NEWS from ICTP

the
abdus salam
international centre for theoretical physics

2 WHAT'S NEW
Spin Glass Spinoff

3 COMMENTARY
Radio Ahead

4 FEATURES
K.R. Sreenivasan

Hear Here

8 DATELINE
Crystal Clear
Nobels
New Staff

10 ACTIVITIES
October-December 2002

12 MONITOR
UN Day
Dubai
World Heritage

14 PROFILE
Viktoriya V. Semeshenko

15 WHAT'S NEXT
Conferences, Schools, Workshops

WINTER
2003

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Brian Hayes
American Scientist

ICTP staff scientist Riccardo Zecchina has teamed with physicists worldwide in an effort to make 'hard' computational problems easier to solve.

Spin Glass Spinoff

"Nature is not embarrassed by difficulties of analysis," said the French physicist Augustin Jean Fresnel.

But physicists are often embarrassed—or at least frustrated—by such difficulties. Problems that nature seems to solve with nonchalant ease yield to the physicist only after painstaking analysis and arduous computation. For example, atoms of iron 'know' how to line up when the material becomes magnetised, but for physicists calculating their configuration is a daunting task.

In the past year new methods of calculation have brought dramatic progress to problems of this general kind. The methods allow a more detailed understanding of certain systems in statistical mechanics. What is more surprising is that the new methods can also be applied to a large family of 'hard' problems in computer science and mathematics.

The roots of the new techniques lie in the study of 'spin glasses,' an area of condensed matter physics that has contributed more than its share of embarrassing difficulties.

A spin glass is something like a ferromagnet but with an added dose of disorder. In the magnet, atomic 'spins' tend to line up in the same direction; in the spin glass, some spins prefer to point the same way, but others favour pointing in opposite directions. Randomness is what makes analysis so difficult.

In the 1980s, Marc Mézard (*Université XI Paris-Sud*, Orsay, France), Giorgio Parisi (University of Rome *La Sapienza*, Italy) and former ICTP director Miguel A. Virasoro (University of Rome *La Sapienza*, Italy) developed an approach to spin glasses called 'the cavity method.'

The basic idea involves removing a selected spin from the system (leaving behind a 'cavity') and then calculating how this small change affects the other spins.

Early work on the cavity method focussed on spin networks with a simple and regular structure; the aim was to calculate statistical properties of collections of many spin-glass systems. Recent innovations have applied the method to less regular networks and to single instances rather than statistical ensembles.

The new techniques were devised about a year ago by ICTP staff scientist Riccardo Zecchina and Mézard, following additional work with Parisi. The inspiration came not only from spin-glass methodology but also from ideas in the theory of error-correcting codes. The calculation of the lowest energy configuration is done by a message-passing protocol, in which messages sent from the edges of the cavity diffuse out to other regions of the network. Zecchina and Mézard call the new variation of the cavity method 'survey propagation.'

The broader significance of this work is that many other problems can be encoded as spin-glass systems. The prototypical example is the problem known as 'satisfiability,' where the task is to assign values of true or false to the variables of a formula in propositional logic. The variables can be represented as spins, with opposite spin directions corresponding to true and false. 'Satisfiability' and several other related problems have practical applications in scheduling, optimisation and other areas.

Additional development of the survey-propagation algorithm was undertaken in the summer of 2002 by a group of about a dozen collaborators from around the world who met in August-September at the School on Statistical Physics, Probability Theory and Computational Complexity and Conference on Typical-Case Complexity, Randomness and Analysis of Search Algorithms. In addition to Mézard, Zecchina and Parisi, the team of researchers included Alfredo Braunstein, Silvio Franz, Michele Leone, Andrea Montanari, Roberto Mulet, Andrea Pagnani, Federico Ricci Tersenghi, and Martin Weigt.

The survey-propagation algorithm has now been implemented in a set of computer programmes. Although the programmes are not yet finely tuned, they routinely handle problems tens or hundreds of times larger than other methods can solve in a reasonable time. That could eventually translate this absolute concept into a tool that computer scientists, information experts and others could find of use.□

Brian Hayes is a long-time science writer currently on the staff of American Scientist. *He visited ICTP for a 10-week study period last fall.*

ICTP's Aeronomy and Radiopropagation Laboratory has given a face-lift to an old technology, helping to advance the communication revolution in Nigeria.

Radio Ahead

Emmanuel Efiong Ekuwem

In our fast-paced electronic world, technologies with an 18-month shelf-life are often considered aging equipment—just one step from a museum showcase or even the dustbin.

Yet, sometimes even half-century-old communication technologies can help power today's communication revolution.

That's exactly what's happened in Nigeria, where radiopropagation technologies, the same technologies that first brought news and music to our homes more than 75 years ago, have helped to usher in the use of email and the internet—all with the assistance of ICTP's Aeronomy and Radiopropagation Laboratory that launched the effort with the ICTP Scientific Computing Section.

"Satellite technologies require an infrastructure beyond the resources of countries like Nigeria and other developing countries," explains Sandro Radicella, head of the Laboratory. "And while cable is more manageable, it is still expensive. Moreover, once cable fibre is put into the ground, it's not only difficult to maintain but virtually impossible to replace without severe disruptions and costs—distinct liabilities when software technologies, system applications, and individual and institutional demand are changing so rapidly."

That's where the propagation of radio waves and equipment that can receive and transmit these waves comes into play. And that's why ICTP's Aeronomy and Radiopropagation Laboratory has been aggressively pursuing this strategy for the past several years.

"ICTP research and training activities in this field actually began in 1989," explains Radicella. "At the time, we provided research and training solely for such conventional uses as voice transmission and reception."

Radicella adds that "We began to shift gears—or, should I say, dials—in the late 1990s when we realised that radiopropagation technologies held enormous potential to jump-start the use of email and the internet in the developing world. We thought that our embrace of radiopropagation technologies could help address some of the difficult problems of access that were contributing to the North-South digital divide."

For Radicella and his colleagues, turning to radio waves as a primary technology for advancing the communications revolution was like taking an old coat out of your closet and matching it with a new scarf to give the coat renewed style and flair.

With the help of ICTP Associates Emmanuel Efiong Ekuwem and Gabriel Olalere Ajayi, the Centre's Aeronomy and Radiopropagation Laboratory conducted an extensive survey of universities and research institutes in Nigeria to determine which would be the best candidate to test their strategy.

The choice for the initial effort was Obafemi Awolowo University in Ile-Ife, Nigeria, largely because it already had a group of faculty members who had participated in the Centre's radiopropagation activities and thus enjoyed the prerequisite training, skills and contacts to assume local responsibility for this effort.

The impact proved both immediate and dramatic. The pilot project that began in Obafemi Awolowo University soon spread throughout Nigeria's teaching and research community. Today, the system reaches literally thousands of scientists and scholars. More recently, it has also helped farmers, meteorologists and medical practitioners link electronically to the broad flow of data and information now passing through the nation's universities and research institutes.

"Indeed the ultimate importance of this initiative," notes Ekuwem, who participated in the Centre's earliest workshops on radiopropagation for electronic communications, "lies not just with the ability of university students and faculty to communicate quickly and efficiently with one another. Rather, the system's true and lasting value lies with the global connections that students and faculty now have with like-minded associates and colleagues via the internet."

Ekuwem has tapped this interest by establishing his own radiotechnology and application business—Teledom International—located in Ile-Ife. The business has become the largest and most profitable of its kind in Nigeria.

Ekuwem's personal achievement has enabled him to illustrate another measure of the programme's success by contributing US$3000 to the ICTP School on Radio Use for Information and Communication Technology that took place this February in Trieste. This marks the first time that a private firm has provided direct financial assistance to an Aeronomy and Radiopropagation Laboratory activity. In fact, it is one of the few times that ICTP has received a donation from a private company in the developing world.

"Ekuwem's contribution," says Radicella, "not only provides a welcomed boost to our activities' budget but also serves as a valuable signal that what we are doing has helped improve the lives of students and researchers throughout Nigeria—both in intangible and tangible ways."□

For additional information about ICTP's Aeronomy and Radiopropagation Laboratory, please contact rsandro@ictp.trieste.it or fax +39 040 224604.

Katepalli R. Sreenivasan, the newly appointed director of ICTP, recently spoke about his hopes and plans for the Centre. Excerpts follow.

Katepalli R. Sreenivasan

What prompted you to apply for and accept the position of ICTP director?
When I was about 12 or 13, my family priest taught me a prayer and said that I was to recite it 108 times a day: one hundred for myself and eight for the rest of humanity. If I did not find the time for 108 recitations, I should do 58, 50 for myself and eight for humanity. And if I couldn't do 58, I should do 33, 25 for myself and eight for humanity. The point is that no matter how much or how little one does for oneself, one should always contribute a constant amount for humanity. Coming to ICTP and furthering its causes may be my way of contributing to the rest of humanity.

What do you view as ICTP's greatest strengths?
On the whole, the science done here is very good. In Italy, the scientific institutions in Rome, especially in physics and mathematics, are generally regarded as the nation's best. But, according to the opinions I have gathered, ICTP and the rest of the scientific institutions that comprise the Trieste System rank very high in quality. In the world at large, there are a few other institutions with visitor programmes similar to those found at ICTP—for example the Institute of Theoretical Physics at Santa Barbara, and the Newton Institute at Cambridge, UK. Yet ICTP is unique in its mandate, which involves not merely serving the global scientific community but paying particular attention to the needs and concerns of scientists from the developing world. ICTP must attract and retain the best scientific talent that it possibly can and, at the same time, promote and support worldclass science in the developing world. Excellence is at the heart of what the Centre does and that is what I intend to support during my tenure in Trieste. I should also emphasise that the centre's excellence is in no small measure due to the work of its dedicated staff.

ICTP operates under a tripartite agreement between the Italian government, the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the International Atomic Energy Agency (IAEA). How do you view the relationship with each of these institutions?
ICTP's relationship with the Italian government and the Italian scientific community is very good. I have met a few government officials, including the Italian ambassador to UNESCO, Francesco Caruso, and they have expressed nothing but praise for the Centre's work. Their interest, I think, is driven by two overall concerns. First, they want to be proud of the Centre and its contributions to science, especially in the developing world. They want the Centre to do its job well. Second, I think that they would like ICTP to become better known among the Italian citizenry. That is something I intend to work on. The Italian government has been generous in its support to ICTP and it is quite reasonable for them to expect that the public knows as much as possible about the Centre. ICTP has good working relationships with Trieste's other scientific organisations, often sharing their resources and expertise in ways that make the entire system stronger than any of its individual components. I support that. ICTP's relationship with IAEA is strong and I think the increased number of joint activities now taking place have added value and strength to this partnership. Yet IAEA understands the need for academic freedom within ICTP. As for UNESCO, there is enormous potential to tap in terms of the avenue it provides to its member states. I fully intend to capitalise on this advantage. Conversely, I think UNESCO can tap ICTP's scientific expertise to its advantage in a number of ways. There's a great deal of common ground worth exploring that, if cultivated properly, could serve the goals of both organisations well. In early discussions with UNESCO, we have agreed to work closely on several activities.

You intend to continue and hopefully expand your own research at the Centre. Could you explain the broad focus of your research and how you plan to pursue it in Trieste?
Broadly speaking, my area of research involves the understanding of a wide range of nonlinear and nonequilibrium problems, with a focus on turbulent flows. There are people at ICTP and next door at the International School for Advanced Studies (SISSA) doing related research in these broad areas and I see myself developing close ties with them. In Italy, there are people in Rome, in particular, but also in Milan and Padua, who have conducted worldclass research in these areas and I intend to interact with them. On an international level, I have worked in India, Australia, the United States, and a few other places, forging close

collaboration with a broad range of people within my field. Here, too, I plan to maintain my contacts. As a result, my research at the Centre will not only be connected to ICTP but to scientific communities in Italy, Europe, and the rest of the world.

What, specifically, has your research on turbulence entailed?

My research includes turbulence in the atmosphere, oceans, aerodynamics, blood vessels, and even home-heating systems. The major challenges facing those studying turbulence is to understand how properties vary as a control parameter is increased and to relate these aspects to the governing equations. This is the spirit of my work. One specific problem my colleagues and I have been working on recently is thermal convection: studies of the motion of fluid to better understand how thermal energy is transported from one part of a system to another—say, from the centre to the edge of the sun; or from the centre to the surface of the earth; or, more simply, from the bottom to the top of a heated pot of water. Typically, the experiments consist of a container with fluid (helium at a few degrees Kelvin) that is heated on the bottom. The fluid on the bottom of the container expands and becomes lighter, causing it to rise to the top. Meanwhile, the fluid at the higher levels of the container, which is colder and denser, tends to sink to the bottom. This creates a continuous motion representing a form of turbulence. The description makes the process sound deceptively simple but it is not. For example, small changes in boundary conditions can lead to dramatic changes in behaviour that are far from easy to understand.

The challenges that ICTP faces today are vastly different from those the Centre faced at its inception. How should ICTP respond to these challenges?

If you read some of the speeches that ICTP's founding director, Abdus Salam, gave during the 1960s and 1970s, you come across passages praising the Soviet Union's scientific enterprise and suggesting that other nations, particularly developing nations, carefully examine those efforts for guidance in designing their own scientific enterprises. Salam, of course, was not the only person expressing this opinion. The same argument today would carry less weight. You simply cannot talk about science organisations in the same political and social context in which they were debated 30 or 40 years ago. Nevertheless, when ICTP was launched, the cold war was in full tilt and the Centre served as a forum where fruitful East-West exchanges took place. Now the scientific community faces challenges that sometimes have a similar slant: most notably, the inability of scientific communities to interact because of political and diplomatic circumstances beyond their control. For example, scientists working in universities and government research laboratories in the United States would like to interact with scientists from Iran at conferences and other events. But such interaction has proven difficult because of the severed diplomatic relations between the two nations. There is no reason why ICTP could not serve as a bridge between the scientific communities in these two nations in much the same way that it served as a bridge between the East and West during the cold war. ICTP's first and foremost functions must be to do and develop good physics, but in the process it can serve as a facilitator promoting mutual understanding among nations, especially those that are isolated from, and suspicious of, one another. On another front, when ICTP was created some 40 years ago, the state of science throughout the developing world was not advanced. Today the situation is different. Some countries, like South Korea, have done very well. China and India, for example, have a few scientific institutions that rank among the best in the world. Yet, the quality of basic science in these same countries is still far from uniform, and has actually declined in some instances. Some other countries have done worse. As a result, today, there is no single strategy for promoting science in the South, and ICTP has to devise different innovative policies for different countries. Whether we should target some countries and work more diligently with them may be something to consider. I am not sure this is the best way to proceed but it is unrealistic to think that one can elevate every country to a high level of scientific excellence in a short time. We must understand the needs of different countries and devise different strategies. If history is any guide, the Centre can make a tremendous difference, and I look forward to being part of this effort.□

The full text of the interview may be found at www.ictp.trieste.it/~sci_info/News_from_ICTP/index.html.

Marcelo Magnasco, who recently joined ICTP's condensed matter physics group, has spent the past decade exploring biological and physical phenomena behind our sense of hearing.

Hear Here

When we hear a songbird sing, the melodious sounds often generate warm gentle emotions. Sweet-sounding sounds have the ability to do that to us.

However, when a songbird hears another songbird sing, the emotions and reactions are often much more significant.

"Song for a songbird is a matter of life and death. The harmonious sounds that they make are used, for example, to signal territorial rights and sexual intentions," says Marcelo Magnasco, who joined ICTP's condensed matter physics group last August after spending the previous decade with Rockefeller University in New York City. "Male songbirds often sing continuously for two or three hours before mating to show their potential partner their fitness for fathering birdlings."

Despite vast differences in purpose and reaction, hearing among songbirds and humans have this much in common: Both must somehow transform sound waves into nerve signals that can be received and interpreted by the brain.

"Hearing," explains Magnasco, "is in many ways the least well understood of our senses. We can produce technological analogues of our sense of sight in cameras, and of our sense of smell in detectors. But, except for implants that operate only at marginal efficiency, we have yet to produce a technological analogue for our hearing organ—the cochlea."

Magnasco's research, which he has conducted in partnership with biologists and physicists (both theorists and experimentalists), has sought to expand our understanding of how organisms hear what they hear and respond to those sounds in particular and predictable ways.

"Only a very few organisms in addition to humans have the ability to learn and replicate 'meaningful' vocalised sounds," notes Magnasco. "Whales, dolphins, and songbirds such as canaries, hummingbirds and zebra finches are among those in this select group."

He and his colleagues chose to study songbirds for obvious reasons. "Transporting whales into our laboratory to examine their brain's neuron-firing patterns and the biological and physical dynamics that drive their sense of hearing," Magnasco wryly notes, "would be a difficult task."

One research project conducted by Magnasco and his colleagues has shown that the wide range of tonal sounds generated by songbirds is due to a complex series of behavioural and physiological responses that begin with a songbird's ability to alter the pressure and velocity of the air passing through its vocal organ, the syrinx. The syrinx, in turn, channels the air to the songbird's two bronchial passages just where these passages meet the windpipe. The labia or tissue flaps that lie between the bronchial passages and windpipe vibrate in response to the air current. A diverse set of melodious tunes is created by the joint action of the pressure created in the syrinx and the stiffness of the labia. Think of the syrinx as the body of a clarinet and the labia as the reed. By manipulating the two, a songbird can croon a wide variety of songs.

In another research project, Magnasco and a group of researchers investigated how songbirds can distinguish between sounds that have a similar pitch and tone but originate from different sources—for example, the same tune made by a bird and imitated electronically. "When songbirds hear another songbird sing, our laboratory research reveals intense neural firings and brainwave activity in specific locations. When the sound is reproduced electronically, no neural firing takes place in the same locations."

Clearly, songbirds know the difference. Or, more accurately, songbirds recognise and respond to a 'real' song sung by a 'real' songbird but do not respond to the same song when it is 'artificially' replicated. As science writer Henry Gee commented in *Nature*, these research findings raise intriguing questions about whether what we hear is

actually taking place or is solely a reflection of what we are genetically predisposed and trained to hear.

But the most noteworthy research Magnasco has been involved in—research that has attracted widespread attention in both the scientific and popular press—has challenged some basic assumptions concerning the dynamics behind our sense of hearing.

This research has drawn not only on laboratory studies examining brain wave behaviour in songbirds, but also on a deep understanding of theoretical physics applied to studies examining how a mammal's spiral-like hearing organ—the cochlea—may function.

Historically, scientists believed that the cochlea passively absorbed sound waves, transformed the waves into nerve impulses, and then electronically transmitted the impulses to the brain in a step-by-step linear process.

Magnasco, however, has been involved in a series of research initiatives showing that the cochlea doesn't just passively accept and then transmit sound waves to the brain, but actually modulates the waves much like a public address system mixes together the original sound and its feedback. Or, to change the metaphor, much like a turbo engine uses the pressure created by the flow of its exhaust gases to compress the gasoline/oxygen mix.

"The result," Magnasco explains, "is that faint sounds detected by the cochlea are amplified, which may explain why mammals, among all organisms, have the capability to hear faint tones. Conversely, when the sound waves reach a high screeching pitch, the cochlea has the ability to narrow the sound waves into a reasonable range that can be tolerated and interpreted by the brain."

Magnasco's research has continually blurred the boundaries between disciplines, particularly between physics and biology. Trained as a theoretical condensed matter physicist at the University of Chicago, USA, his knowledge and understanding of biology and neuroscience has been acquired largely through intricate laboratory experiments and studies involving songbird brain tissue to determine how a songbird's brain reacts to acoustic stimuli. It has been a form of on-the-job training that has allowed Magnasco to cross disciplines without being labelled a renegade by physicists or an intruder by biologists.

Magnasco realises that the vastly different mindsets that have shaped the study of physics and biology have kept the two disciplines far apart. But several recent developments may now be driving the two closer together, particularly in the study of such phenomena as the dynamics of hearing, which involves a deep understanding of many different fields of inquiry.

"First," Magnasco notes, "the sheer volume of data and information related to biological phenomena, made possible by electronic data collection, renders it useful—and perhaps imperative—to develop overarching principles and perhaps models that can help provide a framework for deciphering information that may otherwise become overwhelming. Physicists, who are trained to develop and use theories and models, could assist biologists in making more effective use of the information they acquire and in uncovering connections that may be overlooked."

"Second," Magnasco observes, "physicists have shown an increasing interest in applying their skills in areas beyond the conventional boundaries of their discipline. And third, both biologists and physicists (and, for that matter, chemists and neuroscientists) increasingly recognise that the most advanced research in their fields is taking place not within but across disciplines."

In fact, teams of researchers trained in a wide range of fields are opening new scientific frontiers and pathways of understanding. That is exactly the strategy that has been applied by the diverse teams of researchers that Magnasco has worked with in studying the complex dynamics associated with the sense of hearing. If the scientific community's enthusiastic response to this research is any indication, then people are certainly listening.□

Marcelo Magnasco

DATELINE

Crystal Clear

Sivaramakrishna Chandrasekhar, founder and now director emeritus of the Centre for Liquid Crystal Research, Bangalore, India, helped organise a meeting on discotic liquid crystals, held at ICTP, on 25-29 November 2002.

More than an organiser, Chandrasekhar attended the meeting as an honoured guest. That's because some 25 years ago, Chandrasekhar published a 'pathbreaking' paper in the Indian physics journal *Pramana*, reporting the first synthesis of discotic liquid crystals.

Such crystals display unique part-liquid/part-solid 'mesophases.' Chandrasekhar's team found that these disc-like molecules, which he prefers to describe as poker chips, could be ordered as columns in a two-dimensional hexagonal lattice that is crystal-like (solid) in its horizontal direction, but liquid-like in its vertical direction. As a result, discotic liquid crystals embody a blend of stability (solidness) and fluctuation (liquidness).

Opening up a new liquid-crystal class, distinct from those arising from previously known rod-like molecules, his discovery has attracted increasing interest over the past decade. It is now estimated that as many as 3000 discotic molecules have been created in laboratories worldwide and that an even larger number of scientific papers have been written on the subject.

In addition to conference presentations by scientists from Cambridge University (UK), the Max Planck Institute (Germany), the University of Bologna (Italy), Shinshu University (Japan), the Weizmann Institute of Science (Israel) and the Naval Research Laboratory (USA), work presented by Fuji Co.'s industrial lab indicated growing interest in applications of discotics—for example, in liquid crystal computer displays.

Elected a fellow of the Royal Society and a recipient of many other honours, Chandrasekhar nevertheless has remained steadfastly modest. While delighted to see his molecules arousing such widespread interest, he still prefers to focus on their fascinating behaviour rather than their potential applications in the world of high technology.

"My attitude," says Chandrasekhar, "hasn't made me a rich man, but it has made me a happy one. I've been able to fulfill the dream of discovery. No scientist could ask for more."

Nobels in Trieste

Three of this year's Nobel Laureates have participated in ICTP activities. **Masatoshi Koshiba** (Japan), Nobel prize winner in physics whose first visit to ICTP took place in 1987, last lectured at the Centre at the Fifth School on Non-Accelerator Particle Astrophysics in 1998; **Kurt Wüthrich** (Switzerland), Nobel prize winner in chemistry, lectured at the College in Biophysics in 1992, 1994, and 1996; and **Sydney Brenner** (UK), Nobel prize winner in medicine, lectured at the Symposium on Contemporary Physics in 1968, one of the seminal events in ICTP history.

Masatoshi Koshiba at ICTP 1998

Kurt Wüthrich at ICTP 1992

Sydney Brenner at ICTP 1968

Sir Paul Nurse

Sir **Paul Nurse**, one of the 2001 Nobel Laureates in medicine and recently appointed president of The Rockefeller University, USA, visited Trieste's international scientific institutions on 11 October. Sir Paul met ICTP acting director Erio Tosatti, and officials from the *ELETTRA* synchrotron light laboratory and the International School of Advanced Studies (SISSA), where he held a lecture on "controlling the fission yeast cell cycle."

Volvo Prize

Sir **Partha Dasgupta** and **Karl-Göran Mäler**, the two primary organisers of the ecological economics research and training activity hosted by ICTP, have been awarded the Volvo Prize for their contributions to environmental and resource economics. The prize carries a cash award of US$150,000. Dasgupta, a native of India, is professor of economics at the University of Cambridge, UK. Mäler is professor of economics at the Stockholm School of Economics and director of the Beijer International Institute of Ecological Economics, Sweden. (See *News from ICTP*, "Valuing Nature Through Science," Summer 2002, pp. 4-5.)

ICTP Prize 2002

Mohit Randeria, associate professor, Tata Institute of Fundamental Research, Mumbai, India, has been awarded the 2002 ICTP Prize in the field of condensed matter physics. Randeria is one of the world's foremost experts in high temperature superconductivity and strongly correlated electron systems. His most noteworthy contributions involve the development of a theory of non-Fermi liquid behaviour of high-Tc superconductors and a theoretical interpretation of experiments on the pseudogap state in high-Tc superconductors. His article on the latter subject, published in *Nature* in 1996, has been cited 600 times. The prize is being given in honour of Nobel Laureate Philip W. Anderson, a long-time friend of ICTP.

ECO Award

The Economic Cooperation Organization (ECO) recently honoured former ICTP Associate **Riazuddin** for his life-long contributions to science and technology in Pakistan and southeast Asia. The ceremony took place in October at ECO's 7th Summit Meeting in Istanbul. ECO, whose membership includes Afghanistan, Azerbaijan, Iran, Kazakhstan, Kyrgizstan, Pakistan, Tajikistan, Turkey, Turkmenistan and Uzbekistan, is dedicated to regional economic development and co-operation. Riazuddin, a distinguished theoretical physicist whose affiliation with ICTP dates back to the Centre's earliest days, is director of the National Centre for Physics (NCP) in Pakistan.

Honouring Narasimhan

ICTP and SISSA (International School for Advanced Studies) co-organised a Colloquium on Geometry to celebrate the 70th birthday of **Mudumbai S. Narasimhan**, former head of the ICTP mathematics group and presently a visiting professor at SISSA. The meeting took place from 2-6 December in the ICTP Main Lecture Hall, where international experts presented a series of lectures on topics related to Narasimhan's contributions to the fields of algebraic and differential geometry. Born in a rural village in southern India, Narasimhan served as professor of mathematics at Tata Institute of Fundamental Research in Mumbai for more than 25 years. ICTP's founding director, Abdus Salam, recruited Narasimhan to work at the Centre in 1992, where Narasimhan served as head of the mathematics group until 1998 and subsequently as a consultant. He was elected a fellow of the Royal Society in 1996.

New Staff

Two new staff members have joined ICTP's physics of weather and climate group. German-born **Fred Kucharski**, a visiting scientist at ICTP for the past two years, previously held a postdoc at Reading University's Meteorological Department, UK, and served as a staff member of the meteorological office in Bracknell, UK. His main area of research focusses on global climate variability in timescales ranging from months to decades—research that includes such phenomena as El Niño/Southern Oscillations (ENSO) and North Atlantic Oscillations (NAO). Kucharski earned his Ph.D. at the University of Frankfurt's Institute of Meteorology and Geophysics. Chinese-born **Xunqiang Bi**, who earned his Ph.D. at the Chinese Academy of Sciences' Institute of Atmospheric Physics (IAP) in Beijing, enjoyed a brief tenure as a visiting scientist at the State University of New York at Albany (USA) and worked at IAP's Laboratory of numerical modelling for Atmospheric Sciences and Geophysical fluid dynamics (LASG). Since 1998, he has been a visiting scientist at ICTP, where his research has focussed on regional climate simulation in East Asia, Europe, and Africa.

NEWS FROM ASSOCIATES

ICTP Senior Associate (2001-2005) **A.K.M. Azharul Islam** has been appointed vice-chancellor of the International Islamic University, Chittagong, Bangladesh. In 2001, Azharul Islam was awarded the Islamic Educational, Scientific and Cultural Organization (ISESCO) Science Award for his wide-ranging contributions to physics. His current fields of interest include electronic and structural properties of solids and superconductivity.

ACTIVITIES

ROUND TABLE ON DEVELOPING COUNTRY ACCESS TO ON-LINE SCIENTIFIC PUBLISHING: SUSTAINABLE ALTERNATIVES

4 - 5 October

Gabriel Olalere Ajayi

Ahmadou Wague

Co-sponsors: International Council for Science (ICSU, Paris, France), International Union of Pure and Applied Physics (IUPAP), Third World Academy of Sciences (TWAS, Trieste, Italy), United Nations Educational, Scientific and Cultural Organization (UNESCO, Paris, France), and World Innovation Foundation (WIF, Huddersfield, UK).

Local Organisers: E. Canessa (S&T Collaborium, Trieste, Italy) and H. Cerdeira (ICTP).

WORKSHOP ON ENHANCED ENERGY SYSTEM ANALYSIS FOR SUSTAINABLE DEVELOPMENT

7 - 18 October

Co-sponsor: International Atomic Energy Agency (IAEA, Vienna, Austria).

WORKSHOP ON TETHYSIDES STRUCTURE AND EVOLUTION

12 - 15 October

Directors: B. Mitchell (Saint Louis University, Missouri, USA) and G.F. Panza (University of Trieste and ICTP).

WORKSHOP ON ADVANCED NUCLEAR POWER PLANT SIMULATION

14 - 25 October

Co-sponsor: International Atomic Energy Agency (IAEA, Vienna, Austria).

Directors: G. Bereznai (Ontario Institute of Technology, Oshawa, Ontario, Canada), W.K. Lam (CTI Simulation International, USA/Canada), R. Lyon (IAEA), C. Po (Microsimulation Technologies, Montville, New Jersey, USA), N. Tikhonov (Moscow Institute for Physics and Engineering, Moscow, Russian Federation) and S. Vigovsky (Moscow Institute for Physics and Engineering).

Local Organiser: B. Stewart (IAEA/ICTP).

WORKSHOP ON QUANTUM INFORMATION AND QUANTUM COMPUTATION

14 - 25 October

Directors: D. Di Vincenzo (IBM Thomas J. Watson Research Center, Yorktown Heights, New York, USA), GC. Ghirardi (University of Trieste and ICTP) and M. Rasetti (*Politecnico di Torino*, Turin, Italy).

Local Organiser: GC. Ghirardi.

JOINT ICTP-INFM SCHOOL/WORKSHOP ON ENTANGLEMENT AT THE NANOSCALE

28 October - 8 November

Co-sponsors: Department of Physical and Chemical Methodologies (DMFCI) of Catania University's Faculty of Engineering (Catania, Italy), National Enterprise for Nanoscience and Nanotechnology of the National Institute for the Physics of Matter (NEST-INFM, Italy), and *Scuola Normale Superiore*, Pisa, Italy.

Directors: G. Falci (University of Catania), F. Hekking (*Centre National de la Recherche Scientifique*, CNRS, and *Université Joseph Fourier*, Grenoble, France) and V. Pellegrini (NEST-INFM and *Scuola Normale Superiore*).

Local Organiser: V. Kravtsov (ICTP).

SEVENTH COLLEGE ON MICROPROCESSOR-BASED REAL-TIME SYSTEMS IN PHYSICS

28 October - 22 November

Directors: A.S. Induruwa (University of Kent, Canterbury, UK), U. Raich (CERN, Geneva, Switzerland) and C. Verkerk (formerly CERN).

II WORKSHOP ON WEB ENABLING TECHNOLOGIES FOR SCIENTISTS

11 - 20 November

Co-sponsor: Department of Theoretical Physics of the University of Trieste.

Directors: E. Canessa (ICTP) and G. Pastore (University of Trieste).

WORKSHOP ON THEORETICAL PLASMA PHYSICS

11 - 22 November

Directors: A. Ferrari (University of Turin, Italy) and S.M. Mahajan (Institute for Fusion Studies, University of Texas at Austin, USA).

FIRST EUROPEAN WORKSHOP ON MathML AND SCIENTIFIC e-CONTENTS

21 - 22 November

Co-sponsors: Department of Theoretical Physics of the University of Trieste, Xmath project of Buskerud University College (Kongsberg, Norway), and OpenSource working group of the Italian Association for Informatics and Automatic Calculus (AICA, Milan, Italy).

Directors: E. Canessa (ICTP), G. Pastore (University of Trieste) and O. Bringslid (Buskerud University College).

ICTP MICROPROCESSOR LABORATORY ASIAN COURSE ON ADVANCED VLSI DESIGN TECHNIQUES USING A HARDWARE DESCRIPTION LANGUAGE Quezon City, The Philippines

25 November - 13 December

In co-operation with *Ateneo de Manila* University (Quezon City, The Philippines).

Director: A.A. Colavita (ICTP). A. Cicuttín (ICTP) was head of laboratory exercises.

Local Organiser: R. San José Reyes (*Ateneo de Manila* University).

THIRD INTERNATIONAL SCHOOL ON ATMOSPHERIC RADAR, ISAR-3

25 November - 13 December

Co-sponsors: Scientific Committee on Solar Terrestrial Physics (SCOSTEP) and International Union of Radio Science (URSI, Ghent, Belgium).

Directors: J. Röttger (*Max-Planck-Institut für Aeronomie*, Katlenburg-Lindau, Germany) and D. Narayana Rao (Sri Venkateswara University, Tirupati, India).

Local Organiser: S. Radicella (ICTP).

A COLLOQUIUM ON GEOMETRY, IN HONOUR OF M.S. NARASIMHAN, ON THE OCCASION OF HIS 70TH BIRTHDAY

2 - 6 December

Co-sponsor: International School for Advanced Studies (SISSA, Trieste, Italy).

Scientific Committee: A. Beauville (*Université de Nice Sophia-Antipolis*, Nice, France), U. Bruzzo (SISSA), B. Dubrovin (SISSA), L. Göttsche (ICTP) and C.S. Seshadri (Chennai Mathematical Institute, Chennai, India).

MONITOR

UN Day

For the second consecutive year, ICTP celebrated **UN Day** on 24 October. Trieste's other international scientific institutions—including the Third World Academy of Sciences (TWAS), the International Centre for Genetic Engineering and Biotechnology (ICGEB), the International Centre for Science and High Technology (ICS), and the InterAcademy Panel on International Issues (IAP)—joined in the festivities. Among the dignitaries attending the event were Roberto Dipiazza, mayor of Trieste; Vincenzo Grimaldi, prefect of Trieste; and ambassador Francesco Caruso, Italy's permanent representative to the United Nations Educational, Scientific and Cultural Organization (UNESCO). Highlights included a brief video message by UN Secretary General Kofi Annan; the awarding of long-service medals to ICTP staff; a photographic exhibit focussing on scientists of Trieste's institutions; and an evening concert held at *Teatro Verdi* in downtown Trieste.

In Dubai

More than 400 diplomats and scientists met in Dubai, United Arab Emirates, on 27-30 October 2002, for the first-ever Group of 77 High-Level Conference on Science and Technology. ICTP sponsored a multimedia exhibit and a booklet describing the Trieste System, a unique network of international scientific institutions headquartered in Trieste that focusses much of its research and training activities on scientific capacity building in the South. The Third World Academy of Sciences (TWAS) organised the conference's three scientific workshops on information technology, biotechnology, and applications of appropriate technologies for greater access to safe drinking water. With 134 members, the G-77 serves as the primary voice for developing countries within the United Nations system. The booklet can now be browsed on the web at www.triestesystem.it.

Venezuelan Visit

The deputy minister of science and technology of Venezuela, **Rudolf Römer**, visited ICTP on 24-25 October. He attended the UN Day celebrations and met ICTP acting director Erio Tosatti and acting director of administration Gallieno Denardo to discuss potential strategies for improving the co-operation between Venezuelan scientists and the Trieste System.

World Heritage

Thomas Lovejoy

ICTP served as the host of the UNESCO World Heritage Workshop, "Partnerships for Nature and Biodiversity Conservation," on 11-12 November. The Trieste workshop was one of nine workshops held throughout Italy designed to celebrate the 20th anniversary of UNESCO's World Heritage Programme. Walter Erdelen, UNESCO assistant director general for the Natural Sciences Sector, and Thomas Lovejoy, president of the Heinz Center, USA, were among those participating in the Trieste workshop. The week-long event culminated in an international conference held at UNESCO's regional office in Venice.

Walter Erdelen, UNESCO, Roberto Dipiazza, mayor of Trieste, and Erio Tosatti, ICTP acting director.

System Impact

Roberto Antonione, Italy's deputy foreign minister, met with representatives of the Trieste System, including ICTP acting director Erio Tosatti, on 8 November. At the meeting, which took place at ICTP, Antonione emphasised the important diplomatic and cultural impacts that the Trieste System has had on the global scientific community. He expressed his support for continuing to have the System serve as the primary reference point for the Italian government in its efforts to help scientists from Third World countries.

Retirements

Yu Lu, long-time head of the condensed matter physics group who retired from ICTP last year, has returned to his home country of China to join the Institute of Theoretical Physics' Interdisciplinary Centre of Theoretical Studies (ICTS), which is part of the Chinese Academy of Sciences. His departure followed a 'farewell party' attended by Centre scientists and staff who thanked him for his years of dedicated service to ICTP and wished him well in his future endeavours.

Concetta Mosca, long-time clerk of the Diploma Course, has recently retired. For the past 11 years, Concetta has provided practical assistance and 'motherly' help to the more than 250 students who have participated in the Diploma Course programme. Scientists and staff extend to Concetta warm thanks for her many years of service and wish her well in her retirement.

Hungarian Choir

Pecsi Kamarkorus, a renowned Hungarian chamber choir consisting of professors, physicians and students, performed at the Kastler Lecture Hall in the Adriatico Guesthouse on 16 November. Tillai Aurel, professor emeritus at the University of Pecs, directs the choir.

Women and Peace

"Women and Peace," an international contemporary art exhibition organised by the ICTP Cultural Committee, was held at the Adriatico Guesthouse from 11-20 December 2002. The exhibition featured paintings by 10 women artists from Austria, China, Germany, Holland, Italy and Yugoslavia.

IN MEMORIAM

Per Bak, a Danish theoretical physicist who was one of the founders and most influential contributors to the study of complex systems, died last October. He was 54. Bak had served as a professor of physics at Imperial College, London, UK, since 2000. His most important contribution to science was a general theory of self-organisation, which he labelled self-organised criticality, that shed light on the behaviour of such disparate phenomena as earthquakes, forest fires and stock-market prices. In 1996, Bak wrote *How Nature Works*, which received broad public attention and was translated into several languages. Bak, who visited ICTP on several occasions, last came to Trieste in May 2002 to participate in the Workshop on Self-Organized Criticality and Phase Transitions in Driven Systems.

Bunji Sakita, a mentor of former ICTP director Miguel A. Virasoro, died on 31 August after a lengthy illness. He was 72. Sakita's first visit to Trieste took place in 1967 and his last just a year before his death. Sakita, who received his Ph.D. from the University of Rochester, New York, was teaching at the University of Wisconsin when Miguel Virasoro joined the university's physics department as Sakita's first postdoc. At Wisconsin, Virasoro conducted research that led to the concept of 'Virasoro algebra.' Sakita subsequently moved to the City College of New York, where he remained until his retirement. His contributions to physics range from the SU(6) unification in the 1960s, to the first linear realisation of supersymmetry in the 1970s, to the large N-expansion via collective co-ordinates in the 1980s, to the quantum Hall effect in the 1990s.

René Thom, an internationally renowned French mathematician honoured for his breakthrough 'catastrophe' theory, died at his home at Bures-sur-Yvette, near Paris, on 25 October. He was 79. During World War II, Thom studied at the *Ecole Normale Supérieure* in Paris, then moved to Strasburg, to continue to work with Henri Cartan. After visiting the United States in 1951 (where he met Albert Einstein), Thom was appointed professor at the *Institut des Hautes Etudes Scientifiques* at Bures-sur-Yvette. There, he developed a mathematical description of situations that gradually change forces and, over time, lead to so-called catastrophes or abrupt changes. In 1958, Thom received the Fields Medal for his efforts. He visited ICTP in 1983 and again in 1988.

Master's student Viktoriya Victorovna Semeshenko has travelled widely both with her family and on her own. The one constant in all of her journeys has been her interest in science.

Home and Away

When Viktoriya Victorovna Semeshenko arrived in Trieste from Uzbekistan in early autumn 2001 to begin the ICTP/SISSA (International School for Advanced Studies) Joint Master's Degree Programme in Modelling and Simulation of Complex Realities, it marked her first trip abroad without her family. But that didn't mean she wasn't well-travelled. Indeed Semeshenko has been on the move virtually her entire life.

Born in Minsk, the capital city of Belarus, then a republic of the former Soviet Union, Semeshenko was just one year old when in 1980 her family moved to Potsdam, then in East Germany, not far from Berlin.

"My father was in the Soviet Army but he has a degree in physics from Belarus State University. My mother too has a degree in physics from the same university and my brother is currently studying engineering. So science must be in my genes."

Semeshenko attended primary school in Potsdam. But in 1986 her family moved to Turkmenistan. Five years later they were on the road again, this time relocating to Tashkent, the capital city of Uzbekistan, another former Soviet republic. That's where her family still lives.

"During secondary school," she notes, "I was fond of biology. I did well on a special exam for students designed to gauge their aptitude in science. My score gave me an opportunity to take advanced courses in a wide range of scientific disciplines—biology, chemistry, mathematics and physics—that were given by professors from the University of Tashkent."

"At that time I wanted to become a biologist. I thoroughly enjoyed doing experiments in the school laboratory using microscopes, test tubes and other equipment."

But once the special courses in science began, Semeshenko's interest rapidly tilted towards the study of physics. "The physics courses were taught by a very special teacher, Semyon Efimovich Brener, who is now in Israel. Under his guidance, I became captivated by physics. I decided to major in it, instead of biology, in college."

In 1996 Semeshenko entered Tashkent State Technical University and concentrated her studies in electronics and microelectronics. She received her bachelor's degree in spring 2000 and entered the master's programme that fall. "Photovoltaic systems provided the general framework for my studies. My research, however, focussed specifically on modelling of particle behaviour using molecular dynamics method."

"Shortly before completing my master's degree," she recalls, "I came across an announcement for the ICTP/SISSA Joint Master's Degree Programme in Modelling and Simulation of Complex Realities posted on a bulletin board at my university. I decided to apply without telling my parents. Only after completing and sending off the form did I let them know of my intentions to continue my studies in a school thousands of kilometers from home. Although initially concerned about being so far from family and friends—after all, my family had travelled widely but never apart—both my mother and father expressed their encouragement and support."

Viktoriya Victorovna Semeshenko

Semeshenko arrived in Trieste in October 2001. Last summer, as part of her training, she participated in a work-study project to improve the reliability of smoke detectors using neural networks. Sponsored by the Trieste-based firm *Pittway Tecnologica*, her assignment was co-ordinated by Silvio Franz, a staff scientist in ICTP's condensed matter physics group (see *News from ICTP*, Autumn 2002, pp. 6-7). Semeshenko is now preparing her master's thesis on optimal control of quantum systems. Her advisor is Ugo Boscain, a researcher at SISSA, the Italian degree-granting institution that is based next door to ICTP and serves as a co-sponsor of the master's degree programme.

Since coming to Trieste, Semeshenko has found time to visit many Italian cities. She likes Florence most of all. This winter she broadened her travels to include a journey to Paris, which she found both beautiful and enchanting. She also visited Potsdam, returning to the house where she had lived with her family as a child. "It's where I began my education in primary school. It was interesting to think about how far my educational journey has taken me and how much farther I will need to go to reach my ultimate destination."□

16 - 18 January
Eleventh International Workshop on Computational Physics and Material Science: Total Energy and Force Methods

16 January - 4 February
Winter College on Numerical Methods in Electronic Structure Theory

27 January - 28 February
School on Ecological Economics and Conference on Theoretical Topics in Ecological Economics

3 - 21 February
School on Radio Use for Information and Communication Technology

10 - 21 February
Winter College on Biophotonics: Optical Imaging and Manipulation of Molecules and Cells

3 - 21 March
College on Soil Physics

24 - 28 March
Conference on Monsoon Environments: Agricultural and Hydrological Impacts of Seasonal Variability and Climate Change

31 March - 8 April
Spring School on Superstring Theory and Related Topics

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 2003`
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 automatic replies containing all documentation available on that particular activity.

(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. K.R. Sreenivasan 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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