NEWS from ICTP

the
abdus salam
international centre for theoretical physics

SUMMER 2003

#105

Joseph Niemela
ICTP Fluid Dynamics Group

WHAT'S NEW

It's a long way from Oregon to Italy. But now that ICTP's newest staff member, Joseph Niemela, has arrived, he plans to stay for a while.

Trail to Trieste

'Enjoy your visit...but don't stay!' No, this was certainly not my welcome here in Trieste, Italy, but three decades ago it was oddly the official 'greeting' in the place where I am from—the state of Oregon in the Pacific Northwest, USA—defiantly delivered by our conservationist and governor Tom McCall in a red-hot campaign against the private development of Oregon's scenic lands.

Nothing defines a place like its politics. That the *liberal* McCall belonged to the *conservative* Republican party of then-president Richard Nixon is not atypical at all of Oregon, and only confirms the conventional thinking: that Oregonians of all stripes are unabashed nonconformists.

Joseph Niemela

Oregon—a land of very tall trees and very unconventional citizens—marks the beginning of a long journey for myself, and a shipment of scientific equipment, some of it shown still crated in the accompanying picture.

The centrepiece of this shipment is a relatively massive low-temperature apparatus, nominally operating at about 5 degrees Kelvin above absolute zero, and designed to investigate buoyancy-driven turbulence in a one-meter tall layer of helium gas heated from below.

Why so big, so cold, and, well, so unconventional? Simply put, cryogenic helium gas is, by far, the optimum working fluid for producing intense thermally generated turbulence under controlled laboratory conditions. Likewise, sample heights as large as possible are desirable.

Thus was born this super-sized refrigerated experiment—lovingly called 'the beast' by its operators—designed to aggressively push the frontiers of laboratory turbulence research.

Indeed, beyond the frontiers of this experiment lies a larger purpose: to broaden our understanding of turbulent convection, a ubiquitous flow that plays a prominent role, for example, in the energy transport within stars, atmospheric and oceanic circulations, the generation of the Earth's magnetic field, and innumerable engineering processes in which heat transport is a key factor. More generally, fluid turbulence is a paradigm for nonlinear systems far from equilibrium, with many interacting degrees of freedom. Loosely analogous problems range from weather to fluctuating stock markets.

Experiments will be conducted at Trieste's Elettra Synchrotron Laboratory, in collaboration with ICTP's director, Katepalli R. Sreenivasan. We anticipate that this new research initiative will include close interactions with other groups at ICTP and elsewhere both here in Trieste and beyond. And because many fluid mechanics problems have the advantage of minimal equipment costs and relatively rapid scientific progress, the intellectual challenges these problems pose fit well with ICTP's historical mandate to help scientists from the developing world acquire the knowledge and skill they need to participate in global science.

I am grateful for the warm personal welcome I have received since arriving at ICTP and the fact that the Centre operates within such a vibrant scientific atmosphere. Contrary to my contrarian Oregonians, I've 'enjoyed the visit and plan to stay.' □

Faheem Hussain
ICTP High Energy Physics Group

COMMENTARY

A recent meeting in the Black Sea resort town of Varna marked a warm reunion between two old friends: ICTP and Bulgaria's physics community.

Physics on the Black Sea

Much more renowned for its beautiful coastline on the Black Sea than for its elegant studies of black holes, Bulgaria is nonetheless a nation with a surprisingly strong tradition of excellence in theoretical physics.

Indeed the nation has enjoyed a special relationship with ICTP dating back to the Centre's earliest days. Two of the nation's most prominent physicists—M.D. Mateev, who later became minister of education, and T.D. Palev, with the Bulgarian Academy of Sciences—first visited ICTP in the mid 1960s, soon after the Centre had opened its doors. Since then, there has been a steady stream of Bulgarian scientists coming to ICTP despite Bulgaria's isolation from the global scientific community, first during the Cold War era and later during the post-communist period of the 1990s.

For all of these reasons, it was indeed fitting that ICTP's Office of External Activities (OEA) served as one of the 'travel' sponsors for the Fifth International Workshop of Lie Theory and Its Applications in Physics, held in the picturesque Black Sea resort town of Varna, between 16 and 22 June 2003. The event was organised by the Bulgarian Academy of Sciences' Institute of Nuclear Research and Nuclear Energy. V.K. Dobrev, a prominent researcher with the Institute and frequent visitor to ICTP's High Energy Physics group, served as the lead organiser for the event, which was attended by about 60 scientists.

Lie groups, named after the famed Norwegian mathematician Marius Sophus Lie, are a distinct ubiquitous subset of groups arising in virtually all fields of mathematics and physics.

Groups themselves are fundamental tools of analysis for both physicists and mathematicians, helping to shed light on the endless symmetries inherent in nature that are present in something as delicate as a freshly fallen snowflake and as mysterious as a tightly wound multidimensional superstring.

When first discovered in the 1870s, Lie groups broadened our fundamental understanding of crystal structures and aided in the classification of particles. Today Lie groups play a critical role in studies of quantum groups, gauge field and noncommutative field theories, and supersymmetry. Such studies cross the boundaries between mathematics and physics. As a result, the workshop in Bulgaria served as an open forum where practitioners of both fields could meet to exchange their ideas and learn from one another.

Bulgarian science, including physics and mathematics, experienced a difficult period in the 1990s following the collapse of communism and the inevitable difficulties that arose from efforts to build a new society. Government funding, which had fuelled Bulgarian science during the Soviet era, was dramatically cut and the stability and respect that had been afforded the scientific community during the days of communist rule was lost to the whirlwind of change that took place throughout much of the decade.

Fifth International Workshop of Lie Theory and Its Applications in Physics

Such cataclysmic change disrupted all facets of life, reaching into the most remote corners of academia and scientific research. Yet fears of a mass migration of Bulgarian scientists (including its well-trained community of theoretical physicists) to the West never materialised. Many researchers, despite the personal and professional deprivations that they faced (draconian pays cuts, a dramatic deterioration in working conditions, and a future that for years looked bleaker than the present), stayed the course, deciding that living in their home country was a more alluring alternative than moving abroad.

One of the reasons Bulgaria's researchers decided to remain was the 'open door policy' of ICTP, which enabled them to spend at least a portion of their time in Trieste where they could continue their research and interact with their colleagues. Indeed Bulgarian physicists visited ICTP during the 1990s no less than 530 times, as the Centre continued to play its long-standing role as a 'home away from home' for scientists in need.

Today the situation in Bulgaria is improving—both for its citizens and its scientists. In a sense, the Lie theory meeting was one of a series of events designed to formally announce that the Bulgarian science community has reentered the global scientific community after an extended period of absence—a time when one of the few welcoming pathways to science in the West was provided by an old and dear friend: ICTP.

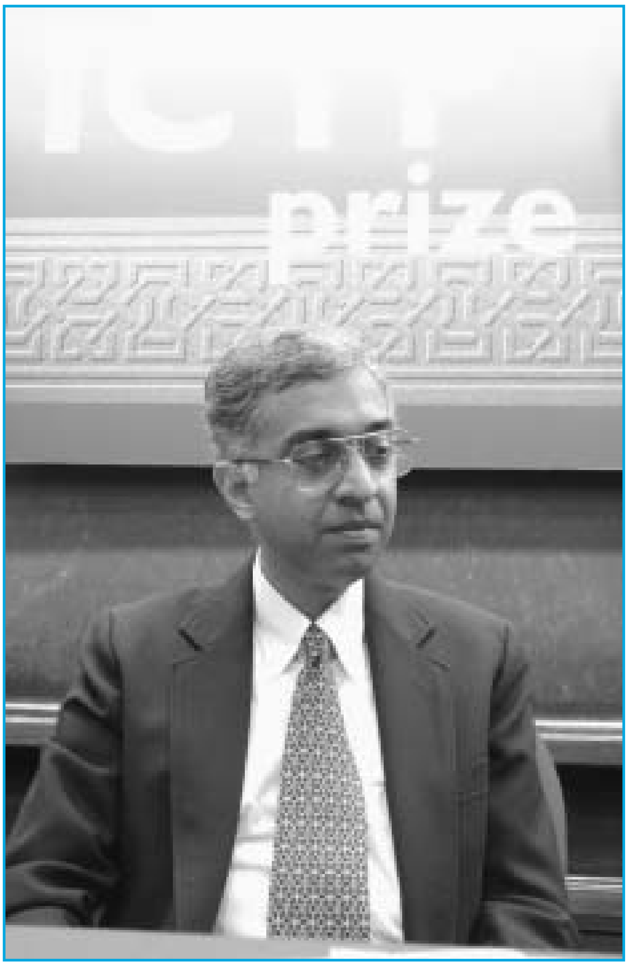
Mohit Randeria
Tata Institute of Fundamental Research, Mumbai, India

FEATURES

Mohit Randeria, winner of the ICTP Prize in 2002, which was given in honour of Philip W. Anderson, examines the 'mid-scale' world of condensed matter physics.

The Matter in the Middle

High energy physics, at the risk of oversimplification, represents the physics of the 'very small.' It's a field of physics where researchers probe matter at ever-smaller scales and ever-closer distances to better understand the intricate yet elegant laws of nature.



Mohit Randeria

Astrophysics and cosmology, on the other hand, represent the physics of the 'very large' where researchers seek to understand the forces of nature that drive and shape our seemingly endless universe.

Standing between these two 'physics poles,' at mid-scale so to speak, is condensed matter physics. Researchers in this subfield are concerned neither with the 'very small' nor with the 'very large.' Instead, they focus on matter at the human or 'macroscopic' scale, which literally means 'visible to the naked eye.' Put another way, the field of condensed matter physics is the study of the complex behaviour of mid-scale material systems comprised of many interacting particles or constituents.

The behaviour of individual particles that form the basis of study for condensed matter physics are now well understood. However, when a large number of macroscopic particles cross paths and interact, they show surprising, often unexpected, properties.

Condensed matter physicists have come to call such unexpected behaviour 'emergent properties'—professional jargon for the collective behaviour of biological and material systems that is qualitatively different than the behaviour of each of the system's constituent parts. The challenge for condensed matter physics, then, lies in understanding the complex emergent phenomena that are characteristic of interacting particles.

Let me give you an example. If you have a cluster of atoms in a confined field or system, under certain conditions, the atoms are a gas. However, if you cool the system, the gas may condense into a liquid. And if you cool it even more, it might solidify.

From the perspective of condensed matter physicists, such increasing rigidity is an emergent property. That's because the atoms themselves are not rigid but become so only after organising themselves in a particular manner—a phase transition that has been fostered by a particular set of conditions (namely, temperature and pressure).

Superconductivity, which allows an electrical current to flow through materials with no detectable resistance, is another emergent property. Individual electrons are not superconducting but they sometimes assume this property upon organising themselves in a certain manner under certain conditions. In other words, it's not the particles themselves but their interaction with one another that enables this pattern of behaviour to take shape.

Biology may offer the most spectacular example of emergent phenomena. Indeed the ultimate emergent phenomena are life and consciousness. That's because individual molecules don't exhibit life-like properties. It's only when complex assemblies of these molecules become a cell, that life is formed. And it's only when a complex assembly of cells becomes a human being that consciousness takes place.

Condensed matter physicists not only study complex interactive phenomena but also examine a vast diversity of systems—for example, granular matter or soft matter (sands, foams, fluids and proteins), and hard matter (metals, semiconductors, magnets and superconductors).

Condensed matter physicists, moreover, are often trained in departments other than physics—for example, materials science, chemistry and electrical engineering. Even within the discipline of physics itself, condensed matter physics overlaps with studies of biophysics, atomic physics, optics, and quantum field theory.

Finally, theories in condensed matter physics are not only explored for the intellectual challenges that they pose but also for the practical applications that may emerge from the theoretical frameworks which are created.

The best known application of theories in condensed matter physics has involved the development of semiconductors, the 'heart and soul' of computers.

Think of our world today. Now think of our world without computers. Although their widespread use dates back less than a quarter century, virtually no aspect of life, in either the North or South, would be the same without them. Certainly not communication. But the same is true of international politics, science, culture and entertainment.

Our lives have been touched and forever transformed by computers. Yet what we have come to call the 'computer age' in the eyes and minds of condensed matter physicists should be more appropriately called the 'semiconductor age.'

No semiconductors, no computers. No computers, no internet. No global communication and the world, as we know it in the early 21st century (both for better and worse), would be a different place. This is not a theory; it's a fact.

Direct applications of condensed matter physics research have led to enormous capital investments in the field. While the money is welcome, it sometimes obscures the reality that condensed matter physics carries enormous intrinsic intellectual content. Even my colleagues sometimes need to be reminded that such fundamental concepts in physics as symmetry breaking and renormalisation group theory grew from studies in condensed matter physics.

Given the enormous range of fields and materials covered by condensed matter physics, observers sometimes lose sight of the fact that this enterprise has an overarching theme and a common goal: that is, to gain insight into the emergent properties of complex materials and systems, and to understand, predict and control these unexpected behavioural patterns. That is what condensed matter physics—whether applied to the study of sandpiles or superconductors—is all about.

High temperature superconductivity, the field that I have concentrated on for the past 10 to 15 years, offers an excellent example of this general theme.

Scientists have known about the existence of *conventional superconducting materials* for about a century and have understood the intricacies of their behaviour for about 50 years. These conventional materials exhibit their unique property of zero resistance to electrical currents at about 10 degrees Kelvin—an extremely low temperature. By way of contrast, the temperature of the room in which you are reading this article is probably about 300 degrees Kelvin.

New high temperature superconducting materials, first uncovered by scientists about two decades ago, lose their resistance to electrical current at 100 degrees Kelvin, still cold but not nearly as cold conventional superconducting materials. Indeed these new materials display their unique zero-resistance qualities at temperatures 10 times warmer than their predecessors.

Why have the new superconducting materials commanded the attention of condensed matter physicists for the past two decades? One reason lies in their potential applications. For example, if scientists could find a way to produce superconducting high-tension transmission wires, electricity could be transported without line loss, saving money and improving reliability. That is likely a long way off; yet, superconducting materials are currently being used for filters in cell phone relay stations, helping to enhance the sound quality and minimise the breaks in transmission.

So, commercial applications of superconducting materials are emerging. Yet, regardless of such lucrative applications, there is another, equally important, reason for studying this subject: Before the emergence of research and studies on new superconductors, condensed matter physicists had developed a set of theories, ideas and even language to describe the behaviour of conventional metals and superconductors. Research into the new high temperature superconductors, however, has challenged conventional paradigms in the field by raising fundamental questions about how systems of strongly interacting electrons organise themselves into novel phases and give rise to unusual phase transitions.

I am sure that I speak not only for myself but for my colleagues as well when I say it is such intellectual challenges that have sparked our curiosity as scientists in the past and will continue to light the way in the future as we continue to uncover the mysteries of our natural world. □

Three pioneering scientists in the field of inflationary theory shared the Dirac Medal of the ICTP in 2002.

Universal Inflation

What exactly happened at the moment the universe was created some 14 billion years ago? Can we trace the universe's origins to a huge fireball that followed on the heels of the Big Bang?

Andrei Linde, a professor of physics at Stanford University, USA, and recipient of the 2002 Dirac Medal, has been one of the main architects of an alternative theory of the universe's origins—one based on inflation.

critical intellectual contributions to the theory. For this reason, Linde, Guth and Steinhardt shared the Dirac Medal of the ICTP in 2002.

Inflationary theory—a construct built on the power of intellectual insight and the elegance of mathematical analyses—has recently received a boost from observational science, thanks to 'cosmic' data collected by astronomical satellites and probes.

ICTP director Katepalli Sreenivasan with 2002 Dirac Medal winners Alan Guth, Paul Steinhardt and Andrei Linde

"The cosmos," he explains, "became exponentially large in the blink of an eye—an infinitesimal fraction of a second. Only then did the universe begin to evolve according to the standard 'post-bang' principles of the Big Bang—an endless process marked by cooling and slow, continual expansion."

Linde adds that he doesn't think "our universe is unique." In fact, he contends that an infinite number of ever-expanding universes, similar to the one in which we live, must exist and that each of these universes, in turn, is capable of spawning additional universes in a never-ending tale of cosmic proportions.

Linde has emerged as the most vocal proponent of inflationary theory. But he would be the first to admit that he is not alone in this effort. Indeed Alan Guth, Victor Weisskopf professor of physics at the Massachusetts Institute of Technology, and Paul Steinhardt, Albert Einstein professor of physics at Princeton University, USA, have also made

Linde, now 55, was born in the former Soviet Union, which was also the birthplace of inflationary theory. Alexei Starobinsky, a scientist at the Landau Institute of Theoretical Physics in Moscow, presented the first theory of inflation in 1979. However, the idea remained largely confined to a small group of Soviet cosmologists who, while well known in science circles within their own country, had only limited contact and visibility among their counterparts in western Europe and the United States.

Meanwhile, Linde received his doctorate degree in physics from the University of Moscow's Lebedev Physical Institute in 1974, focussing his dissertation on cosmological phase transitions. Based on the findings of his dissertation but first fully articulated in 1976, his notion that phase transitions experienced in a supercooled vacuum state may be sufficient to transform a cold universe into a hot one subsequently became a fundamental element of inflationary cosmology.

In 1981, Alan H. Guth, a postdoctoral student in physics at Cornell University, USA, devised his own inflationary model, independent of any knowledge of the work being done in the Soviet Union.

Indeed it was Guth who chose the word 'inflation' to describe the universe's exponential expansion in an infinitesimal moment (estimated to be 10 to minus 37 seconds). During this fleeting time, matter and energy, at first compressed into a space the size of a proton, filled the void that became the universe—creating on a cosmic scale the same dynamics that unfolds when an airbag is released inside an automobile.

Despite its elegance, Guth's theory contained several shortcomings. Seeking to refine and improve Guth's model, two other youthful American physicists, Andreas Albrecht and Paul Steinhardt, working together at the University of Pennsylvania, constructed yet another model of inflation and, in 1982, Linde began to offer his contributions to the field. One year after the fall of communism in 1989, Linde left for the United States, bringing the disparate strands of inflationary theory closer together.

What accounts for the growing force of inflationary theory within the larger field of cosmology? Part of its appeal is that the theory answers several difficult cosmological questions that remain unanswered by the Big Bang theory and therefore provides a more coherent framework for understanding how the universe began and evolved.

For example, why does the universe's broad landscape appear to be flat when Einstein's theory of relativity indicates that the universe should be curved? The answer? Inflationary theory holds that the universe is so large that we can see only a tiny portion of it. So, from our limited perspective, the universe seems flat when in reality it is curved.

Similarly, why have we not been able to detect primeval monopoles—particles with a single magnetic pole that theoretical physicists have concluded should be present in our universe? Again proponents of inflationary theory contend that the universe is so large that such particles may be literally lost in the vastness of space and thus beyond the 'detection' capabilities of our current instruments.

Finally, what accounts for the universe's homogeneity and isotropy at a large scale? Again proponents of inflationary theory have an answer. Inhomogeneous elements that were present before inflation were eliminated—or, as cosmologists prefer to say, were 'stretched' or 'ironed'—during the breathtaking fragmentary moment that led to the universe's creation. At the same time, inflation produced its own inhomogeneities resulting from small quantum fluctuations that rushed into the vacuum. Stars and galaxies emerged from these 'matter-and-energy' ripples.

"In the past," says Linde, "cosmologists could often only discuss their ideas as abstractions or philosophical musings. Today, however, we are able to probe the outer reaches of space to prove or disprove our theories. Even the harshest critics now acknowledge that our analytical description of the universe's origins is rooted more in science than science fiction. That's because cosmology's theories can increasingly be tested experimentally."

"Cosmologists," Linde is quick to add, "can no longer contend that a theory is right because it's beautiful and elegant, as sometimes happened in the past. Experimental data now plays a crucial role in our research, requiring us to prove that what we say may be true is, in fact, true."

Linde's personal observations about his work are backed by satellite observations in space. In 1992, for example, the US National Aeronautics and Space Administration's (NASA) Cosmic Background Explorer (COBE) satellite took the first 'pictures' of the energy remnants associated with the early universe—photos in the form of fossilised microwave radiation casting faint, frozen images lodged in an environment that existed when the universe was just 200,000 years old and its temperature decreased to about 3000 degrees Kelvin. Browsing through COBE's picture album you can gaze at the predicted elemental ripples of matter and energy from which new galaxies may be spawned in the future.

In 1999, the Boomerang mission over Antarctica, a scientific balloon experiment jointly managed by US and Italian space agencies and universities, enabled scientists to collect even more detailed data on the universe that seemed to confirm COBE's results. The data, however, was based only on a small patch of the universe and more surveys are currently underway to verify the Boomerang mission's findings.

Then, just a few months ago, NASA's Wilkinson Microwave Anisotropy Probe (WMAP), launched in 2001, provided a triumphant confirmation of inflationary theory through its recording of far-away detailed pictures of the remnants of the early universe that parallel theorists' concepts of what we might expect to find.

While Linde welcomes these emerging proofs of his theories, he has recently taken inflationary principles beyond their initial theoretical boundaries into new intellectual frontiers. He hypothesises that the entire universe may consist of an infinite number of inflationary balls that emerge one from another "much like a 'cosmic tree' that grows exponentially over time generating new seedlings that ultimately take root on their own."

"What I am proposing," he notes, "is the existence of a 'fractal-like,' self-reproducing inflationary universe in which each new universe abides by its own physical laws, creating—or denying—conditions that can support life as we know it within our own universe."

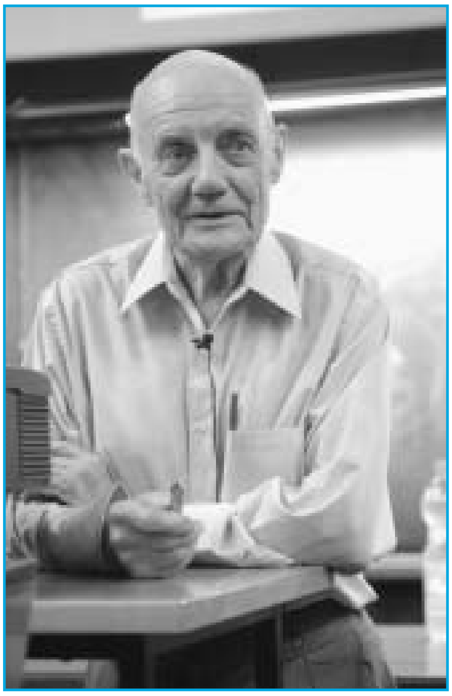
"The inflationary paradigm," Linde proudly notes, "is no longer an obscure segment of the Big Bang theory, which was the case just 20 years ago. On the contrary, the Big Bang theory has now become part of the inflationary model."

Inflationary theory's journey from the backstage to the centrestage of cosmology has made its most 'star' players—Guth, Linde and Steinhardt—worthy recipients of the Dirac Medal of the ICTP. ☐

DATELINE

In the News

Science carried a feature article on ICTP in its 11 April edition examining the key role that ICTP has played as a bridge between scientific communities—both North and South, East and West. The article also looked at the current and future challenges that the Centre faces. Meanwhile, *Nature* and *Physics World* published articles on the Workshop on Capacity Building for Academies in Countries with Predominantly Muslim Communities and Symposium on Science, Religion and Values, which took place on the ICTP campus on 5-7 March. The events were cosponsored by the InterAcademy Panel on International Issues (IAP), the Third World Academy of Sciences (TWAS), the US National Academy of Sciences, the Organization of the Islamic Conference's Standing Committee on Scientific and Technical Cooperation (COMSTECH) and the Islamic Educational, Scientific and Cultural Organization (ISESCO). For copies of the articles, please contact sci_info@ictp.trieste.it.



Nobel Chemist

John B. Fenn, who was awarded the Nobel Prize in chemistry in 2002, lectured at ICTP on 27 June at a Joint ICTP-Democritos Colloquium. His talk, "Electrospray Wings for Molecular Elephants," examined the scientific foundation and subsequent development of electrospray mass spectrometry (EMS), for which he won the Nobel Prize. The technique, which allows for the attainment of virtually fragmentation-free mass spectra of proteins and other macromolecules, has revolutionised many areas of chemistry and biochemistry. Born in 1917, Fenn is professor emeritus at Virginia Commonwealth University, Richmond, VA, USA.

SLAC Partner

ICTP's electronic Journals Delivery Service (eJDS) has signed a memorandum of understanding (MOU) with the Stanford Linear Accelerator Center's (SLAC) PingER project. The primary purpose of the MOU is to utilise the eJDS network for monitoring real-time connectivity patterns among research and educational institutions in developing countries. The joint project is a direct response to the recommendation made at the Round Table on Developing Country Access to On-Line Scientific Publishing: Sustainable Alternatives, held at ICTP in October 2002. For additional information about the PingER project, see www-iepm.slac.stanford.edu/pinger. For additional information about eJDS, see www.ejds.org.

New Staff Member

Ramadas Ramakrishnan has joined ICTP's Mathematics group. He assumed his position in May. Before arriving in Trieste, he was a professor at the Department of Mathematics, *Université de Montpellier II*, France and, for 25 years, a researcher at the Tata Institute of Fundamental Research, Mumbai, India. Ramakrishnan has also served as a researcher at the Institute for Advanced Study at Princeton, NJ, USA, and a visiting professor at the Massachusetts Institute of Technology, USA. His major research areas focus on the interface between geometry and physics. In 1988, he was awarded the Bhatnagar Prize of the Indian Council of Scientific and Industrial Research (CSIR), India's highest science award.

Prizes and Fellowships

Jean-Pierre Serre, honorary professor of algebra and geometry at the *Collège de France* in Paris, has won the first Abel Prize. The prize, sponsored by the Norwegian Academy of Science and Letters, is given to individuals for outstanding lifetime achievements in mathematics. Serre was honoured "for playing a key role in shaping the modern form of many parts of mathematics, including topology, algebraic geometry and number theory." **Jacob Palis**, professor of mathematics at the *Instituto Nacional de Matemática Pura e Aplicada* in Rio de Janeiro, Brazil, who has been on the ICTP Scientific Council since 1995, served on the five-member selection committee. The prize, which carries a cash award of € 750,000, is named in honour of the distinguished 19th century Norwegian mathematician Niels Henrik Abel. The prize ceremony took place at the University of Oslo in June.

The American Physical Society (APS) 2003 Prizes winners include two scientists who have had close association with ICTP.

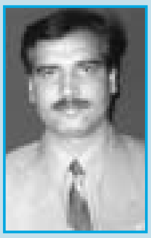
Frank Wilczek, recipient of the J.E. Lilienfeld Prize, was awarded the Dirac Medal of the ICTP in 1994.

Boris Altshuler, recipient of the O.E. Buckley Prize, is director of ICTP's training activities on mesoscopic physics.

APS also recently announced the selection of 192 new fellows. Forty-one of the new fellows—more than 20 percent of the total—have an affiliation with ICTP, including **Masatoshi Koshiba**, Nobel Laureate in physics 2002, who last visited ICTP in 1998, and **Alexei M. Tsvelik**, director of ICTP's workshops in strongly correlated electron systems.

NEWS FROM ASSOCIATES

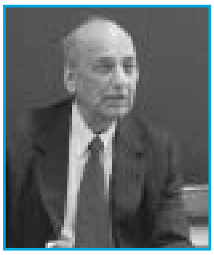
ICTP's senior associate **Panamalai Ramarao Parthasarathy**, professor, Department of Mathematics, Indian Institute of Technology, Chennai, has been elected a fellow of the Institute of Mathematical Statistics (IMS), based in Beachwood, Ohio, USA.



ICTP's regular associate **Surender Dhankhar Singh**, Department of Agricultural Meteorology, Haryana Agricultural University, India, has been awarded two national gold medals by India's president, A.P.J. Abdul Kalam. Singh was honoured for his research on regional monsoon dynamics and its relation to El Niño/La Niña phenomenon.

Elections and Appointments

Several scientists closely associated with ICTP have been elected members or foreign associates of the US National Academy of Sciences (NAS).



Praveen Chaudhari, former chairperson of the ICTP Scientific Council and newly appointed director of Brookhaven National Laboratory, USA, was one of 72 distinguished scientists elected a member of NAS.

Helen Quinn, a theoretical physicist at the Stanford Linear Accelerator Center (SLAC) and winner of the Dirac Medal of the ICTP in 2000, was also elected.

Edouard Brézin, a member of the ICTP Scientific Council and professor, Laboratory of Theoretical Physics, *Ecole Normale Supérieure*, Paris, France, and **Giorgio Parisi**, ICTP Dirac Medallist in 1993 and professor, Department of Physics, University of Rome *La Sapienza*, Italy, were two of 18 distinguished scientists holding citizenship outside the United States who were elected foreign associates. NAS's total membership now stands at 1922; the number of foreign associates in the Academy now totals 341.

S. George H. Philander, professor of meteorology, Department of Geosciences, Princeton University, USA, and a member of the ICTP Scientific Council since 1996, is among the 187 new fellows elected to the American Academy of Arts and Sciences (AAAS), headquartered in Washington, DC.

Giuliano Francesco Panza, head of ICTP's Structure and Non-Linear Dynamics of the Earth (SAND) group and professor of seismology at the University of Trieste, has been elected a foreign member of the Russian Academy of Sciences. Three years ago, the European Geophysical Union honoured Panza with the prestigious Beno Gutenberg Medal for his research on earthquake prediction.

ACTIVITIES

WORKSHOP AND CONFERENCE ON RECENT TRENDS IN NONLINEAR VARIATIONAL PROBLEMS

22 April - 9 May

Directors: A. Ambrosetti (International School for Advanced Studies, SISSA, Trieste, Italy), H. Brézis (*Université Paris 6*, France, and Rutgers University, New Brunswick, NJ, USA) and S.Y.A. Chang (Princeton University, NJ, USA).

Local Organiser: C.E. Chidume (ICTP).

INTERNATIONAL WORKSHOP ON PROTEOMICS: PROTEIN STRUCTURE, FUNCTION AND INTERACTIONS

5 - 16 May

Directors: J.R. Banavar (Pennsylvania State University, University Park, USA) and A. Maritan (International School for Advanced Studies, SISSA, Trieste, Italy).

Jayanth R. Banavar and Amos Maritan

FOURTH INTERNATIONAL CONFERENCE ON PERSPECTIVES IN HADRONIC PHYSICS

12 - 16 May

Cosponsor: Italian National Institute for Nuclear Physics (INFN).

Directors: S. Boffi (University of Pavia, Italy), C. Ciofi degli Atti (University of Perugia, Italy) and M.M. Giannini (University of Genoa, Italy).

Fourth International Conference on Perspectives in Hadronic Physics

WORKSHOP ON THE USE OF THE SIMPACTS MODEL FOR ESTIMATING HUMAN HEALTH AND ENVIRONMENTAL DAMAGES FROM ELECTRICITY GENERATION

12 - 23 May

Cosponsor: International Atomic Energy Agency (IAEA, Vienna, Austria).

Directors: J. Spadaro (IAEA).

ICTP-INFM SPRING SCHOOL ON MAGNETIC PROPERTIES OF CONDENSED MATTER INVESTIGATED BY NEUTRON SCATTERING AND SYNCHROTRON RADIATION

19 - 28 May

Cosponsor: Italian National Institute for the Physics of Matter (INFM).

Directors: O. Moze (INFM, University of Modena and Reggio Emilia, Italy) and G. Rossi (INFM, University of Modena and Reggio Emilia, and INFM-TASC Laboratory, Trieste).

ICTP-INFM Spring School on Magnetic Properties of Condensed Matter Investigated by Neutron Scattering and Synchrotron Radiation

WORKSHOP ON NUCLEAR DATA FOR SCIENCE AND TECHNOLOGY: MATERIALS ANALYSIS

19 - 30 May

Cosponsor: International Atomic Energy Agency (IAEA, Vienna, Austria).

Directors: I. Vickridge (*Centre National de la Recherche Scientifique*, CNRS, and *Université Paris 6 et 7*, France) and M. Herman (IAEA).

Local Organiser: N. Paver (Italian National Institute for Nuclear Physics, INFN, and University of Trieste).

Nello Paver

ICTP WORKSHOP ON THE THEORY AND USE OF REGIONAL CLIMATE MODELS

26 May - 6 June

Directors: F. Giorgi (ICTP), J. Pal (ICTP), and E. Eltahir (Massachusetts Institute of Technology, MIT, Cambridge, MA, USA).

SUMMER COLLEGE AND CONFERENCE ON THE PHYSICS AND CHEMISTRY OF RARE-EARTH MANGANITES

1 - 18 June

Directors: T.V. Ramakrishnan and A.K. Raychaudhuri (Indian Institute of Science, IIS, Bangalore, India).

AFRICAN WORKSHOP ON OPEN SOURCE AND WEB TECHNOLOGIES FOR DEVELOPMENT, Abuja, Nigeria

2 - 6 June

In collaboration with the National Information Technology Development Agency (NITDA) of the Federal Ministry of Science and Technology of Nigeria.

Organisers: E. Canessa (ICTP) and O.G. Ajayi (NITDA).

African Workshop on Open Source and Web Technologies for Development

SCHOOL ON MATHEMATICS IN STRING AND FIELD THEORY

2 - 12 June

Cosponsor: Italian National Institute for Nuclear Physics (INFN).

Directors: P. Aspinwall (Duke University, Durham, NC, USA), R. Dijkgraaf (University of Amsterdam, The Netherlands) and N. Nekrasov (Institute of Theoretical and Experimental Physics, Moscow, Russian Federation).

Local Organisers: E. Gava (INFN and ICTP) and G. Thompson (ICTP).

COURSE ON CLIMATE VARIABILITY STUDIES IN THE OCEAN "TRACING AND MODELLING THE OCEAN VARIABILITY"

16 - 27 June

Cosponsor: International Atomic Energy Agency (IAEA, Vienna, Austria).

Directors: G. Civitarese (Italian National Research Council - Institute of Marine Sciences, CNR-ISMAR, Trieste), M. Gacic (Italian National Institute of Oceanography and Experimental Geophysics, OGS, Trieste) and P.P. Povinec (IAEA Marine Environment Laboratory, Monte Carlo, Monaco).

Local Organisers: A. Bracco (ICTP) and F. Molteni (ICTP).

SUMMER SCHOOL ON PARTICLE PHYSICS

16 June - 4 July

Cosponsor: Italian National Institute for Nuclear Physics (INFN) and International School for Advanced Studies (SISSA, Trieste, Italy).

Directors: M. Lindner (*Technische Universität München*, Munich, Germany), A. Masiero (INFN and University of Padua, Italy) and A.Yu. Smirnov (ICTP).

Local Organiser: A. Özpineci (ICTP).

Response to SARS

The World Health Organization's (WHO) global SARS (severe acute respiratory syndrome) alert put the ICTP Medical Services on special alert for several months beginning last April. Visitors from all affected areas were required to undergo a medical test, both upon their arrival and once again 10 days later. Letters were sent to all scientists and staff outlining the Centre's response to the outbreak and a special email address was set up to field questions about the virus. Nurses' hours, moreover, were extended to the weekend. Only 15 of the 68 scientists from China and nearby countries who had been invited to ICTP during the alert actually arrived—a reflection of how SARS impeded travel both to and from affected areas. All the 15 scientists who arrived at ICTP underwent two medical examinations. On 5 July 2003, WHO announced that the SARS alert had been resolved and the ICTP Medical Services returned to its normal operating procedures.

Ghirardi to Head *Consorzio*

GianCarlo Ghirardi, head of ICTP's Associate programme and professor of physics at the University of Trieste, has been appointed president of the *Consorzio per l'incremento degli studi e delle ricerche dei dipartimenti di fisica dell'Università di Trieste*. The consortium, established in 1964, promotes local and regional initiatives in physics. Ghirardi replaces Margherita Hack, past director of Trieste's Astronomic Observatory.

Centre Art Exhibition

The ICTP Cultural Committee's latest art exhibition, "An Art Rendez-Vous in Trieste," featured the works of six well-known artists from southern Italy. The exhibition, which was located in the lobby of the Main Building, began 20 May and continued through 20 June.

IN MEMORIAM

Ilya Prigogine, a Nobel Laureate in chemistry (1977), died on 28 May in Brussels. He was 86. Born in Moscow in 1917, Prigogine was just a few months old when his family emigrated first to Germany and then to Belgium, the latter becoming his adopted homeland. He studied chemistry and physics at the *Université Libre de Bruxelles*, earning a Ph.D. in 1941. Soon after graduation, Prigogine began his intense life-long examination of the thermodynamics of irreversible processes, enabling him to forge critical links between physics, chemistry and biology. In his later years, he sought to extend his interdisciplinary pursuits to sociology and economics, becoming one of the world's leading authorities on complexity. In the United States, where he worked from 1967 until his death, Prigogine founded and then directed the Center for Statistical Mechanics at the University of Texas at Austin, later named in his honour. In 1959 he also became director of the International Solvay Institutes for Physics and Chemistry in Brussels. Prigogine was a brilliant lecturer and essayist. His speeches and writings fascinated scientists, students and laymen alike, and his books—notably, *La Nouvelle Alliance*, written with Isabelle Stengers—have been among the best-selling books in science in many countries. In 1968, Prigogine visited ICTP to participate in the Centre's historic Symposium on Contemporary Physics.

George Marx, an eminent figure in Hungarian science and frequent visitor to ICTP, died last December. He was 76. After earning undergraduate and graduate degrees in physics and chemistry at the University of Budapest, Marx turned his considerable analytical skills to high energy physics, astronomy and later bioastronomy. He confirmed the earliest models of the superheated early universe and, later, his research on neutrinos helped to broaden the study of astrophysics. During the Cold War, Marx developed many personal contacts with leading researchers on both sides of the Iron Curtain. A passionate teacher, he was a leading advocate for the modernisation of the physics curriculum in Hungary, coauthoring several books with teachers and numerous newspaper and journal articles. He travelled extensively in Asia and Africa, where he was asked by UNESCO to organise physics seminars for teachers. With ICTP's support, in the late 1980s, Marx launched a series of workshops in Africa on applications of microcomputers in science and mathematical education that played a major role in expanding the use of computers in science throughout the continent.

Bruna Marcuzzi, long-time head of housekeeping at the ICTP guesthouses who retired in June 2002, died on 6 May. She was 78. Many Centre visitors will remember Bruna as the person who first welcomed them to ICTP and then made their stay so hospitable. Colleagues will remember Bruna for her warmth and enthusiasm. Centre staff and visitors extend their condolences to Bruna's family and friends.

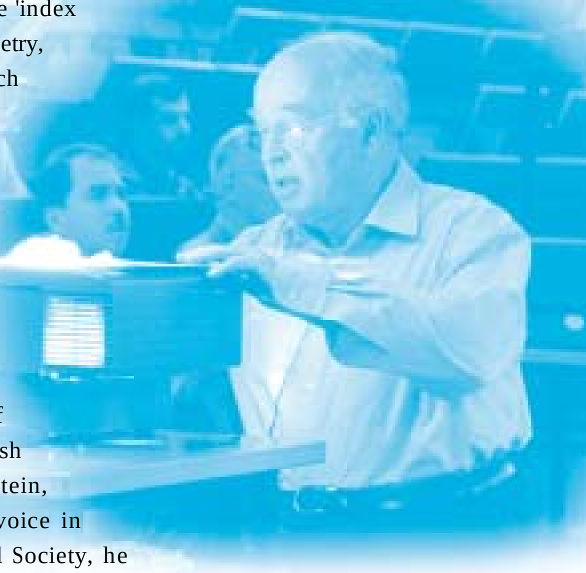
Fields Medallist Sir Michael Atiyah recently visited ICTP to share his broad insights on the future of mathematics.

Sir Michael Atiyah

"Until some 20 years ago, modern physics and mathematics seemed to be set on different unrelated paths of discovery. Since then, however, their paths have been crossing with increasing frequency as theories in physics have enriched mathematics and as mathematical concepts have shaped and directed pathbreaking insights in physics."

These were some of the observations made by Sir Michael Atiyah, a Fields Medal winner (1966) and one of the world's most renowned mathematicians, during his recent visit to ICTP. Atiyah travelled to Trieste to participate in the ICTP/SISSA (International School for Advanced Studies) Colloquium on Geometry, which was held in honour of M.S. Narasimhan, long-time head of ICTP's Mathematics group who was celebrating his 70th birthday.

"When the ties between mathematics and physics first began to take hold about two decades ago," Atiyah notes, "it was not clear whether practitioners in these fields would be crossing paths quickly and quietly in the night or forging active long-term ties. Two decades later, the union has proven to be an enduring one—stronger today than ever before." Atiyah's cooperative research efforts with the renowned string theorist Edward Witten, which has led to a recent joint publication, is just one example of this growing relationship between the two disciplines.



Atiyah, formerly a professor at Oxford and Cambridge, UK, is no stranger to efforts seeking to find common intellectual ground between different fields of knowledge. In the 1960s, he and Isadore Singer of the Massachusetts Institute of Technology (MIT), proved the 'index theorems,' a mathematical concept providing powerful connections between geometry, topology, algebra and ultimately quantum field theory. He also developed a branch of geometry called K-theory, which was initially concerned with the interrelationship between topology and linear analysis, but ultimately exerted an important influence on physics, including string theory.

"The things that interest me in mathematics," says Atiyah, "are the interconnection between different parts of mathematics" and the way "in which mathematics can unify and simplify our quest to answer difficult problems, whether in mathematics itself or in other scientific fields."

Atiyah's quest to respond with clarity and precision to difficult questions has not been limited to the classroom and blackboard. Serving as president of the Royal Society (1990-1995) in the UK and the internationally renowned Pugwash community (1997-2002), which has included such luminaries as Albert Einstein, Bertrand Russell, Max Born and Linus Pauling, Atiyah has been a leading voice in discussions related to the role of science in society. While heading the Royal Society, he helped to launch the InterAcademy Panel on International Issues (IAP), an association of national science academies, whose secretariat is now located in Trieste under the administrative umbrella of the Third World Academy of Sciences (TWAS). Twenty years earlier, Atiyah had been elected a founding associate fellow of TWAS itself.

"With all of the threads being weaved between mathematics and other disciplines, ranging from economics to physics, now it is a great time to be a member of the mathematics profession. There are so many new avenues to explore and questions to ask and answer both as an intellectual challenge and for their applications in solving critical issues of importance to our society. Young—and not so young—mathematicians can truly have some fun crossing different borders both within their own fields and the fields of others."

"Mathematics," Atiyah goes on to say, "is a solitary exercise. You sit and you think hard for hours. It gets boring, so a bit of social interaction adds a whole new dimension and makes life so much more interesting and attractive. Some people don't collaborate and work by themselves, but I find interaction one of the more satisfying parts of what I do."☐

7 - 18 July
Advanced School in Basic Algebraic Geometry

14 - 19 July
ICTP-INFM Conference on New Frontiers in Nano-Biotechnology: Monitoring Protein Function with Single-Protein Resolution

14 July - 1 August
Genes, Genomics and the Development of Behaviour: The Development of Function in the Nervous System

4 - 22 August
Summer School and Conference on Real Algebraic Geometry and its Applications

11 - 15 August
Third Stig Lundqvist Conference on Advancing Frontiers of Condensed Matter Physics: Fundamental Interactions and Excitations in Confined Systems

25 - 29 August
Euroconference on Ab-Initio Many-Body Theory for Correlated Electron Systems

1 - 4 September
Tenth Hopping and Related Phenomena Conference (HRP 10)

1 - 5 September
Workshop on Receptor Binding Assay (RBA) for Algal Toxins

8 - 17 September
ICTP-INFM Summer School on Transport, Reaction and Propagation in Fluids
followed by
Conference on Kolmogorov's Legacy in Physics: One Century of Chaos, Turbulence and Complexity

15 - 19 September
Seventh Trieste Conference on Chemical Evolution and the Origin of Life: Life in the Universe: From the Miller Experiment to the Search for Life on Other Worlds

15 - 26 September
Advanced School and Conference on Sources of Gravitational Waves

22 - 26 September
Seminar on Development and Application of Isotope Tracer Diagnostics in Regional Climate Models

29 September - 11 October
Seventh Workshop on Non-Linear Dynamics and Earthquake Prediction

30 September - 3 October
First International Workshop on Integrated Climate Models: An Interdisciplinary Assessment of Climate Impacts and Policies

ICTP ON THE WEB

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

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

ON E-MAIL
(1) For Yearly Calendar of Scientific Activities
Create a new e-mail message and type
To: `smr@ictp.trieste.it`
Subject: `get calendar 2004`
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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