



# NEWS *from* ICTP

the  
**abdus salam**  
international centre for theoretical physics



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## Erio Tosatti

Erio Tosatti is a professor of physics at the International School for Advanced Studies (SISSA) and a long-time consultant with ICTP's Condensed Matter Group.

## WHAT'S NEW

Italian researchers have determined that the Earth's core may be much cooler than previous estimates suggested, possibly confirming what Jules Verne anticipated nearly 150 years ago in his *Journey to the Centre of the Earth*.

# Core Values

**W**hile we know with great accuracy the temperature of the Sun and, in fact, of many celestial bodies several light years away, we have yet to accurately determine the temperature of the Earth's core, a 'bare' 3,000 kilometres (km) beneath our feet.

With remarkable foresight, Jules Verne, in *Journey to the Centre of the Earth* (1864), maintained that the Earth's core is solid—an opinion that contrasted sharply with those of most scientists in his day. The latter contended that the Earth's core is comprised of hot volcanic liquid.

In the early twentieth century, more than 50 years after Verne published his classic science fiction travel story, seismic data gathered by scientists indicated that the Earth's nucleus consists mainly of iron in two states—a liquid layer about 2,200 km thick, surrounded by a solid core of about 1,200 km in radius. This solid core, foreshadowed by Verne, guarantees that the core's inner temperature cannot exceed iron's melting temperature.

The melting temperature of iron under ordinary conditions is well known—about 1,500°C. But the temperature at pressures found in the Earth's core, of the order of 3 million atmospheres, is much more open to question.

To reproduce in the laboratory such extreme pressure and temperature, researchers at Lawrence Livermore National Laboratory, in California, created impacts with special ultra-high-speed 'gunshots' containing bullets travelling at 10 km per second. Others, including Soviet scientists in the 1960s, conducted experiments in the immediate vicinity of nuclear explosions. These violent methods led to estimates that the core's melting

temperature was most likely below 7,000°C. But the results were never free of uncertainties.

In an effort to remove these uncertainties, Alessandro Laio, Guido L. Chiarotti, Sandro Scandolo and Erio Tosatti, of the International School for Advanced Studies (SISSA), Italian National Institute for the Physics of Matter (INFN), and Abdus Salam International Centre for Theoretical Physics (ICTP), and Stéphane Bernard of the French *Commissariat à l'Énergie Atomique*, chose an alternative approach that is perhaps more elegant and surely less dangerous.

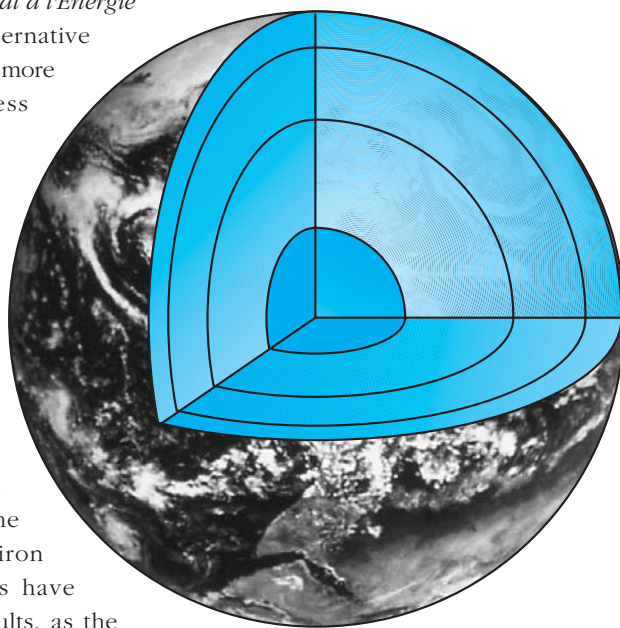
Instead of trying to reproduce for real the Earth's core conditions in the laboratory, they sought to reproduce the conditions—or, more precisely, simulate them—in the computer by solving in real time the fundamental equations governing the motion of individual iron atoms. The simulations have provided surprising results, as the authors of the research revealed in the 11 February edition of *Science*.

The conclusions suggest that the Earth's core is somewhat cooler than previous estimates—a 'mere' 4500-5000°C or 2000°C cooler than prevailing projections. The heat liberated during crystallisation is also more modest, about one-half the previously accepted value.

This conclusion implies, among other things, an increase in the speed at which the Earth's solid core grows at the expense of the liquid layer above it. That, in turn, may reduce the time

expected for the entire core to solidify and begin to cool down. Moreover, the simulations reveal that the theoretical speed of transverse sound in solid iron at Earth's core is anomalously low, and essentially identical to that accurately measured for real seismic waves.

As a result, we could hypothesise, as Ronald Cohen of the Geophysical Laboratory in Washington, D.C., and



Lars Stixrude of the Georgia Institute of Technology in Atlanta, Georgia, have done, that the Earth's solid core may be compared to a single iron crystal of cyclopic dimensions, a unique gigantic gem confined forever by geological history to the deepest recesses of our planet. □

For more detailed information, see *Physics of Iron at Earth's Core Conditions in Science 287 (11 February 2000), pp. 1027-1030.*

China, the world's most populous nation, is also one of the world's most rapidly growing nations. Air pollution, an unwanted by-product of that growth, may pose a threat to China's efforts to promote development in the future. An ICTP staff member explains why.

## Hazy Future

**R**ecent studies conducted under the auspices of CHINA-MAP, an international research programme sponsored by U.S. and Chinese organisations, contend that environmental factors may play a critical role in China's efforts to maintain its blistering pace of economic progress in the future. Project researchers conclude that regional pollution, a by-product of China's rapid development, may significantly curb the nation's crop yields. That, in turn, may endanger the sustainability of the nation's economic and social growth.

The unwanted consequences of pollution on agriculture output may be felt in three ways.

First, volatile organic compounds, carbon monoxide and nitrogen oxides caused by the burning of fossil fuels in power plants or automobile emissions may create high ozone levels that prove damaging to vegetation. Indeed persistently high ozone levels in any single growing season could significantly depress crop yields.

Second, fine particles discharged into the atmosphere either by direct emissions during fossil fuel combustion or by the oxidation of such gaseous pollutants as sulphur dioxides, nitrogen oxides and volatile organic compounds may continue to reside in the atmosphere for days or even weeks—scattering and absorbing solar radiation and enhancing the optical thickness and longevity of clouds. This would reduce solar radiation at the surface and, in turn, decrease photosynthesis and crop productivity.

Third, reductions in solar radiation due to anthropogenic regional haze may decrease regional surface temperature. That could create a less hospitable growing environment resulting in lower crop yields.

Such troubling impacts could prove to be more acute in China than in other countries. Why? Because of China's heavy reliance on fossil fuels (especially coal), its rapidly expanding industrial sector and its growing use of automobiles.

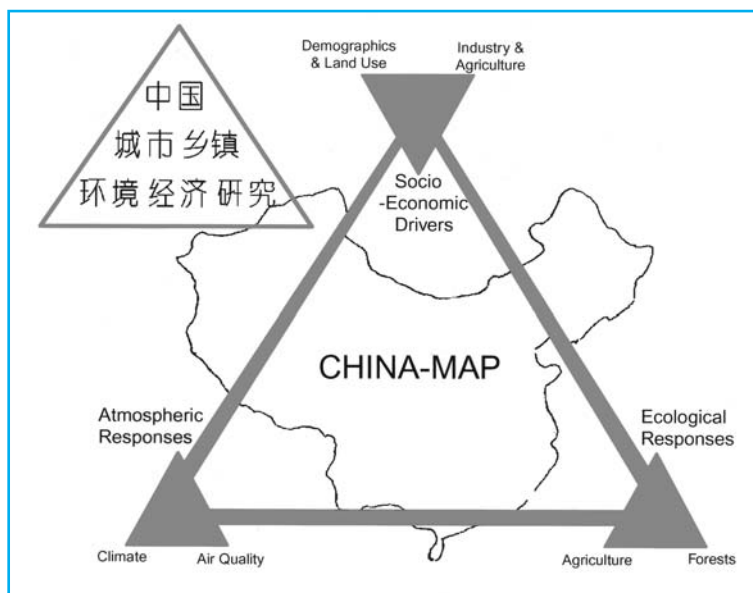
The CHINA-MAP research team has recently completed a series of pilot studies on the potential effects of pollution on crops. The studies draw on meteorological, chemical and crop models as well as *in situ* analytical observations.

Early findings suggest that regional haze in China may be depressing optimal crop yields of wheat and rice, which account for 70 percent of the total Chinese crop production, by 5 to 30 percent. Such impacts are likely to accelerate as pollution emissions increase as a by-product of rapid economic growth. In addition, the findings indicate that a rise in anthropogenic aerosols are causing regional temperature to decrease in several agricultural-rich areas of east China.

For China to successfully meet its rapidly increasing food demands in the years ahead, it must better understand the relationship between its development-related pollution emissions and its agricultural output.

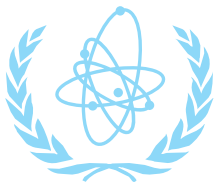
Although the results of the CHINA-MAP research programme are preliminary, it's nevertheless clear that China faces a formidable

challenge in fostering plans for rapid development that do not undermine the long-term health of its agricultural sector, which has made historic progress over the past half century. □



*For more technical evaluations of the CHINA-MAP's research findings, see W.L. Chameides, et al., "Is Ozone Pollution Affecting Crop Yields in China?" Geophysical Research Letters 26 (1 April 1999), pp. 867-870, and W.L. Chameides, et al., "Case Study of the Effects of Atmospheric Aerosols and Regional Haze on Agriculture: An Opportunity to Enhance Crop Yields in China through Emission Controls?" Proceedings of the National Academy of Sciences 96 (23 November 1999), pp. 13626-13633. Filippo Giorgi co-authored both studies.*





**Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA), recently sat down with the editor of *News from ICTP* for a wide-ranging discussion focusing on the overall challenges confronting IAEA.**

## Conversation with Mohamed ElBaradei

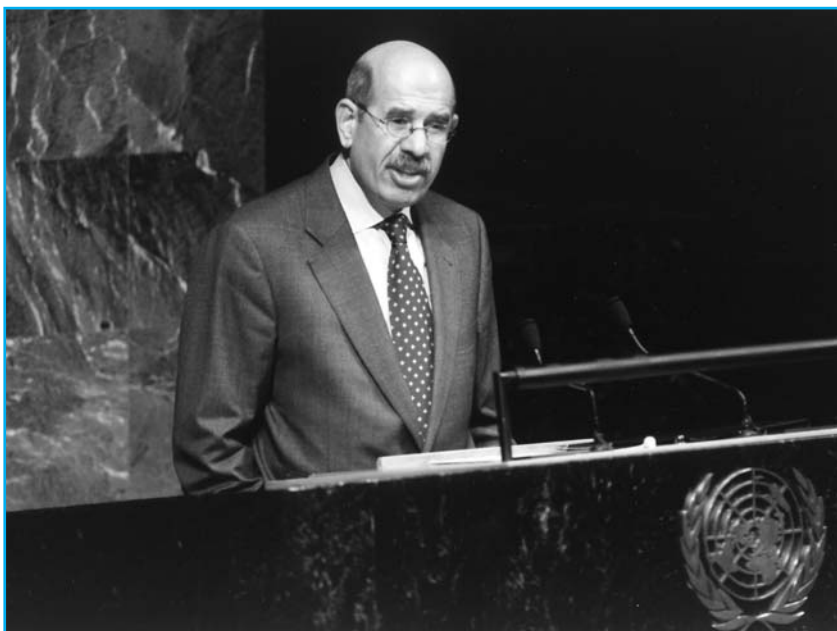
**E**gyptian-born Mohamed ElBaradei earned his initial law degree in the 1960s at the University of Cairo, and his master's degree and doctorate in international law at New York University in 1974. He began his diplomatic career in the Egyptian Ministry of Foreign Affairs in 1964, serving in the Permanent Missions of Egypt to the United Nations in New York and Geneva. He has been a senior member of IAEA Secretariat since 1984, holding several high-level policy positions, including representative of the Director General of IAEA to the United Nations in New York, the Agency's Legal Adviser and Director of the Legal Division. He was subsequently appointed Head of the Division of External Relations and Assistant Director General for External Relations. ElBaradei became Director General of IAEA on 1 December 1997.

### What are the critical challenges that IAEA faces today?

IAEA's mandate is to focus on nuclear technology and to ensure that it is used safely and exclusively for peaceful purposes. Nuclear power is at a standstill in many parts of the world, particularly in the North. Many forces are driving this trend, including questions of safety, waste management, economic competitiveness and, perhaps most significantly, public confidence. People throughout the world remain fearful of another severe accident like the one that took place at Chernobyl.

On the other hand, the public has become increasingly concerned about the potential impacts of global climate change. Nuclear power is one of the few energy sources that can generate large amounts of 'clean' electricity—clean in terms of greenhouse gas emissions. From IAEA's point of view, only two options—fossil fuel and nuclear power—are available to meet the expected explosive growth in demand for electricity over the next few decades. If, as many experts agree, climate change poses a threat to the environment, then increased use of

fossil fuels carries distinct liabilities. However, for nuclear power to remain an option, the public must be convinced that it's safe and investors must be convinced that it's economically competitive with other energy sources. That's why IAEA must work with member states to extend the culture of nuclear safety throughout the world, restore nuclear power's economic viability, and rebuild public confidence by helping to educate people about nuclear energy's risks and benefits. Another challenge facing IAEA is to ensure that technical knowledge about nuclear energy continues to be made available. Here the discussion moves beyond electricity to such equally vital areas as health, agriculture and hydrology. Take, for example, efforts to locate precious ground water supplies, an issue of vital importance to the developing world. The use of nuclear isotopes offers a much more efficient method for finding ground water reserves. Nuclear technology may also play a role in the detection of abandoned land mines, helping to rid the world of these terrible devices that cripple and kill so many innocent people. IAEA's technical co-operation programme is our main vehicle for transferring nuclear applications to developing countries. Because our budget is limited, we must be sure that our efforts fit within a nation's larger development strategies and we must work closely with others seeking the same goals.



*Mohamed ElBaradei addressing the General Assembly of the United Nations in New York, 4 November 1999*

## What steps do you think need to be taken to restore public confidence in nuclear technology?

Education is the key. There's a lot of public misunderstanding and misperceptions about nuclear technology. A credible and comprehensive educational initiative will require the co-operation of IAEA member states, non-governmental organisations and private industry. People are hypersensitive to nuclear technology and we must help them understand that, like all other technologies, nuclear technology carries benefits and risks, and that mature ways have been developed for weighing one against the other. Decisions on whether and how to use nuclear technology will differ from one country to another depending on a nation's needs and priorities. Nevertheless, there's a need for an organisation like IAEA to ensure that the public receives appropriate information to make intelligent decisions about the available options. This raises another problem. Today, many nations view nuclear technology as a technology of the past. Yet, we will need to continue to train young nuclear scientists and technicians if we hope to keep the nuclear option alive in the future. Even in the worst-case scenario, assuming that nuclear technology will fade into history, we would still need nuclear scientists for the next 30 to 50 years to deal properly with the more than 450 existing reactors worldwide for closing down and decommissioning them. Well-trained nuclear scientists will also be instrumental in addressing issues related to nuclear disarmament. Earlier this year, IAEA held a meeting attended by representatives from nuclear research centres from around the globe to discuss the growing problem of how to attract talented young people to nuclear-related fields. Internships, training, and university collaboration were all cited as potentially fruitful strategies. This is an issue that's likely to be a high priority for IAEA. And it's an issue where ICTP can play an important role given the Centre's successful efforts in training young nuclear scientists in many areas of nuclear physics and in bringing scientists from the South and North together for discussion and collaboration.

## What guidance does IAEA give member states on nuclear research and its applications?

IAEA presents the facts as we see them; we do not advise country X, Y or Z to use nuclear technology. We say, 'Here's the technology, here's what you can do with it, and here's what we can do for you if you decide to use that technology.' As an intergovernmental organisation, our mandate is to make sure that nuclear technology is available to member states so that they can make maximum use of it for economic and social development. But the decision of whether and how to use this technology clearly rests with the member state.

## How does IAEA reach out to developing countries?

IAEA's technical co-operation programme, which is our main vehicle for the transfer of nuclear technology to developing countries, has an annual budget of about US\$80 million. In addition, we launched and have been a major sponsor of ICTP, which over the past three decades has been a vital participant in the transfer of science and technology to our developing member states. In fact, ICTP has been—and continues to be—an invaluable tool for co-operative efforts in the development of training, research and fellowships—key aspects of our outreach efforts. I visited ICTP last fall and I was impressed by the facilities and the quality of the staff and visiting scientists. We are now engaged in a dialogue with ICTP to see how to increase our interaction for the benefit of developing countries. I believe that nuclear science and technology are at the heart of science and technology, and without science and technology developing countries cannot prosper. IAEA's work on issues related to nuclear safety and international nuclear arms verification often make the headlines. However, our less visible work in technical co-operation remains a critical part of our mandate, which calls for fostering peaceful applications of nuclear technology, especially to facilitate development in developing member states.

## How would you describe IAEA's relationship with ICTP since the change-over in prime administrative responsibility for the Centre from IAEA to the United Nations Educational Scientific and Cultural Organization (UNESCO) in 1996?

The relationship between the two institutions is good. We sit on the steering committee of ICTP and have a voice in setting the agenda for the Centre's training and research activities. However, I also think there's room for us to work more closely together. There was a distancing in our relationship after the change of management from IAEA to UNESCO when we did not rely as much as we should have on ICTP. I think this is something we need to correct. Our recent discussions indicate that we are now returning to a closer relationship. ICTP is a creation of IAEA and we should continue to make full use of both the Centre's human resources and facilities. I would like to see more Agency use of ICTP's training facilities, more co-ordinated research activities between IAEA and ICTP, and more fellows visiting ICTP through our technical co-operation programme. In all these areas, I think opportunities exist to develop a closer, more dynamic relationship, especially for the benefit of developing countries. □



Mohamed ElBaradei visiting ICTP, 3 September 1999

Mathematicians are exploring new ways to address critical issues related to ecology, genetics and population dynamics. It all adds up to a 'new math' that is stretching the traditional boundaries of the profession well beyond the classroom.

## When Math Meets Ecology

Can we project the pathways of such deadly diseases as AIDS? Are we capable of anticipating future patterns of forest growth? What exactly is the relationship between biodiversity and healthy ecosystems?

These are some of the complex questions that mathematicians are exploring as they turn from their chalk boards and note pads to nature's fields, forests and rivers—putting their skills to work in addressing critical problems of global concern.

The result is the emerging field of mathematical ecology and the related field of ecological economics. The first seeks to address ecological issues by applying such tools as mathematical models; the second seeks to determine the value of so-called 'ecoproducts' and 'ecoservices' often neglected by the market place—for example, the value of an uncut tree in a national forest (can we place a price on the aesthetic and recreational services the tree supplies?); or an endangered species that escapes extinction (can we determine the species' worth based on its contribution to the intricate functioning of an ecosystem?).

The ICTP recently conducted a four-week course on mathematical ecology that included a week-long introduction to ecological economics. Presentations on risk and environmental assessment, population dynamics, conservation biology and biological migrations revealed the broad issues to which mathematical tools are being applied to better explain the functioning and value of our natural world.

As Princeton University's mathematical ecologist Simon Levin, one of the course directors, explains: "Mathematical ecology is a broad subject that ranges from highly theoretical and highly abstract mathematical investigations to studies closely tied to data."

"The best mathematical ecology," Levin asserts, "is driven by biological questions, not mathematical ones. In a similar vein, the best ecological economics is based on economic

principles. It seeks to account for goods and services that have often been left out of market calculations despite their inherent contributions to our ecological and economic well being."

Mathematical ecology emerged from the roots in the work of the great Italian mathematician, Vito Volterra, who devised a series of mathematical models on the increase in predator fish population—and consequent decrease in prey fish population—in the Adriatic Sea during World War I. Volterra's precedent-setting models were based on research conducted by his son-in-law, Umberto D'Ancona, a distinguished biologist at the University of Padua, who was interested in the population dynamics among fish stocks in the Adriatic Sea.

Volterra used pen and paper and simple mathematical calculations to draw his conclusions. Today high-powered computers and sophisticated mathematical models drive the research efforts. A wide range of studies has proven particularly fruitful in examining changes in forests and fisheries, the spread of diseases and the loss of biodiversity, particularly in tropical environments. More recently, the effort has moved beyond specific resource areas into the

theoretical world of complex systems.

As Levin observes: "Ecological systems, like economic systems, are complex adaptive environments where macroscopic patterns emerge from microscopic interactions among individual agents on local scales. Relating these scales," he maintains, "is a fundamental challenge in the study of ecology."

Levin points to work on the impact of global climate on forest ecosystems. "We can examine, with relative ease, the impact that global climate change is having on the physiology of trees within a forest. But the critical question is: how are changes in the microenvironment affecting the dynamics of the entire ecosystem—the soil, vegetation, insect populations and animal life within the forest?"



Simon Levin

The intricate relationships between the diverse components of an ecosystem are not linear but interactive and dynamic. Understanding these relationships requires high-speed computation and state-of-the-art analytical strategies that allow researchers to simplify their models without compromising the insights that these models provide for what is happening in the real world.

For practitioners of mathematical ecology and ecological economics, mathematics is a tool for grappling with larger ecological issues. "The critical juncture in my career," explains Levin, "occurred when I decided that to do good work in mathematical ecology, I had to think like an ecologist rather than a mathematician. What accounts for changes in the virulence of viruses? How much vaccination is needed for control? What are the consequences of social interactions or antibiotic resistance?"

"I now urge my students and postdocs who come from physics or mathematics to do the same, instead of continuing to do research that will impress their physics or math colleagues. Once they choose to take this new path, they often do work that is more impressive to their physics and math colleagues than if they had continued to pursue more conventional research agendas."

However interdisciplinary relationships evolve among academic colleagues, Levin is convinced that both "mathematical ecology and ecological economics will grow in influence in the years ahead as policy makers and the public seek quantitative solutions to problems related to ecological and organisational complexity."

Ultimately, Levin says, we need to know how human activities, as well as natural trends, are affecting goods and services that ecological systems provide us—our very life support systems. □

## WORLD OF OPPORTUNITY

When Graciela Ana Canziani arrived at the Second Autumn Course on Mathematical Ecology in 1986, she had a problem. As an associate at the University of Buenos Aires and Argentina's Institute of Mathematics, she had refined her skills in mathematics—both as a teacher and researcher—and vastly increased her knowledge concerning the intricate and elegant world of matrices, equations and numerical algorithms.

But when a colleague in the architecture and urban planning department asked her to use her skills to analyse the impact that continued population growth would have on urban infrastructure—transportation, water, sewage and school systems—she didn't have a clue about how to examine such commonplace, yet critical, issues.

"I came to the Centre that first year seeking to find out if and how I could use my knowledge in mathematics to address these practical concerns," explains Canziani. "I left the course not only with some answers on how to proceed but with the prospects of a new world of opportunity in my chosen profession."

The new career pathways opened to Canziani were largely the result of the ideas and inspiration of Thomas Hallam and Louis Gross, both from the University of Tennessee in the United States. "Not only have they been instrumental in the success of the Centre's mathematical ecology activities from

the beginning, but they have had a lasting impact on the overall growth of the field in both the developed and developing worlds."

Since her first visit to the ICTP, Canziani has transformed her career from a traditional mathematician into a mathematical ecologist by using her skills and knowledge in mathematics to address ecological and economic issues that once seemed entirely disconnected from her discipline.

Her involvement with the Centre reflects the growth of her career over the past 15 years. In 1990 and 1992, she returned to the Centre as a lecturer and, in 1996, she was appointed a course director—an assignment she has assumed again this year for the Fifth Course on Mathematical Ecology.

In addition to her participation in ICTP activities, Canziani has launched a successful series of mathematical ecology courses in the math department of her university, Argentina's *Universidad Nacional del Centro de la Provincia de Buenos Aires*, and spearheaded the organisation of a Latin American network of mathematical ecologists, which now includes some 50 researchers from 9 countries.

Today she serves as a principal investigator for a US\$1-million, 3-year project, funded by the European Union, which is designed to provide a wealth of information and projections on the fast-growing region of Esteros del Iberia, in

northeast Argentina. The project involves 11 universities in 6 nations in Latin America and Europe.

"Rapid population growth, increased tourism and intensive rice cultivation," Canziani says, "are having a dramatic impact on the area's ecology and traditional community structures. Most observers agree that these pressures will become even more acute in the future."

"Our job is to use our skills in mathematics and modelling to analyse a whole range of parameters, including scenarios for land use, hydrology and pesticide contamination. We are trying to create a comprehensive state-of-the-art geographic information system using remote sensors, on-site monitoring, historic data and field studies. It's a huge multidisciplinary undertaking that requires sophisticated quantitative inputs and analyses that can only be provided through the use of mathematical tools."



Graciela Ana Canziani





### **A New Physics?**

Two recent announcements have stirred great interest among high energy theoreticians at ICTP and SISSA (International School for Advanced Studies) in Trieste. A series of experiments at CERN in Geneva, Switzerland, have offered evidence of the existence of a new state of matter in which quarks are completely free instead of bound up in more complex particles like protons and neutrons. Such a state must have existed just a few microseconds after the Big Bang.

The second announcement, made at the 4th International Symposium on Sources and Detention of Dark Matter in the Universe, recently held in Marina del Rey, California, noted that a team of Italian physicists working at the Gran Sasso Laboratory of the Italian National Institute of Nuclear Physics (INFN) may have uncovered traces of the elusive neutralinos. These weakly interacting massive particles (WIMP) could be the first supersymmetric particles that theoretical physicists have foreseen as candidates for dark matter.

### **Far From Equilibrium**

Danish-born physicist Per Bak, a professor at Imperial College in London, opened ICTP's Research Workshop on Self-Organized Criticality and Phase Transitions in Driven Systems with a lecture outlining his views on homogeneity and non-homogeneity in the universe. Bak, a frequent visitor to the Centre, is one of the founding fathers of the science of self-organised critical systems, which emphasises the deeply disruptive, yet self-correcting, forces—such as earthquakes and volcanic eruptions—that seem to drive the Earth's "metabolism." Although Bak's theory remains a controversial tool for understanding the behaviour of natural systems, it has gained a great deal of notice in the field of economics, especially for deciphering the sometimes volatile behaviour of the stock market. Bak's work has attracted the attention of several public officials, including U.S. vice-president and major presidential candidate Al Gore.



Per Bak

### **TWAS Receives G77 Award**

The Third World Academy of Sciences (TWAS) has received the Group of 77/United Nations Development Programme (UNDP) award for economic and technical co-operation among developing countries (ECDC/TCDC) for the year 2000. The award is given to institutions or individuals making significant contributions to the promotion of South-South co-operation. Previous recipients include the South Centre, Third World Network, South-North Development Monitor and

Eduardo Praslj, chairperson of the Perez-Guerrero Trust Fund for Economic and Technical Cooperation among Developing Countries. UNDP is the largest source of assistance for development and the main body for co-ordinating the United Nations' development work. The G-77, with 133 members, is the largest Third World coalition in the UN. Its goal is to advance the developing world's economic interests and to enhance its negotiating capacity on international economic issues within the UN system.



Arbab Ali Khan

### **ICO-ICTP Prize**

Arbab Ali Khan, assistant professor in the Department of Electronics at Quaid-i-Azam University in Islamabad, Pakistan, is the first recipient of the International Commission for Optics (ICO)-ICTP Prize. The award, established in August 1999, is given to a young researcher who was born and continues to live and work in a developing country. Khan, whose major fields of interest are fibre optics and lasers, was honoured at a special ceremony during ICTP's Winter College on Optics and Photonics. He received US\$1000 and a certificate. Comprised of 44 institutions, ICO is dedicated to advancing global knowledge and high-level research findings on optics through conferences, meetings, schools, fellowships and awards. It is an affiliate commission of the International Union of Pure and Applied Physics (IUPAP). IUPAP is a member of the International Council of Scientific Unions (ICSU).



## Panza Honoured

The European Geophysical Society has awarded Giuliano Francesco Panza the Beno Gutenberg Medal. Panza, professor of seismology at the University of Trieste and head of the ICTP Structure and Non-Linear Dynamics of the Earth (SAND) programme, is being honoured for his scholarly achievements in earthquake modelling and for advancing international co-operation in earthquake analysis and prediction. The award, established in 1996, is named in honour of the great German-born seismologist who is credited with discovering the Earth's core and helping to explain the physics of continental drift. The award ceremony will take place in Nice, France, this spring during the opening of the XXV General Assembly of the European Geophysical Society.



Giuliano Francesco Panza

## Blix Chosen as Chief Inspector



Hans Blix

The UN Security Council has chosen Hans Blix to be chief inspector of a new disarmament commission for Iraq. Blix served as director general of the International Atomic Energy Agency (IAEA) from 1981 to 1997—a crucial period in the Agency's history marked by the increasing risks posed by nuclear weapons' proliferation, especially in the developing world, and rising public concerns and controversies following the accident at the Chernobyl nuclear plant in the former Soviet Union. Blix has visited ICTP on several occasions, including the Abdus Salam Memorial Meeting in 1997 and the official ceremony for the transfer of the Centre's management responsibilities from IAEA to UNESCO in 1996.

## Wolf Prize

Masatoshi Koshiha, professor of physics at the University of Tokyo, Japan, and Raymond Davis, professor of physics at the University of Pennsylvania, USA, have been awarded the prestigious Wolf Prize for physics for their investigations of the elusive subatomic particles, neutrinos. The prize citation noted that their findings and observations "have opened a new window of opportunity for the study of astronomical objects, such as the Sun and exploding stars, and the fundamental properties of matter." Koshiha visited the ICTP in July 1998, just a few weeks after the discovery of neutrino's mass in Japan's SuperKamiokande detectors. Koshiha led the detectors' design and construction team. Both he and Davis will receive \$100,000. The awards ceremony will take place at the Israeli Knesset (Parliament) on 21 May.



Masatoshi Koshiha at the ICTP 5th School on Non-Accelerator Particle Astrophysics (29 June - 10 July 1998) with (from left) Alexei Smirnov, Giorgio Giacomelli, Miguel Virasoro and Nello Paver.

## NEWS FROM ASSOCIATES

ICTP Senior Associate **Ghulam Murtaza** has been named the first Salam Professor of Physics at Government College in Lahore, Pakistan. The chair was established by the government of Pakistan to honour the memory of ICTP founder and Nobel Laureate Abdus Salam. Murtaza, who was a pupil of Salam at Imperial College in London, recently wrote to the Centre to say that the "Salam Chair is an honour and at the same time a challenge. I hope I will be able to come up to it. And of course I shall need strong support from various quarters, particularly from the Abdus Salam ICTP."



## REPORT ON REPORTS

### **JOINT INFN-the ABDUS SALAM ICTP SCHOOL ON MAGNETIC PROPERTIES OF CONDENSED MATTER INVESTIGATED BY NEUTRON SCATTERING AND SYNCHROTRON RADIATION TECHNIQUES**

1 - 11 February

**Co-sponsors:** Italian National Group

for the Structure of Matter of the Italian National Research Council (GNM-CNR) and Italian National Institute for the Physics of Matter (INFN).

**Directors:** O. Moze (INFN, University of Modena and Reggio Emilia, Italy), F. Sacchetti (INFN, Perugia University, Italy), S. Nannarone and G. Rossi (INFN, University of Modena and Reggio Emilia).

**Local Organiser:** M. Fabrizio

(International School for Advanced Studies, SISSA, and ICTP, Trieste, Italy). *The School introduced researchers to the basic principles and applications of neutron and photon scattering for investigating the magnetic properties of condensed matter. Leading researchers in magnetism/neutron/synchrotron radiation outlined recent developments in both fields.*

### **SCHOOL ON DATA AND MULTIMEDIA COMMUNICATIONS USING TERRESTRIAL AND SATELLITE RADIO LINKS**

7 - 25 February

**Co-sponsors:** International Union of Radio Science (URSI, Gent, Belgium) and Telecommunications Development Bureau of the International Telecommunication Union (BDT-ITU,

Geneva, Switzerland).

**Directors:** S.M. Radicella (ICTP) and R.G. Struzak (Radio Regulation Board of ITU).

**Local Organiser:** S.M. Radicella. *The School included tutorial lectures and laboratory work on the following topics: modern communication potential and needs in developing countries; perspectives of information society and global information infrastructure; recent developments in satellite- and terrestrial-*

*based broadband systems; access to spectrum/orbit resources and principles of spectrum management; spread-spectrum techniques; and Earth-to-Earth and Earth-to-space radiopropagation issues related to broadband systems. Laboratory work provided practical exercises on computer networking using terrestrial and satellite radio links; intranet multimedia campus networks; and videoconferencing.*

### **WINTER COLLEGE ON OPTICS AND PHOTONICS**

7 - 25 February

**Co-sponsors:** International Commission of Optics (ICO) and Optical Society of America (OSA).

**Directors:** A.T. Friberg (Royal Institute of Technology, Stockholm, Sweden), A. Ghatak (Indian Institute of Technology, New Delhi, India), F. Gori (Università Roma Tre, Rome, Italy) and

G.T. Sincerbox (Optical Sciences Center, University of Arizona, Tucson, USA).

**Local Organiser:** G. Denardo (University of Trieste and ICTP).

*The College introduced participants to the rapidly growing fields of modern optics, photonics and optoelectronics. Lectures covered basic principles and theories in optical physics and instrumentation; applications in optical storage; guided-wave technology; lasers;*

*and miniature optics. Demonstrations and hands-on laboratory and internet activities were organised on the following topics: fibre optic principles, components and amplifiers; micro-optics and nanostructures; new laser methods, devices and applications; optical and quantum physics polarisation, coherence and propagation; optical storage and display technologies; geometrical optics; and optical design.*

**JOINT ICTP-ICS TRAINING  
COURSE ON OPTICAL  
DESIGN AND  
OPTIMIZATION**

28 February - 3 March

**Co-sponsor:** International Centre for Science and High Technology (ICS, Trieste, Italy).

**Local Organiser:** G. Denardo (University of Trieste and ICTP).

*The Course emphasised software-related*

*solutions to optical problems. Lectures focused on lens design theory and presented successful case studies of optical and laser system implementation.*

*Computer sessions utilised commercial and freeware software for ray tracing and diffraction-based analysis. The Course sought to train scientists/technicians in modern optical design; give participants practical experience in use of commercially*

*available software for ray tracing and diffraction analysis; introduce successful applications of optical and laser methods for solving practical industrial problems; help representatives of small industries in developing countries improve the quality and competitiveness of their optics and laser-related products and services; and initiate contacts and promote co-operation among industries and research institutions.*

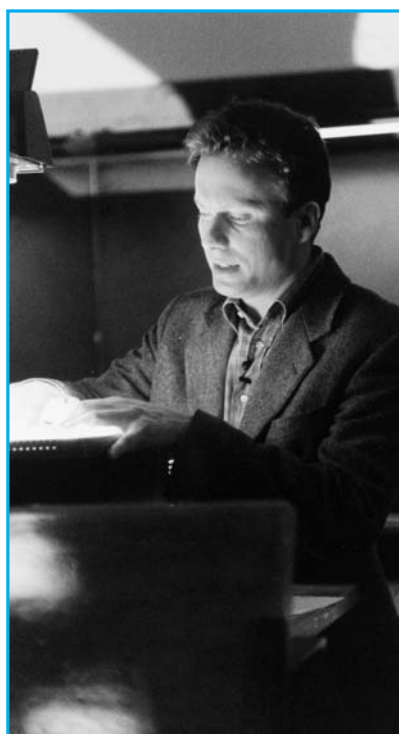
**FIFTH COURSE ON MATHEMATICAL  
ECOLOGY, including an INTRODUCTION TO  
ECOLOGICAL ECONOMICS**

28 February - 24 March

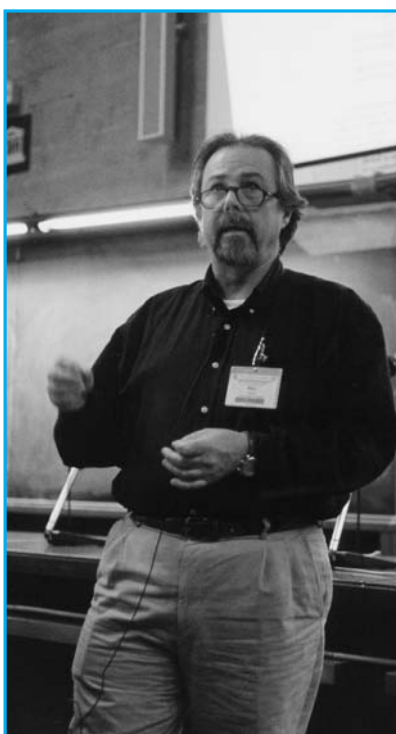
**Directors:** G.A. Canziani (*Universidad Nacional del Centro de la Provincia de Buenos Aires, Tandil, Argentina*), P. Dasgupta (*Cambridge University, UK*), L.J. Gross and T.G. Hallam (*University of Tennessee, Knoxville, USA*) and S.A. Levin (*Princeton University, USA*).

*The Course examined mathematical tools currently being applied to problems in ecology, environment and economics.*

*Such tools include ordinary, partial and stochastic differential equations; linear algebra; control and game theory; and stochastic processes. The first three weeks explored such topics as population dynamics, food webs, ecosystem assessments, epidemiology and global ecology. The fourth week, which represented a new avenue of inquiry for this activity, examined ecological economics. Discussions focused on market failures to deal with environmental impacts and such new concepts as valuations of 'ecosystem services,' including how this approach could be used to promote sustainable development. Mathematicians, economists, biologists and environmental engineers were among the participants. (See page 6.)*



Alessandro De Leo



Vincent Hull



Thomas G. Hallam



## RESEARCH WORKSHOP ON SELF-ORGANIZED CRITICALITY AND PHASE TRANSITIONS IN DRIVEN SYSTEMS

1 - 4 March

**Directors:** D. Dhar (Tata Institute of Fundamental Research, Mumbai, India), A. Stella (University of Padua, Italy) and A. Vespignani (ICTP).

**Local Organiser:** A. Vespignani. *The Workshop brought together leading researchers working in the field of self-*

*organised criticality to discuss the most recent developments and research directions in this field. Topics included avalanche dynamics; nonequilibrium critical phase transitions; and extremal dynamics models. (See page 8.)*

## WORKSHOP ON NUCLEAR REACTION DATA AND NUCLEAR REACTORS: PHYSICS, DESIGN AND SAFETY

13 March - 14 April

**Co-sponsors:** International Atomic Energy Agency (IAEA, Vienna, Austria) and Italian Commission for New Technologies, Energy and the Environment (ENEA, Rome, Italy).

**Directors:** A. Gandini (University of Rome and ENEA), A. Koning (Nuclear Research and Consultancy Group, Petten, The Netherlands), J. Kupitz (IAEA), P. Oblozinsky

(IAEA) and A. Trkov (Institute Jozef Stefan, Ljubljana, Slovenia).

**Local Organiser:** N. Paver (Italian National Institute of Nuclear Physics, INFN, and ICTP, Trieste, Italy).

*The Workshop offered training to scientists and engineers from developing and developed countries in modern nuclear reaction theory, nuclear data production and data use. Discussions focused on the practical use of modern computer codes relevant to these topics; rapidly advancing information technologies for retrieval of nuclear data; and new trends in advanced nuclear systems for energy generation. The programme concentrated on the*

*physics of nuclear fission; analysis of neutron resonances; statistical theory of nuclear reactions; pre-equilibrium models; evaluation of nuclear reaction data; online nuclear data retrieval; nuclear data formatting and processing; application of nuclear data for reactor calculations; advanced nuclear systems for energy generation; and research and power reactor design, safety, operation and performance analysis.*



Teresa Kulikowska



Maurizio Cumo



Augusto Gandini

## SPRING WORKSHOP ON SUPERSTRINGS AND RELATED MATTERS

27 March - 4 April

**Directors:** C. Bachas (Ecole Normale Supérieure, Paris, France), R. Iengo (International School for Advanced

Studies, SISSA, Trieste, Italy), J. Maldacena (Harvard University, Cambridge, USA), K.S. Narain and S. Randjbar-Daemi (ICTP).

*The Workshop explored the following topics: AdS/CFT correspondence; BPS and non-BPS states; black holes;*

*large-scale compactifications; non-commutative geometry; and boundary conformal field theory. Participants included theoretical physicists and mathematicians knowledgeable in quantum field theory, general relativity and string theories.*



## PROFILE

**ICTP Associate Ivane Murusidze remains optimistic that his native Georgia can regain its footing in science after a difficult period of transition.**

# Tradition and Transition

**W**hen ICTP Associate Ivane Murusidze leaves Trieste to return to his home in Tbilisi, Georgia, in early May, it will mark the end of his third visit to ICTP during the past six years. Murusidze, who is trained as a plasma physicist, is thankful for the opportunities that the Centre has provided him during a period of unprecedented change for both scientists and scientific institutions in his home country.

Georgia is one of the 'newly independent states,' located between the Black and Caspian seas in the Caucasus, that re-emerged after the collapse of the U.S.S.R. in 1991. "Our problems," Murusidze notes, "are similar to the problems faced by other republics that belonged to the Soviet Union. Economically, we now resemble a developing country, but scientifically we do not."

In fact, Georgia has a long tradition of excellence not only in science but in other fields of inquiry—for example, history, philosophy and the arts—that date back to the 12th century. "Our culture has a deep and abiding respect for education," he notes, "and that respect has found expression in the accomplishments of our teachers, humanitarians, artists and scientists."

Murusidze cites the work of Elevter Andronikashvili, who served as the director of the Georgian Academy of Science's Institute of Physics between 1950 and 1988, as a prime example of his country's enviable history of scientific excellence. Andronikashvili is considered to have been one of the world's foremost condensed matter physicists.

"Under communism," Murusidze says, "scientific institutions were part of a large, politically powerful network able to secure sufficient resources to sustain high-level research in physics and many other fields."

"Today, however, we are in a period of transition. Our ties to the Soviet system of science have been severed and we have yet to develop a fully functioning market economy." As a result, funding for scientific institutions has declined dramatically. "In the late 1980s," Murusidze notes, "about 200 physicists worked at the Georgian Academy of Science's Institute of Physics." Some former employees have retired, some have moved to the West and some have migrated to other fields, notably computer science and business. Despite the exodus, the scientists who remain continue to do excellent work.

Murusidze acknowledges that the benefits he derives from his association with ICTP "may be different from the benefits derived by his younger colleagues from other parts of the world where scientific institutions have not been strong."

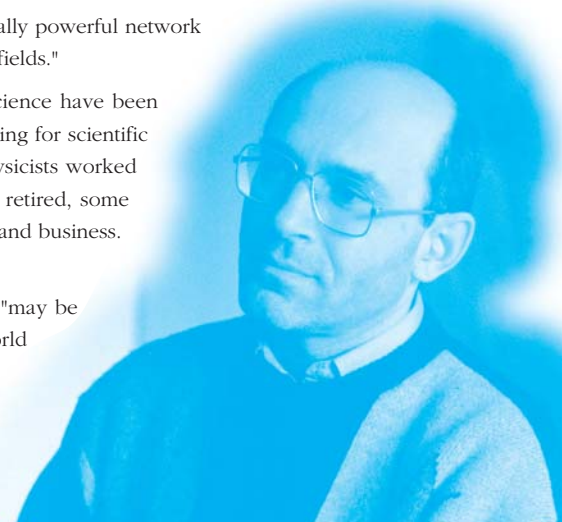
At the same time, he maintains that "the benefits he has received from his ties to the Centre are no less valuable." ICTP is a "unique place that has enabled me to remain in contact with colleagues who share my research interests. The Centre's library and computer facilities have also proven invaluable. No other single library in Europe houses as comprehensive a collection of journals and monographs in physics and mathematics. Meanwhile, the capacity and speed of the Centre's computer network has facilitated my efforts in model building and simulations, which has proven indispensable to my research. I owe a particular sense of gratitude to Swadesh Mahajan, who has been course director of the College in Plasma Physics for many years."

Murusidze's two major fields of research are nonlinear wave dynamics in plasma and nonlinear optics in semiconductors. In the first field, his research focuses on laser-plasma interactions at relativistic (very high) intensities.

"Small-scale experiments in laser-plasma interactions," he notes, "have proven that lasers can be used to compress and then ignite plasma. Scientists are now studying how the laser pulses would interact with plasma on a large scale. The challenge is that the relationship is nonlinear. Simply put, the pulse quickly changes the material properties of the plasma, making the pulse unstable."

Theoretical investigations into these areas require a first-class research environment and state-of-the-art computer networks. "That's why I've found my visits to ICTP so productive," Murusidze says. "Being able to converse with colleagues and utilise the Centre's facilities has helped push my research forward."

Despite the difficult period of transition Georgia has faced over the past decade, Murusidze remains optimistic about his country's future. "Young Georgians continue to come to our universities to learn science and their families continue to value science as a noble endeavour. These are encouraging signs for my country." □



*Ivane Murusidze*

## TRIBUTES



### Sigvard Eklund 1911-2000

Sigvard Eklund, director general of the International Atomic Energy Agency (IAEA) from 1961 to 1981, died in Vienna, Austria, on 30 January 2000. He was 89. Among his many accomplishments, Eklund played a decisive role in the creation of the Abdus Salam International Centre for Theoretical Physics (ICTP) and the choice of Trieste as its headquarters.

Swedish-born Eklund was appointed director general just one year after IAEA received the first formal proposal for the creation of an international centre for theoretical physics.

Despite opposition from several member states and a critical assessment by the Agency's scientific advisory committee, Eklund cleverly exploited one of the committee's 'alternative' recommendations—to sponsor summer seminars at existing institutions—by agreeing to organise a

seminar on theoretical physics under the guidance of Abdus Salam and Paolo Budinich. The seminar took place at the *Scuderie* (horse stables) of Miramare Castle in Trieste in 1962, in co-operation with the University of Trieste.

Thanks to Eklund's persistent yet low-keyed pressure, in February 1963 IAEA's board of governors agreed to turn the concept into reality. Trieste, however, was not the only city hoping to host the new centre. Ankara, Turkey; Copenhagen, Denmark; Lahore, Pakistan; and Vienna, Austria, were also in the running. Trieste won the competition thanks to the Italian government's generosity and the advice of Eklund and members of the site selection committee.

Before the official launching of the Centre, Eklund visited Trieste to inspect its temporary offices at Piazza Oberdan in the heart of the city and to help select the land on which a permanent structure would be built (what became the Miramare campus just north of the *Scuderie*). Once the Centre was operational, Eklund attended many annual meetings of ICTP's scientific council to gain

first-hand knowledge of the Centre's training and research activities.

Without Eklund's support and guidance, it's unlikely that ICTP would have ever been established. Thousands of scientists throughout the world owe a debt of gratitude to this wise and giving man.

*André-Marie Hamende  
former Senior Administrative and  
Scientific Information Officer  
ICTP*



### Stig Lundqvist 1925-2000

Stig Lundqvist, the driving force behind the creation of the Centre's Condensed Matter Group and Chairman of the ICTP Scientific Council from 1983 to

1992, died on 6 April, as News from ICTP went to press. A full discussion of Lundqvist's career and impact on ICTP will be presented in the next edition of the newsletter.

### Italy's President Visits Trieste

ICTP director Miguel Virasoro gave a brief presentation before Italy's President **Carlo Azeglio Ciampi** (third from right) at Area Science Park on 24 February. The director was invited to speak about the role of international scientific institutions in Trieste and the surrounding area, noting that the historic roots of the city's thriving scientific network lie with the creation of ICTP in 1964. That network now includes *Elettra* (the synchrotron light source), International Centre for Genetic Engineering and Biotechnology (ICGEB), International Centre for Science and High Technology (ICS), International School for Advanced Studies (SISSA), Third World Academy of Sciences (TWAS), University of Trieste, and field offices of the Italian National Institute of Nuclear Physics (INFN) and Italian National Institute for the Physics of Matter (INFM). During his talk, the director paid tribute to the inspired and dedicated work of Abdus Salam and Paolo Budinich and the generosity of the Italian government.



### Plaster Surgery

The Adriatico Guesthouse's Lower Level 1 has received a major facelift that not only puts the area in compliance with all safety regulations but makes better use of the floor space. The Main Lecture Room has a new improved look and a small room has been built behind it for additional classroom and meeting space. Computer jacks have been added to all meeting rooms for direct access to the Centre's electronic resources and world wide web. The first research activity to take place in the refurbished surroundings was the Workshop on Nuclear Reaction

Data and Nuclear Reactors: Physics, Design and Safety, which began in early March. Meanwhile, the Galileo Guesthouse has been re-wired. Computer connections are now available in each room.



## 25 April - 12 May

School on Vanishing Theorems and Effective Results in Algebraic Geometry

## 15 May - 9 June

Spring College on Electronic Structure Approaches to the Physics of Materials

## 22 - 25 May

Research Workshop on Graph Theory and Statistical Physics

## 29 May - 14 June

Summer Colloquium on the Physics of Weather and Climate: Chemistry-Climate Interactions

## 5 - 9 June

Conference on Gravitational Waves: A Challenge to Theoretical Astrophysics

## 12 - 23 June

Workshop on Correlation Effects in Electronic Structure Calculations

## 12 - 30 June

Summer School on Astroparticle Physics and Cosmology



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](mailto: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](mailto: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](mailto: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](mailto: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](mailto: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 ICTP and initiatives in their home countries. The text may be reproduced freely with due credit to the source.

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