly vulnerable.

In 1950, about 50 percent of the world's urban earthquake-threatened population lived in developing countries. Today, it's 85 percent. Earthquakes, moreover, can devastate economies, especially those of developing countries. The 1972 earthquake in Guatemala caused an estimated 40-percent loss in gross domestic product (GDP). In contrast, devastating earthquakes in Kobe, Japan, in 1995 and Los Angeles, USA, in 1994 led to a loss in GDP of less than 1 percent in each of those countries.

In response to these alarming disparities, and in the context of this International Decade of Natural Disaster Reduction, the United Nations Educational, Scientific and Cultural Organization (UNESCO), European Commission, North Atlantic Treaty Organization (NATO), and other international organisations have launched several projects aimed at improving earthquake prediction, raising public awareness, enhancing readiness and sharing information. One UNESCO project involves a massive international collaboration on modelling seismic events in megacities: ICTP Structure and Non-Linear Dynamics of Earth (SAND) Group is a key collaborator in this initiative.

Geological disasters—for instance, earthquakes, volcanic eruptions and landslides—occur in the outer shell of the solid Earth—the lithosphere or rock domain—which consists of blocks that move relative to each other, through fluid interactions, friction, buckling and fracturing. Such mechanisms create strong instabilities, turning the lithosphere into a 'hierarchical' chaotic system. Geological disasters, like earthquakes, are critical phenomena in this system.

Short-term earthquake prediction—the where and when—remains a dream. Yet, with sufficient information about a site's geology, we can compute the local ground motion that would result from sizeable earthquakes. Scientists from countries as far apart as Chile, China and Romania, to name just a few, have adopted a common approach for modelling ground motions caused by destructive earthquakes.

Earthquake research at ICTP is the responsibility of SAND, led by Giuliano Francesco Panza, who is also a professor of seismology at the University of Trieste. Associates and visiting scientists focus on two distinct questions: What happens to the ground during a quake, and where and when will such events take place? The first makes use of knowledge of ground and experimental data collected from actual events to create hazard maps used, for example, in devising building codes.

SAND projects have examined the physical instability of megacities through seismic hazard mapping. Such research parallels the agenda of UNESCO's project "Realistic Modelling of Seismic Input for Megacities and Large Urban Areas."

Begun in 1997, this five-year project focuses on being prepared for seismic events. About 20 cities, including Beijing, Cairo, Delhi, Mexico City, and Rome, are included in the project. These cities face a wide range of seismic risks, which require different strategies for attaining sufficient levels of preparedness. The project, moreover, requires extensive collaboration. Collecting data is a multidisciplinary task, involving on the one hand knowledge of soil engineering,

geophysics and lithology, and on the other, information on tectonics, paleoseismology and seismotectonic models.

Detailed models are used to predict seismic ground motion and prepare hazard maps. These efforts are made possible through data input from a network of global observation points, together with the application of modern theories and powerful computers.

ICTP also has contributed to a European Union (EU)-COPERNICUS-funded project addressing the security of nuclear power reactors in Bulgaria, Hungary, Romania and Slovenia. The goal is to determine how to retrofit existing plants to make them more secure. Centre researchers also participate in a related project, "Impact of Vrancea Earthquakes on the Security of Bucharest and Other Adjacent Urban Areas," involving "ground motion modelling and intermediate-term prediction." The latter has been organised within the framework of the NATO Science for Peace programme.

The other line of research at ICTP, which tackles actual earthquake prediction, combines non-linear dynamics modelling, based on concepts of chaos and self-organisation, with vast databases assembled through observations. The findings of such research are relevant to a wide class of so-called hierarchical chaotic systems, a subject currently generating multi-faceted research at ICTP in areas ranging from condensed matter to statistical physics to the physics of weather and climate.

Applied to earthquake prediction and seismic-risk analyses, the approach focuses on intermediate-term prediction. This effort is spearheaded by a group of Russian researchers who are regular visiting scientists at ICTP. Vladimir Isaakovich Keilis-Borok is the group leader.

The team's two main projects are non-linear dynamics of lithosphere blocks and the testing of algorithms for earthquake prediction. Their efforts are conducted within the framework of several international initiatives funded by the European Union, U.S. National Science Foundation, NATO, INTAS (an association promoting co-operation among the republics of the former Soviet Union), and bilateral initiatives involving France, Italy, South America, Sweden, and the United States.

The ultimate goal of intermediate-term prediction is to narrow the forecast and area in which an event will likely occur and to develop predictive measures of its magnitude. ICTP collaborators have developed a model that predicts strong quakes based on empirical studies of anomalies in everyday weak seismic activities. Significant variations—warning signs that something serious may happen—are fed into a system of empirical formulas that use pattern recognition techniques to signal the time of increased probability for the occurrence of an earthquake with a magnitude above a given threshold.

The global predictive capability of this approach has exceeded 80 percent. The technique predicted the 1994 quake in Northridge, California, which caused at least US$20 billion in economic damage. The prediction, made well in advance, covered an area of 400 square kilometres and time span of 18 months. On the other hand, the technique failed to predict the recent earthquake in Turkey.

As Keilis-Borok notes, "four unstable systems—earth, life, engineering and society—are tied together in megacities." As a result, a powerful quake could claim tens of thousands lives, cause billions of dollars in damage, and lead to long-term social disruptions and even economic depression.

Basic research exploring chaotic systems could help improve our efforts to curb the impact of earthquakes and other types of disasters. Events like the recent tragedies in Turkey, Taiwan and Mexico remind us that such mitigation efforts are well worth pursuing. □

Devastation left by the recent earthquake in Turkey

Maria Fasanella
Head of the ICTP Library

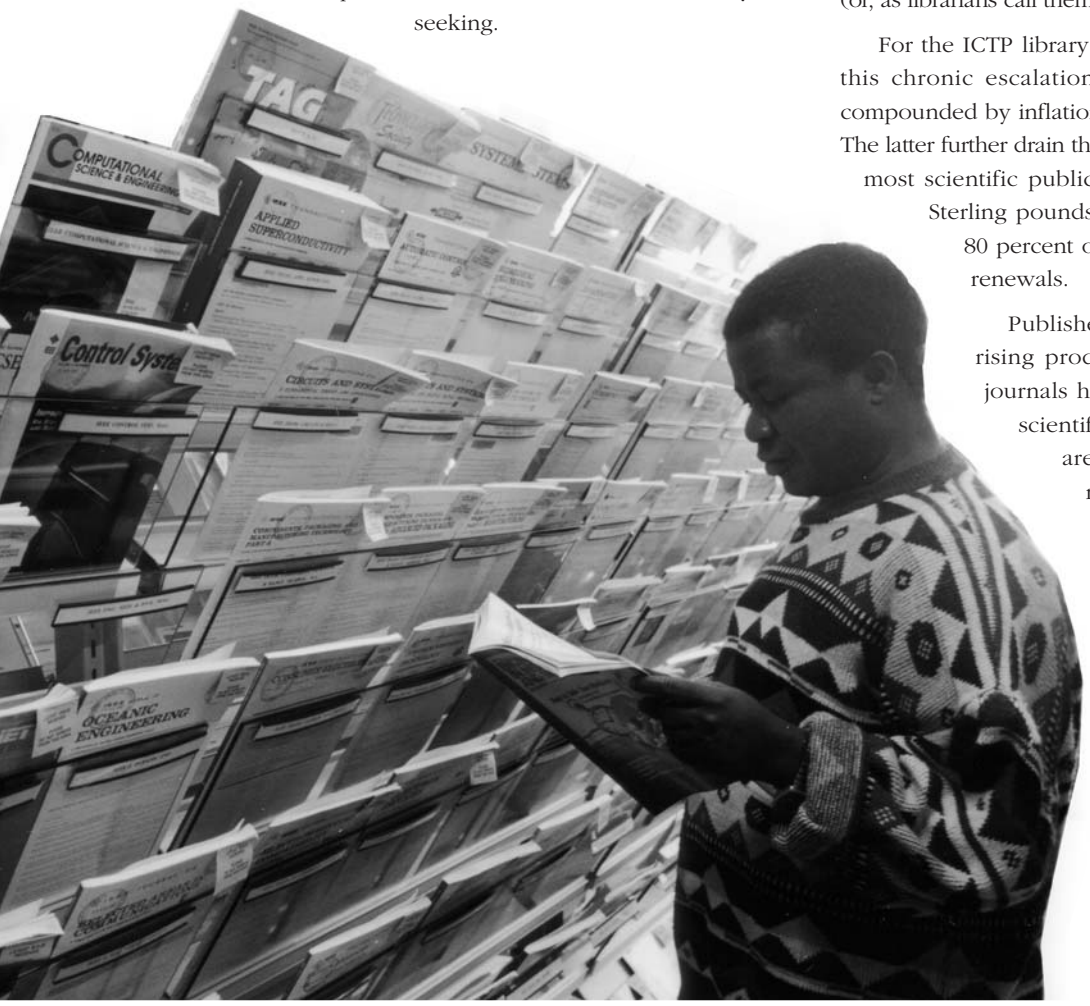
FEATURES

Rising prices of periodicals have placed increasing pressures on library budgets worldwide. Will electronic publishing and the creation of consortia ease these pressures, helping libraries maintain—and expand—their traditional levels of service?

Serial Crisis

With more than 53,000 monographs and 900 journal subscriptions, the Abdus Salam International Centre for Theoretical Physics (ICTP) library is one of the finest scientific libraries in Europe. The collection is particularly strong in the fields of high energy physics, condensed matter physics and mathematics. Our monographs and journals also cover other fields that are integral parts of ICTP's research and training activities.

To ensure that scientists have access to the most current material in the easiest and fastest possible way, in 1994 the library launched a wide-ranging initiative to automate its services. The most important result of this effort has been our expanding access to electronic journals and databases. Centre researchers can now stroll through ICTP's open-shelf library at their leisure or browse through the web at warp speed in search of the information they are seeking.



Journal display in the ICTP library

Moreover, readily available printers and copiers enable visitors to make and then take home 'hard copies' of the materials they need, which helps them continue their work far beyond the walls of the ICTP Main Building in Trieste.

Little wonder that our visitors constantly praise the library as one of the Centre's most valuable resources. Some course directors, in fact, include 'library time' in their activity schedules so that participants don't feel they have to steal time from their day-to-day commitments to take advantage of the Centre's wealth of monographs, journals and electronic information.

Like other scientific libraries throughout the world, however, the ICTP library currently faces financial pressures marked by steep annual increases in the price of journal subscriptions. These price increases have averaged between 10 and 13 percent a year for science, technology and medicine (or, as librarians call them, STM) journals over the past decade.

For the ICTP library, the financial pressures created by this chronic escalation in subscription fees have been compounded by inflation and unfavourable exchange rates. The latter further drain the library's purchasing power because most scientific publications are priced in US dollars or Sterling pounds. In total, the library spends about 80 percent of its annual budget on subscription renewals.

Publishers justify their increases by citing rising production costs. They point out that journals have increased their page counts as scientific output grows and new features are introduced. At the same time, the number of subscribers to scientific journals is declining, partially in response to rising prices. As a result, increases in production costs must be spread over a smaller subscriber base.

Price increases imposed by non-profit publishers have not been as steep as those imposed by commercial publishers. But that provides little comfort to libraries. A majority of the world's most prestigious scientific journals are owned by commercial publishers—for example, Elsevier,

Kluwer and Wiley—which have become bigger and more powerful with each new take-over of smaller publishing houses. The monopoly effect created by this trend has pushed prices even higher. Meanwhile, scientists, who may be increasingly reluctant to personally subscribe to prestigious but expensive journals in their fields, are more determined than ever to publish their papers in them. As long as a journal remains prestigious, libraries will be pressured to subscribe regardless of the price.

The ICTP library has pursued several different strategies to address the 'serial crisis.' In 1993, the Centre cancelled 35 titles, carefully determining that 27 of these titles could be found nearby at the International School for Advanced Studies (SISSA) library and that the other eight titles were duplicate copies available through the University of Trieste's Department of Theoretical Physics. Nevertheless, for the first time in the Centre's history, the library had cut back its journal subscription list. We all knew once the first retrenchment decision was made, it would be much easier to do it again.

In fact, the following year, another 64 titles were cancelled. This time additional criteria were adopted. Not only did we investigate whether the journal was located at SISSA and other scientific institutions in Trieste, but we discontinued titles that were not strictly related to ICTP's current or future programmes.

In 1996, on-going financial pressures spurred the creation of the ICTP/SISSA Library Co-ordination Committee, which was established to 'co-ordinate' acquisitions and cancellations of periodicals in the two institutions. The goal was to maximise the availability of journal titles on the Miramare campus and, at the same time, prevent unnecessary and costly duplications. Both institutions agreed not to cancel a journal subscription before discussing their decision with the other. They also agreed to inform each other of new acquisitions.

For the thousands of scientists who have participated in ICTP's research and training activities during the past 35 years, the Centre's periodical collection has been a constant source of intellectual nourishment. The library has been able to extend its reach by tapping into inter-library-loan and document-delivery services. As a result, the impact of rising cost of periodicals—and the cutbacks in our serial collection—have been blunted by our ability to turn to other avenues to meet our researchers' needs.

And our efforts have not stopped there. For example, we have explored the possibility of joining a consortium of libraries that are willing to share costly electronic licensing fees.

Whether such arrangements are financially and logistically feasible remains to be seen. However, if this strategy proves viable, it should help us maintain our high level of service while freeing space for other essential services. To advance this promising alternative, we join other libraries around the world in urging publishers to re-examine their subscription fees to electronic journals, which in principle can be distributed more cheaply than paper editions. □

SEARCH AND DISCOVER

How many of you have visited the ICTP Library, sat before a PC, called up one of our databases and discovered that your article has been cited by a colleague on the other side of the world?

This is just one small, yet highly personal, example of what modern technology can do for you. No more cramped spaces in the back of the library; no more sitting on the floor in a dark corner of the room; no more flipping through hundreds of pages with tiny characters; no more wondering if your hard work and talent goes unnoticed.

Today, with a simple click of your mouse, you can save precious time examining reference and bibliographical material from the comfort of our library.

CD-Roms databases available at the ICTP library include:

- ***Science Citation Index***

Provides access to current bibliographic information and cited references.

- ***INSPEC - Physics Abstracts***

Contains citations, with abstracts, to physics literature worldwide.

- ***MathSci*** and ***Zentralblatt-MATH***

Present citations of the world's current mathematical literature.

- ***INIS***

Produces bibliographic references and lists availability of scientific literature published world-wide on peaceful uses of nuclear energy.

- ***Journal Citation Reports - Science Edition***

Offers a means of determining the relative importance of science journals within subject categories.

For additional information, visit the ICTP library homepage at http://library.ictp.trieste.it.

DATELINE

Pakistan Physics Centre

Riazuddin, a distinguished theoretical physicist whose affiliation with ICTP dates back to the Centre's earliest days, has been named Director of the newly created National Centre for Physics (NCP) in Pakistan. The Centre, which is part of Quaid-i-Azam University in Islamabad, held its first research activity earlier this year.

"NCP represents the fulfilment of a dream of Abdus Salam's," Riazuddin noted during a recent visit to the ICTP. "When Salam helped launch the International Nathiagali Summer College on Physics and Contemporary Needs in Pakistan in 1976, he hoped that it would eventually evolve into an international physics centre. If he were alive today, I am sure he would be delighted to see that his vision has been transformed into reality."

Like ICTP, NCP will host workshops, colleges, schools, conferences and symposia on subjects related to physics and mathematics. In addition, the Centre will pursue a small number of activities in experimental physics through a co-operative agreement with CERN in Geneva, Switzerland. CERN's Large Hadron Collider (LHC) will serve as the focal point of NCP's experimental work.

"Thanks largely to Salam's efforts, Pakistan enjoys a strong tradition in physics. In fact, there are about 20 university physics departments located throughout the country," explains Riazuddin. "But researchers in these departments often find themselves isolated both from their colleagues and major developments in their fields."

NCP hopes to break this isolation by offering Pakistani physicists the opportunity to work with the world-class scientists who will be invited to lecture and participate in the Centre's research activities. Riazuddin is also convinced that the face-to-face interaction taking place among Pakistani researchers at NCP will help energise the physics community in his home country.

"Each year," he notes, "NCP will focus on three of its six major areas of interest, which include condensed matter physics, particle physics and cosmology, laser physics, plasma physics, mathematical modelling and computational physics."

Riazuddin (right)

NCP's first activity, "Frontiers of Physics," which took place in January, was a one-day symposium that attracted more than 30 Pakistani high-energy physicists who were joined by several colleagues from CERN, the DESY synchrotron laboratory in Hamburg, Germany, and the University of Moscow, Russia. This fall, the Centre held a workshop on computational physics, a symposium on relativity and astrophysics, and a workshop on particle physics. Researchers from CERN, DESY and nuclear research facilities in Italy agreed to participate in the latter activity.

"With financial support from the Pakistani government and co-operative agreements with physics research centres and universities across the globe," Riazuddin adds, "I am hopeful that NCP will quickly become a thriving research centre. The success of our efforts would provide another fitting tribute to the legacy of Abdus Salam."

Physics and Technology

Klaus Von Klitzing

The work of two Nobel Laureates, who participated in ICTP's First Stig Lundqvist Research Conference on the Advancing Frontiers in Condensed Matter Physics, held at ICTP on 26-29 July, represent some of the best examples of physics' ability to reshape today's technology. **Klaus von Klitzing**, acting director at the Max Planck Institute for Solid State Research in Stuttgart, Germany, received the Nobel Prize in 1985 for his discovery of the behaviour of electrons under strong magnetic fields. His finding, which solved the quantised Hall effect, allows more precise measurement of electrical resistance and more accurate testing of theories about electronic movements in solids. **Horst L. Störmer**, who holds a joint appointment with Columbia University in New York City and Lucent Technologies in New Jersey (USA), won the Nobel Prize in 1998 for his discovery of the so-called fractional quantum Hall effect—a phenomenon in which electrons subject to extremely powerful magnetic fields and low temperatures form new particles carrying charges that are fractions of electron charges. These particles, which condense into a kind of quantum fluid, have provided profound insights into the inner structure of matter. That knowledge, in turn, has proven instrumental in increasing our understanding of the behaviour of superconducting materials. The conference was named in honour of Stig Lundqvist, the noted Swedish physicist who headed the Centre's Scientific Council from 1983 to 1992 (see p. 10).

Horst L. Störmer

A Hoax in Search of Truth

Alan D. Sokal

In 1996, **Alan D. Sokal**, professor of physics at New York University (USA), published an essay in *Social Text*, a cultural studies journal, suggesting a link between quantum mechanics and postmodernism. The same day, Sokal published an article in *Lingua Franca*, a literary journal, proclaiming that his 'learned' article in *Social Text* was a hoax designed to expose, among other things, the flimsy thinking and unscientific use of scientific language practised by some renowned postmodernist scholars of literature, psychology and sociology—among them, Jacques Derrida, Julia Kristeva and Jacques Lacan.

Sokal's 'hoax' sparked a firestorm of debate among intellectuals in both the United States and Europe. That debate, in fact, spread from academic circles to the popular press, earning Sokal coverage in *The New York Times*, *Le Monde* and *The Times*.

Today, Sokal leads two lives—one as a theoretical physicist, the other as a cultural critic. Both were recently on display when he came to Trieste to lecture at ICTP and SISSA (International School for Advanced Studies).

At the Centre, Sokal lectured on statistical mechanics; at SISSA, he debated the meaning of his 'hoax' with a number of scientists, philosophers and science journalists from Trieste and the surrounding area. The latter event, which touched on a wide range of issues, including the role of the sciences and humanities in modern culture, drew more than 150 people.

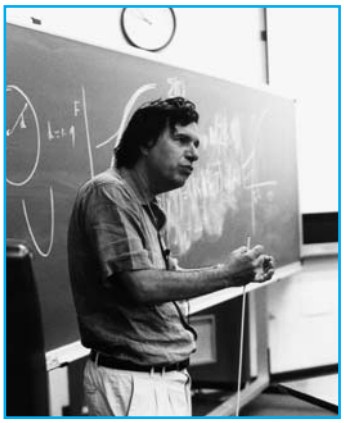
NEWS FROM ASSOCIATES

Abderrahmane Kadri, an ICTP Regular Associate from 1989 to 1996 and professor at the Physics Institute of the University of Oran, Algeria, has been appointed Chairman of the Atomic Energy Commission of Algeria. In a recent letter to the ICTP Director, Kadri expressed "heartfelt gratitude for the wonderful mission that ICTP has been accomplishing for many years, by providing continuous and invaluable support to many generations of scientists from throughout the world."

Diplomas Coming and Going

This September, ICTP awarded graduate certificates to 25 students who successfully completed the Centre's 1998-1999 Diploma Course. The certificates, granted in the fields of high energy physics, condensed matter physics and mathematics, were given to students from 19 developing countries. Twelve of ICTP's 1998-1999 Diploma Course graduates will be moving on to doctorate programmes at institutes in North America and Europe, including Cornell University, Auburn University, and the University of California at Davis in the United States; the University of Toronto and the University of Western Ontario in Canada; the University of Berlin in Germany; and Paul Scherrer Institute in Switzerland. At the same time, ICTP welcomed 27 students from 19 developing countries, including Cuba, Iran, Liberia and Senegal, to its 1999-2000 Diploma Course. The programme, launched in 1991, provides students who have earned master's degrees in physics or mathematics in their home countries with a one-year post-graduate training course.

ICTP's 1999-2000 Diploma students



Giorgio Parisi

1999 Dirac Medal

Giorgio Parisi, professor of physics at the University of Rome *La Sapienza,* is the recipient of the ICTP 1999 Dirac Medal. He will receive the award at a ceremony to be held at the Centre early next year. Parisi's outstanding contributions to physics have spanned a broad range of topics, including elementary particle physics, phase transitions, mathematical physics, string theory, theoretical immunology, neural networks, disordered systems, and non-equilibrium statistical physics. He has worked at Columbia University, New York, USA, and the *Institute des Hautes Etudes Scientifiques* and *Ecole Normale Supérieure,* in Paris, France. He has also led the APE (Array Processor Experiment) project for the construction of an advanced fast computer under the sponsorship of the Italian National Institute of Nuclear Physics (INFN). Parisi has written two books: *Statistical Field Theory* and *Spin Glass Theory and Beyond* (with Marc Mezard and Miguel Virasoro).

REPORT ON REPORTS

INTERNATIONAL CONFERENCE ON MACROSCOPIC QUANTUM COHERENCE PHENOMENA

5 - 9 July

Directors: S. Fantoni (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP), A. Leggett (University of Illinois at Urbana-Champaign, USA) and A. Smerzi (SISSA).

The Conference assembled experts on macroscopic quantum coherence to discuss theoretical and experimental issues in the following fields: Bose-Einstein condensates; superfluid helium; superconductors; and quantum optics.

XI WORKSHOP ON STRONGLY CORRELATED ELECTRON SYSTEMS

12 - 23 July

Directors: G. Baskaran (Institute of Mathematical Sciences, Chennai, India), M. Fabrizio (International School for Advanced Studies, SISSA, Trieste, Italy, and ICTP), A. Georges (*Ecole Normale Supérieure*, Paris, France), G. Kotliar (Rutgers State University, Piscataway, USA), E. Tosatti (SISSA and ICTP), A. Tsvelik (University of Oxford, UK) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

Local Organiser: Yu Lu.

The Workshop, the 11th in a series, focused on problems and perspectives in strong correlation physics. Topics included quantum phase transitions; realisation of correlated electron physics in mesoscopic devices; experimentally motivated aspects of cuprate physics; giant magnetoresistance and novel phenomena in transition metal oxides; complex heavy fermions; and quantum glasses.

THE FIRST STIG LUNDQVIST RESEARCH CONFERENCE ON THE ADVANCING FRONTIERS IN CONDENSED MATTER PHYSICS: QUANTUM PHASES IN ELECTRON SYSTEMS OF LOW DIMENSIONS

26 - 29 July

Director: A. Pinczuk (Columbia University, New York, and Bell Laboratories - Lucent Technologies, Murray Hill, USA).

Co-Directors: E. Burstein (University of Pennsylvania, Philadelphia, USA), S.M. Girvin (Indiana University, Bloomington, USA) and C. Tejedor (*Universidad Autónoma de Madrid*, Spain).

Local Organiser: Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

This Conference, named in honour of the noted Swedish physicist and long-time ICTP friend and supporter Stig Lundqvist, created a forum for in-depth discussions of the most recent findings in studies of the behaviour of low-dimensional electron systems in semiconductor quantum structures. Topics included exciton condensation phenomena in 2D and 1D; quantum phase transitions in 2D electron systems; quantum phase transitions in quantum Hall states; composite quasi-particles in quantum Hall states; Luttinger liquids in 2D and 1D; single electron transport

Ganapathy Baskaran and Abdullah Sadiq (third and fourth from left) with Spenta Wadia and Ashoke Sen

in nanostructures; carbon nanotubes; Aharonov-Bohm and interference effects in 2D electron systems; spin and pseudospin texture excitations; localisation in the quantum Hall regimes; Kondo effect in low-dimensional semiconductors; and scanning microscope probes of low-dimensional electron systems.

SCHOOL ON ALGEBRAIC GEOMETRY

26 July - 13 August

Directors: J. Le Potier (*Université de Paris VII*, France), E.J.N. Looijenga (University of Utrecht, the Netherlands) and M.S. Narasimhan (ICTP).

Local Organiser: L. Göttsche (ICTP).

The School focused on one of the two major themes chosen by the ICTP Math Group in 1999. The first two weeks were devoted to instructional lectures. Topics included geometric Langlands programme; moduli spaces of sheaves; moduli spaces of curves; and quantum cohomology. The third week consisted of lectures by experts on the most recent developments in the fields.

WORKSHOP ON CALCULATION OF MATERIAL PROPERTIES USING TOTAL ENERGY AND FORCE METHODS AND AB-INITIO MOLECULAR DYNAMICS

9 - 18 August

Co-sponsors: Psi-k Network.

Directors: P. Kratzer, J. Neugebauer and M. Scheffler (all from Theory Department, *Fritz-Haber-Institut*, Berlin, Germany).

Local Organiser: J. Kohanoff (ICTP).

The Workshop focused on density-functional electronic structure calculations and introduced participants to the computer programme FHI99MD. Lecture topics included density functional theory as a tool in computational solid state physics and

chemistry; numerical methods to solve the Köhn-Sham equation; pseudopotential generation/transition metals; FHI99MD programme development; nonlocal exchange-correlation functionals; self-interaction corrected functionals; GW calculations; magnetic materials; and ab-initio molecular dynamics. Afternoons were devoted to hands-on training with computations of simple physical properties using the computer code FHI99MD.

ADRIATICO RESEARCH CONFERENCE ON HIGH FIELD TRANSPORT IN SUPERLATTICES

10 - 13 August

Directors: S.J. Allen (University of California at Santa Barbara, USA), P.N. Butcher (University of Warwick, UK) and G.H. Döhler (University of Erlangen, Germany).

The Conference brought together experimentalists and theoreticians working in the field of superlattice transport for in-depth discussions of the following topics: unified description of DC transport combining the semiclassical (momentum space) 'Boltzmann picture' with the quantum mechanical (real space) 'Wannier-Stark picture'; current self-oscillations, stationary and propagating low/high field domains; and FIR-photon assisted tunnelling and negative absolute conductivity under combined application of DC and high-frequency AC fields.

1999 NORDIC-TRIESTE WORKSHOP: ASTRONOMICAL SOURCES FOR GRAVITATIONAL RADIATION

15 August - 15 September

Directors: M. Abramowicz (Chalmers University of Technology, Gothenburg, Sweden) and A. Lanza (International School for Advanced Studies, SISSA, Trieste, Italy).

The Workshop—the third in a series—concentrated on discussions of astrophysical sources of gravitational radiation. Emphasis was placed on radiation generated by pulsation of massive neutron matter tori around black holes or neutron stars. Experts from Cambridge (UK), Moscow, Oxford, Rome and Stanford were invited to attend.

WORKSHOP ON DYNAMICS OF NONEQUILIBRIUM SYSTEMS

16 - 27 August

Angelo Vulpiani

Directors: M. Barma (Tata Institute of Fundamental Research, Mumbai, India), A. Maritan (International School for Advanced Studies, SISSA, Trieste, Italy) and R. Stinchcombe (University of Oxford, UK).

Hideki Takayasu

Local Organiser: A. Maritan.

The Workshop focused on a related set of topics, including collective behaviour in diffusive systems; disordered driven systems; jamming, slow dynamics and granular flow; and aggregation and fragmentation. Participants ranged from senior researchers to students with advanced degrees. A small number of lectures each day allowed ample time for brief, informal discussions and presentations.

Tang Leihan

ADRIATICO RESEARCH CONFERENCE ON NON-HERMITICITY AND DISORDER

23 - 26 August

Directors: Y.V. Fyodorov (*Universität Gesamthochschule*, Essen, Germany), F. Haake (*Universität Gesamthochschule*, Essen, Germany) and J.J.M. Verbaarschot (State University of New York, SUNY, Stony Brook, USA).

Local Organiser: V. Kravtsov (ICTP).

The Conference brought together physicists and mathematicians for broad discussions of applications of non-Hermitean random matrices and non-selfadjoint random operators in theoretical physics and reviewed recent progress in the field. Topics included general theory of non-Hermitean random matrices; resonances and time delays in quantum chaotic scattering; localisation transition in non-Hermitean quantum mechanics; QCD at finite chemical potential; hydrodynamic stability and pseudospectra; diffusion in a random velocity field; and non-Hermiticity and integrable models.

INTERNATIONAL SUMMER SCHOOL ON STATISTICAL PHYSICS AND PROBABILISTIC METHODS IN COMPUTER SCIENCE: A PRIMER FOR PHYSICISTS, MATHEMATICIANS AND COMPUTER SCIENTISTS

23 August - 3 September

followed by

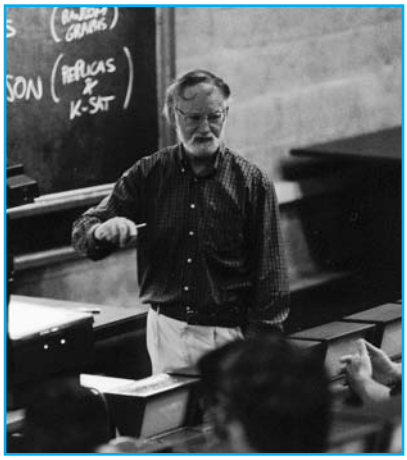
TOPICAL CONFERENCE ON NP-HARDNESS AND PHASE TRANSITIONS

6 - 10 September

Steering Committee Board: B. Bollobás (University of Memphis, USA, and University of Cambridge, UK), C. Borgs (Microsoft, Seattle, USA), J. Chayes (Microsoft, Seattle, USA), S. Kirkpatrick (IBM Thomas J. Watson Research Center, Yorktown Heights, USA), R. Monasson (*Ecole Normale Supérieure*, Paris, France), B. Selman (Cornell University,

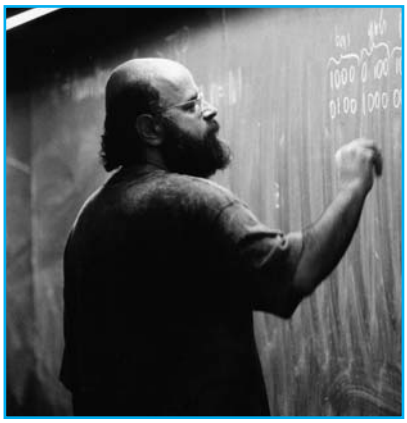
Ithaca, USA), J. Spencer (New York University, New York, USA) and R. Zecchina (ICTP).

Local Organisers: S. Franz (ICTP) and R. Zecchina.



David Sherrington

The School encouraged young mathematicians, computer scientists and theoretical physicists to broaden their horizons, learn new subjects and apply sophisticated tools in mathematics and theoretical physics to the field of computer science. The School included lectures emphasising multidisciplinary subjects. Topics included complexity theory; analysis of algorithms; statistical mechanics approach to phase transitions in random combinatorics; heuristics optimisation and simulation of hard physical/combinatorial models; random graphs and hypergraphs; disordered physical systems; and combinatorics. The Conference explored phase transitions and critical phenomena in random combinatorial structures and problems.



Christos Papadimitriou

SECOND AFRICAN REGIONAL COLLEGE ON MICROPROCESSOR-BASED REAL-TIME SYSTEMS IN PHYSICS—THEORY AND APPLICATIONS, held in Dakar, Senegal

23 August - 11 September

Co-sponsor: United Nations University (UNU, Tokyo, Japan).

Directors: C. Lishou (*Ecole Supérieure Polytechnique*, Dakar-Fann), A.S. Induruwa (presently University of Kent, Canterbury, UK) and C. Verkerk (ICTP).

Local Organisers: A. Corenthin (*Ecole Supérieure Polytechnique*, Dakar-Fann), C. Lishou and A. Wagué (*Université Cheikh Anta Diop*, Dakar-Fann), in co-operation with *Ecole Supérieure Polytechnique* and *Département de Physique* of *Université Cheikh Anta Diop*.

The Second African Regional College, held in Dakar, Senegal, was open only to scientists from African countries. The goal was to teach participants—mostly physicists—how to use real-time operating computer systems in the design and implementation of experiments. Participants put the concepts presented in lectures into practice during laboratory sessions.

Second African Regional College on Microprocessor-Based Real-Time Systems in Physics

EU ADVANCED COURSE IN COMPUTATIONAL NEUROSCIENCE

23 August - 17 September

Co-sponsors: European Commission (Brussels, Belgium), Boehringer Ingelheim Fonds (Stuttgart, Germany), and Brain Science Foundation (Tokyo, Japan).

Directors: E. De Schutter (University of Antwerp, Belgium), K. Obermayer (Technical University Berlin, Germany), I. Segev (Hebrew University, Jerusalem, Israel) and A. Treves (International School for Advanced Studies, SISSA, Trieste, Italy).

The Course, which introduced students to the problems and methodology of computational neuroscience, addressed neural organisation from subcellular processes to operations of the entire brain. It was designed for advanced graduate students and postdoctoral fellows in diverse disciplines, including neuroscience, physics, electrical engineering, computer science and psychology.

Jacques Mehler

Evening lecture by Jack Cowan

Correction: In Issue #89, page 10, the picture of Anders Nilsson was mistakenly identified as Chuck Fadley. We apologise for the error.

PROFILE

Seifallah Randjbar-Daemi, who has been associated with the Centre for some 20 years, is currently head of the ICTP High Energy Physics Group.

Seif on Science

"I first met Abdus Salam at Imperial College in London in 1976, when I was looking for a supervisor for my thesis," recalls Iranian-born Seifallah Randjbar-Daemi, head of the ICTP High Energy Physics Group. "Salam was spending most of his time in Trieste or travelling; so, I eventually ended up working with Thomas Kibble."

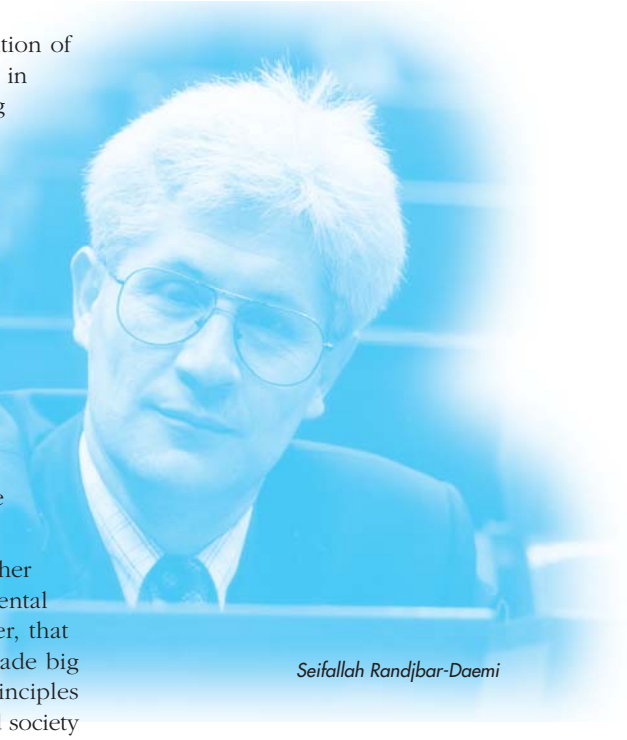
Randjbar-Daemi's thesis focused on quantum gravity, and after completing it in 1980, he arrived at ICTP in the fall as a postdoc. "That's when my collaboration with Salam truly began. I would continue to work closely with him until 1993, when Salam's illness made it impossible for him to continue."

In characteristic fashion, Salam pushed Randjbar-Daemi in several different directions at one time. "In addition to our joint research projects," he notes, "Salam asked me to lecture at the Centre's schools and workshops and to consult with him on a wide range of issues."

Then, in 1988, Salam asked Randjbar-Daemi to join the Centre as a staff member. Within two years, he was placed in charge of the High Energy Group, a position he has held ever since.

With five staff members and 10 post-docs, Randjbar-Daemi's group is the largest research group at the Centre. In addition to its training activities, the group has built a solid reputation for research, especially in the fields of particle physics, string theory and cosmology.

"Most Islamic countries," Randjbar-Daemi observes, "have a good tradition of learning. But," he adds, "this tradition by itself is not sufficient. Progress in modern science requires the encouragement of innovation and strengthening of mechanisms that foster creativity. These elements are missing in most developing countries and Islamic countries are no exception."



Seifallah Randjbar-Daemi

"Because not a single Islamic country's scientific output is comparable to the scientific output in advanced countries, some observers conclude that science and Islam are mutually incompatible. I do not believe this is correct," he says. "Over the past centuries, scientists from Islamic culture have made significant original contributions to the development of the natural sciences and mathematics."

"In our times," Randjbar-Daemi adds, "many scientists from Islamic countries have built successful careers in scientifically advanced nations. Some, in fact, have reached the pinnacle of their professions. The best known example is Abdus Salam who was both a devout Moslem and one of the outstanding scientists of our time."

Randjbar-Daemi also acknowledges that the public may currently find other branches of science—for example, genetic engineering and the environmental sciences—more engaging than theoretical physics. He maintains, however, that this is not a new phenomenon. "Quantum mechanics apparently never made big headlines during the first three decades of this century when its basic principles were being discovered. Yet, hardly any aspect of modern life in industrialised society fails to make use of the principles of quantum theory."

Moreover, Randjbar-Daemi does "not fully agree that theoretical physics no longer excites the public imagination." The public, he notes, finds astrophysics and cosmology, which have important theoretical aspects, quite interesting. "Dark matter and to a lesser extent black holes are purely theoretical concepts for now; yet, that's not prevented them from becoming among the hottest topics of discussion in popular scientific magazines. And just last year, physicist Brian Greene's *Elegant Universe*, a non-technical account of string theory, became a best-seller on both sides of the Atlantic."

Randjbar-Daemi also finds the increasing use of physics and mathematics in other fields promising. "Throughout history," he observes, "the cross-fertilisation of concepts and ideas has nurtured progress in all fields, and science is no exception. The soft boundaries between mathematics, physics and engineering helped clear a path for the technical progress that has been the hallmark of modern society. Now the same dynamic may be taking hold between mathematics, physics and other sciences like economics." □

MONITOR

IAEA Director General Visits ICTP

The Director General of the International Atomic Energy Agency (IAEA), Mohamed ElBaradei, visited ICTP on 3 September. He was accompanied by Sueo Machi, IAEA's Deputy Director General, Department of Nuclear Sciences and Applications, and H.S. Cherif, IAEA's Head of the Office of Programme Support and Evaluation. The Director General met with ICTP Director Miguel Virasoro; heads of ICTP's scientific research groups, external support services and administration; and Centre associates and diploma students. He also toured the Centre's facilities, including its lecture halls, library and computer facilities. In addition, the Director General addressed ICTP staff and scientists in the Main Lecture Hall, where he expressed his support for strengthening the Agency's relationship with ICTP—a relationship dating back to the Centre's earliest days. Abdus Salam officially launched his campaign to create the Centre in 1960 at the IAEA's Fourth General Conference. The Centre became a reality four years later under the auspices of the IAEA.

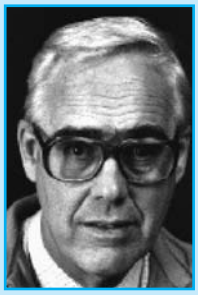
UNESCO Evaluation

The UNESCO External Evaluation Team toured the Centre on 9-10 July. The team, which consists of eight members, was headed by M.A.J. Mariscotti, President of the Directorate of the National Agency for the Promotion of Science and Technology in Argentina. Members of the team met with the ICTP director and the heads of the Centre's research groups. In addition, they talked with ICTP associates, postdocs and diploma students, and received a brief tour of the Centre's library and computer facilities. The evaluation is part of UNESCO's biennial evaluation plan.

Visitors East and West

Xu Hai, Scientific Counsellor at the Embassy of the People's Republic of China in Rome, Italy, visited ICTP on 12 July. He was accompanied by Sun Chengyong, the Counsellor's First Secretary in Science, who received his Ph.D. in ecology from the University of Parma with help from ICTP and the International Centre for Science and High Technology (ICS). On 27 July, Andrew W. Reynolds, Counsellor for Environment, Science and Technology at the U.S. Embassy in Rome, Italy, visited the ICTP.

TRIBUTE



Paul N. Butcher, 70, Professor Emeritus at the University of Warwick, UK, and a founding father of the ICTP condensed matter theory group, died on 6 August 1999. Paul earned degrees in mathematics and solid state physics from Imperial College, London, and worked 16 years for the Royal Radar Establishment in Malvern, UK, before joining the department of physics at the University of Warwick in 1967 as the university's first professor of theoretical physics. He held that position until his recent retirement. Paul's research spanned many areas, including semiconductors, amorphous systems, non-linear optics and transport theory. His involvement with ICTP began in the 1970s, when he joined Trieste's emerging cadre of condensed matter people—including John Ziman, Stig Lundqvist, Norman March, and later Mario Tosi, Yu Lu and myself. Our goals were to nurture good research and good contacts among Northern and Southern scientists.

Paul is remembered fondly as one of the most active directors of ICTP workshops, sitting unselfishly through every lecture and finding time for everyone. His presence at ICTP and the larger world of science will be remembered by many for many years to come. And so will the many cheerful moments—a good laugh, a quiet discussion over coffee, a dinner on the *Carso*. Paul was an extraordinarily nice human being. We were not at all prepared to lose him and he was not prepared to lose us either. When asked what his retirement plans were, he said he really had no other interests than physics. We rejoiced, for it meant that we would see him at ICTP and benefit from his presence and wisdom long into the future. It was not to be. Nonetheless, the contributions Paul made to science and the help he gave to less fortunate colleagues will remain with us forever.

Erio Tosatti
International School for Advanced Studies
ICTP Condensed Matter Group

4 - 22 October
Fifth Workshop on Non-Linear Dynamics and Earthquake Predictions

18 - 29 October
School on Exploring the Atmosphere by Remote Sensing Techniques

20 - 22 October
Second Workshop on Fusion Related Physics and Engineering in Small Devices

25 - 26 October
Workshop on Broad-Band Seismic Observations and the Geodynamics of the Scotia Sea Region, Antarctica

25 October - 19 November
Autumn College on Plasma Physics

8 - 19 November
Workshop on Web Enabling: Technologies and Authoring Tools

8 November - 3 December
Microprocessor Laboratory Sixth Course on Basic VLSI Design Techniques

29 November - 8 December
ICTP/ICGEB Ibero-American School of Astrobiology: Origins from the Big-Bang to Civilization (Caracas, Venezuela)

ICTP ON THE WEB

Throughout the year, the most up-to-date information on ICTP activities may be found on the World Wide Web and via e-mail. Here's how to find out what's going on.

ON THE WORLD WIDE WEB (WWW)
Our address is `http://www.ictp.trieste.it/`
The site includes detailed information on our research groups and activities, and a listing of our preprints, awards and job opportunities.

ON E-MAIL
(1) For Yearly Calendar of Scientific Activities
Create a new e-mail message and type
To: `smr@ictp.trieste.it`
Subject: `get calendar 2000`
Leave the body of the message blank. Send it.
Your e-mail will generate an automatic reply from the ICTP server containing the most updated version of the yearly Calendar.

(2) For Information on a Specific ICTP Activity
Each activity in the Calendar has its own 'smr' code number, which is located on the last line of each activity description. The 'smr' number will enable you to obtain more information—if available—on those activities you are interested in. To receive this more detailed information, create a new e-mail message and type the smr code number that you found on the calendar:
To: `smr####@ictp.trieste.it`
Under the e-mail's subject, type
Subject: `get index`
Leave the body of the message blank and send it.
You will receive an automatic reply listing all documentation available on that particular activity—the `announcement` or `bulletin` and, in most cases, a separate `application_form`.
To receive the full text of the announcement and/or application form, you will need to send another e-mail message to the same smr code
To: `smr####@ictp.trieste.it`
Subject: `get announcement application_form`
Again, leave the body of the message blank, and send it.

(3) For Information on All ICTP Activities
A free online service for the dissemination of information on all ICTP activities, programmes and related announcements is available via e-mail. To subscribe, create a new e-mail message and type:
To: `courier-request@ictp.trieste.it`
Leave the subject line empty.
In the body of the message type
`subscribe`
and your e-mail address.
Send the message.
Any comments or suggestions on this service are most welcome. Please address them to `pub_off@ictp.trieste.it`.

NEWS from ICTP

The Abdus Salam International Centre for Theoretical Physics (ICTP) is administered by two United Nations Agencies—the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Atomic Energy Agency (IAEA)—under an agreement with the Government of Italy. Miguel Virasoro serves as the Centre's director.

News from ICTP is a quarterly publication designed to keep scientists and staff informed on past and future activities at the ICTP and initiatives in their home countries. The text may be reproduced freely with due credit to the source.

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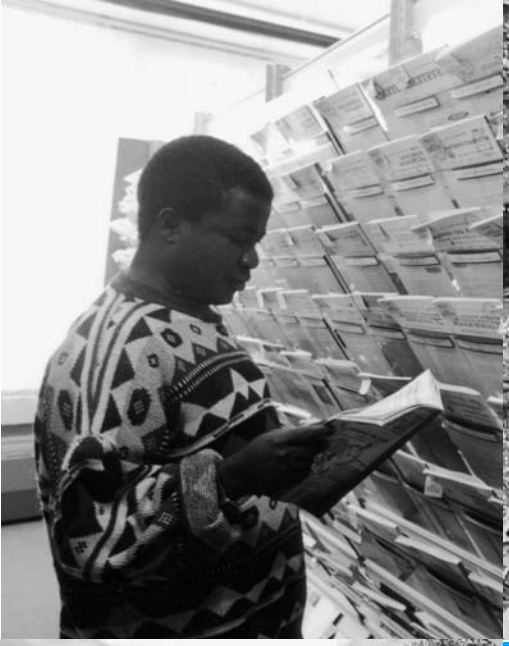



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