The Abdus Salam
International Centre for Theoretical Physics

UNESCO United Nations Educational, Scientific and Cultural Organization
IAEA International Atomic Energy Agency

Registrazione presso il Tribunale di Trieste n. 1044 del 01.03.2002 | Contiene Inserto Redazionale

String theorists win Dirac Medal

P-2

Is string theory a theory or a framework? What impacts will the Large Hadron Collider experiments have on the field? ICTP Dirac Medallists Juan Martín Maldacena, Joseph Polchinski and Cumrun Vafa share their insights on this proposal for a unified description of fundamental interactions in nature, and also describe what they find most exciting about string theory • • •

ICTP celebrates Year of Darwin

P-5

The link between physics and human evolution may not seem immediately obvious. Yet, the tools of modern physics can date human evolution and dispersal accurately. The tools and techniques used to pinpoint the age of human bones and teeth were the subject of an ICTP exhibit and lecture series held in conjunction with UNESCO's symposium on Darwin, Evolution and Science • • •

Focus on Africa

CENTREFOLD

ICTP has a long tradition of scientific capacity-building in Africa. Over the last few decades, ICTP has supported numerous activities throughout the continent, including training programmes, networks and the establishment of affiliate centres. In Trieste, ICTP has welcomed more than 10,000 African visitors since 1970, providing advanced research and training opportunities unavailable to scientists in their home countries • • •

NEWS
n°127
Spring/Summer 2009
from ICTP

Poste Italiane S.p.A. - Spedizione in Abbonamento Postale - D.L. 353/2003 (conv. in L. 27/02/2004 n° 46) art. 1, comma 2, DCB Trieste

Noted physicists awarded Dirac Medals

+ Cumrun Vafa received the Dirac Medal in June 2009, during the Summer School on Particle Physics in the LHC Era.
++ Juan Martín Maldacena and Joseph Polchinski at the Dirac Medal 2008 award ceremony.
+++ Close-up of Dirac Medal.

CEREMONY HONOURS WORK RELATED TO STRING THEORY

ICTP presented its Dirac Medal to the winners of the 2008 prize at a ceremony held on 26 March at the Centre. The Dirac Medal is given in honour of P.A.M. Dirac, one of the greatest physicists of the 20th century and a staunch friend of ICTP, to scientists who have made significant contributions to physics.

The recipients—Juan Martín Maldacena of the Institute for Advanced Study, Princeton; Joseph Polchinski of the Kavli Institute for Theoretical Physics, University of California at Santa Barbara; and Cumrun Vafa of Harvard University—were honoured for their substantial contributions to string theory, a proposal for a unified description of fundamental interactions in nature.

News from ICTP posed a number of questions related to string theory to the three medallists; their thoughts on the theory are presented below.

DIRAC MEDALS

Is string theory a theory or a framework?

Maldacena: It is a theory under construction. We do not yet know what the fundamental principles underlying it are.

Polchinski: I think it is a theory because all signs are that its equations are unique. But these equations have many solutions, so in a way it behaves as a framework. This property, having few equations with many solutions, is essential to the nature of physics, which explains many phenomena in terms of a few principles. String theory is perhaps the extreme example of this.

Vafa: It is in some aspects a theory and in others a framework. There are pieces of string theory that are quite well developed, and there are parts which are very primitive and more like a framework.

Do you think string theory will ever be accepted as widely as the theory of general relativity? What would it take for that to happen?

Maldacena: What is necessary is that some prediction of the theory is experimentally verified. If that happens, it would then be accepted widely.

Polchinski: This question has two parts: is it the right theory, and will we know? For the first part, I feel strongly that it is the right theory. More precisely, since it is incomplete, it is headed toward the right theory. Part of the reason for this belief is theoretical: it ties together so many things that we already know. For example, there is a theory of quantum gravity hidden in the strong nuclear force, and this turns out to be string theory. Also, the dark energy is an experimental hint, it was predicted by Steven Weinberg based on assumptions that seem to follow from string theory.
Will we ever know? In the long term I am an optimist, one learns surprising things that were completely unexpected.

Vafa: Yes, I believe it will. It is hard to predict exactly how this will happen, but the richness of string theory and the connections it already

has made with general relativity, quantum field theory and other areas of physics make this unavoidable.

Are the Large Hadron Collider (LHC) experiments likely to have a fundamental impact on the field of string theory?

Maldacena: Yes, discovering the new layer of physics will probably be very useful for guiding us towards the correct theory. Understanding how electroweak symmetry is broken is very important. Questions that will be answered are: Is there a natural explanation for the scale at which electroweak symmetry is broken? Do we have supersymmetry at this scale?

Polchinski: There are some possible smoking guns—extra dimensions and black holes—but these are long shots. But whatever we learn will be important, since there are so many possibilities now and a real mystery as to what will be seen. The strongest candidate, supersymmetry, is very interesting and is an important part of string theory, so if the LHC has enough energy to find it we are in good shape.

Vafa: I believe it will, and I am hopeful that it would refine our understanding of string theory. LHC is bound to have a lasting impact on the whole field of high-energy physics.

Can you give an example of a prediction of string theory that might be experimentally verified in coming years?

Maldacena: We would have to be lucky to have any verification in the near future. There are scenarios where verification would be possible in the next few years, but they seem to be a narrow class of possibilities. One possibility is that the string scale is very low, of the order of the energies that will be explored at the LHC. The other is that cosmic fundamental strings were produced in the beginning of the big bang and have survived until now.

It might be possible that somebody understands the theory better and comes up with a prediction that applies to a wider spectrum of possibilities.

Finally, I should say that string theory could be easily falsified by any experiment that shows a departure from quantum mechanics. Since string theory is based on quantum mechanics, any violation of the usual rules of quantum mechanics by any tabletop experiment would rule out string theory.

Polchinski: I have been studying the possibility of cosmic strings, which would have expanded with the universe and today might be seen through their gravitational effects. Again, they are present in some solutions but not all, so they are not a firm prediction. But if they are found, they will be a huge new window into high-energy physics.

Vafa: Together with my student Jonathan Heckman and with many other collaborators, we have come up with a framework from string theory with very specific predictions for particle physics and what LHC may find. This includes the mass of supersymmetric particles we may discover at LHC, as well as specific candidates for dark matter. We also have predictions for neutrino physics which would be interesting to verify in the near future experiments. I am hopeful that with some luck we may see some of these predictions proven true at LHC. We are fortunate to be living in exciting times for particle physics!

What is the most exciting aspect of string theory for you?

Maldacena: It is the possibility of describing the initial instants of the big bang. We do not yet understand the theory well enough to say whether it does indeed describe it, but this is the most exciting prospect and a strong motivation for developing the theory further.

Polchinski: The way that it connects things. An example is the way that the strong nuclear force and gravity are dual, just different classical limits of a single quantum theory. The duality between black holes and strongly interacting plasmas is a striking illustration of this. Seemingly distant parts of physics end up being closely related, in surprising ways.

Vafa: The interconnection between ideas and the unifying framework that string theory provides for physics is very exciting. Also, how one corner of string theory transitions to another seamlessly through string dualities is quite beautiful.

How can fundamental science contribute to the growth of developing countries?

Maldacena: Researchers in basic areas of science are a resource for people who work on more applied areas, which would be the ones most crucial for development. I do think that applied research is best done by the private sector, which has a better sense of what is most economically viable.

Polchinski: I think that all people wonder about the nature of things, how they began and what is at the bottom of everything. So I think it is good to invest some resources into fields like particle physics, astronomy, cosmology, and so on, to nurture this sense of wonder. One would hope that this would have practical benefits too, in educating and inspiring young people who end up doing more applied work.

Vafa: Abdus Salam had a clear vision that I find very true: Fundamental science being pursued by scientists in developing countries leads to a scientific culture in their countries that encourages growth of science in all directions. In particular, applications of science to solve various problems in developing countries can be a natural, trickle-down effect of such an attitude.

What advice would you give to students in ICTP's physics training programmes who might be considering pursuing the field of string theory?

Maldacena: To get a broad physics background. To understand theoretical methods that are used in various areas of physics.

Polchinski: To think of oneself broadly as a physicist, not just a string theorist, and to work on a variety of things. It gives one more perspectives and tools to combine, and a greater choice of research directions in the future. ICTP's Dr. Acharya is a great example of what is possible, going from string theory to experimental analysis for the LHC.

Vafa: I would suggest that they enjoy learning what we have already discovered about string theory without worries about their immediate application. Also I would encourage them to be as open as possible to the links that string theory provides to various areas of physics and mathematics. Moreover, I think it would be healthy for them to not only see what progress we have made in understanding string theory, but also what shortcomings we have, which are plenty! Needless to say, we would need their help to advance in this subject!

Past Dirac Medal recipients

Forty-seven scientists have received ICTP's Dirac Medal since the first one was announced in 1985. In addition, many Dirac medallists have gone on to win even more prestigious prizes:

Nobel Prize:

- Martinus J.G. Veltman (1999)
- David J. Gross (2004)
- Frank Wilczek (2004)
- Yoichiro Nambu (2008)

Wolf Prize:

- Yoichiro Nambu (1994)
- Yakov G. Sinai (1996)
- Michael Berry (1998)

Fields Medal:

- Edward Witten (1990)

Dirac medallists

2007 John Iliopoulos, Luciano Maiani
2006 Peter Zoller
2005 Sir Samuel F. Edwards, Patrick A. Lee
2004 James D. Bjorken, Curtis G. Callan
2003 Robert H. Kraichnan, Vladimir E. Zakharov
2002 Alan Guth, Andrei Linde, Paul Steinhardt
2001 John J. Hopfield
2000 Howard Georgi, Jogesh Pati, Helen Quinn
1999 Giorgio Parisi
1998 Stephen L. Adler, Roman Jackiw
1997 Peter Goddard, David Olive
1996 Tullio Regge, Martinus J.G. Veltman
1995 Michael Berry
1994 Frank Wilczek
1993 Sergio Ferrara, Daniel Z. Freedman, Peter van Nieuwenhuizen
1992 Nikolai N. Bogolubov, Yakov G. Sinai
1991 Jeffrey Goldstone, Stanley Mandelstam
1990 Sidney R. Coleman, Ludwig D. Faddeev
1989 Michael B. Green, John H. Schwarz
1988 Efim S. Fradkin, David J. Gross
1987 Bryce DeWitt, Bruno Zumino
1986 Yoichiro Nambu, Alexander Polyakov
1985 Edward Witten, Yakov Zeldovich

ICTP, UNESCO celebrate **Darwin**

ICTP ACTIVITIES COMPLEMENT UNESCO DARWIN SYMPOSIUM IN VENICE

ICTP joined efforts with BRESCE, UNESCO's regional office in Venice, to celebrate Darwin's bicentennial. As side events to UNESCO's 3-day Darwin 200 Symposium, ICTP organised a small exhibition, "Darwin & Modern Science", and an afternoon of lectures with the help of several institutions from Trieste, including Zoic Srl, Natural History Museum of Trieste, National Museum of Antarctica, University of Trieste, ELETTRA Synchrotron Light Laboratory and the Mongolian Academy of Science.

The exhibit, which opened on 27 April, highlighted modern physics tools that can provide precise information on chronology and microstructure in evolution studies. It included reproductions of some remains that have helped scientists to quantify evolution, including a Slovenian flute made by a Neanderthal man 40,000 years ago. Also on display were bones of the hominid remains from Krapina (Croatia) that are being used to sequence the Neanderthal genome and the remains of a hominid from the Trieste area who was the common ancestor of Neanderthals and modern humans.

DARWIN

The "Darwin, Evolution and Science" afternoon of lectures, which were held on 29 April, included two speakers from ICTP—Claudio Tuniz and Julian Chela-Flores. Tuniz also spoke at the UNESCO symposium on "Latest Developments from Physics for the Study of Evolution", during a special UNESCO-ICTP session.

Both the exhibit and the lectures were held at the BRESCE office in Venice. Items from the exhibit will be displayed at ICTP for the duration of the "Year of Darwin".

+ ICTP Assistant Director Claudio Tuniz at ICTP's symposium on "Darwin, Evolution and Science", UNESCO-BRESCE, Venice, 29 April 2009.

New science for **clean energy**

THE FUTURE LOOKS SUNNY FOR AFFORDABLE PHOTOVOLTAICS

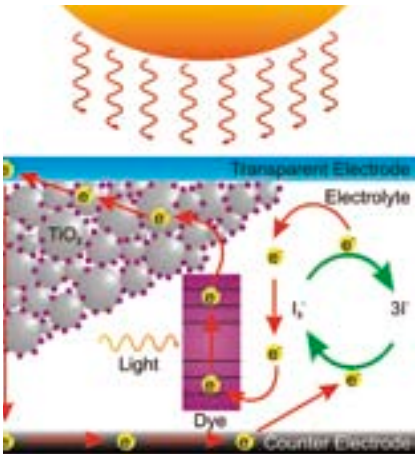
The massive worldwide use of fossil fuels for energy has led to some of the most daunting challenges facing the world today. Global climate change and countless regional conflicts can be linked directly to the world's dependence on oil, coal and gas. A sustainable way out of this dependence on fossil fuels is through the use of renewable energies like solar or wind. Solar energy especially has vast potential: the sun provides us with an unimaginable 120,000 terawatts of power, meaning that if we could cover just 0.16% of the land of the Earth with 10% efficient solar cells, this would provide enough energy to meet about twice the world's consumption rate of fossil energy.

In spite of this huge potential, the direct conversion of solar light into electricity has so far played a negligible role in meeting the world's energy needs. Due to the high costs of traditional silicon-based solar panels, photovoltaic energy has remained a niche application. This is particularly true for developing countries, where the sun often shines abundantly, where small-scale decentralised electricity generation could be very useful, but where high costs are especially prohibitive.

The advent of nanotechnology, however, promises a sunny future for affordable photovoltaics, by offering new ways to harvest the sun's energy in solar cells that are radically different from traditional designs. Rather than relying on bulk semiconductor heterojunctions, these nano-structured solar cells combine different electronic properties of various molecules to effectively form electrochemical cells on specially treated surfaces. These new kinds of solar cells offer various advantages: some come in the form of flexible plastic sheets, others can be integrated into glass windows or in other materials, and they perform best in diffuse light conditions (such as below clouds or in tropical climates). And, most importantly, such nanostructured solar cells promise to be cheap. There is no need for expensive, rare or particularly pure raw materials. No clean rooms or high temperatures are needed for their production.

Still, these new kinds of solar cells are not yet available commercially. Several issues need to be addressed, such as improving their lifetime, increasing their efficiency and finding the best combination of materials. But given the prospect of an alternative, cheap and abundant decentralised source of electricity, such systems already now attract strong interest from industry and many governments, especially in developing countries.

+ Solar cells based on nanotechnology promise more flexibility and lower costs. © Fraunhofer-Gesellschaft.
++ Dye sensitised solar cell scheme.



ICTP is actively promoting basic research in photovoltaic materials through workshops and training programmes, and its Condensed Matter and Statistical Physics (CMSP) section has a European grant for numerical research in photovoltaic materials. By performing computer simulations of structural and electronic properties of a dye sensitized solar cell, CMSP scientists have gained a deeper insight of the interplay between the atomic structure and the optical absorption properties in such systems. This can guide the experimental development of better devices.

by Ralph Gebauer, CMSP

Experimental **plasma physics** at ICTP

DEVICE OFFERS MULTIPLE RESEARCH APPLICATIONS

ICTP's Multidisciplinary Laboratory (MLab) is resuming and enhancing an important historic ICTP experimental research activity on plasma physics by setting up a Dense Plasma Focus device (DPF) for exploring applications in materials, medicine and plasma sciences.

The overall goal is to establish a research centre for reference on plasma-focus science and applications at ICTP with a visible contribution to mainstream research, higher education and innovative non-commercial and commercial applications. Applications include characterisation of nanotechnology materials, dynamical defectoscopy of fast moving, rotating objects such as turbines or tires, materials testing, detection of explosives and other illicit materials, and production of isotopes for medical diagnosis and cancer therapy.

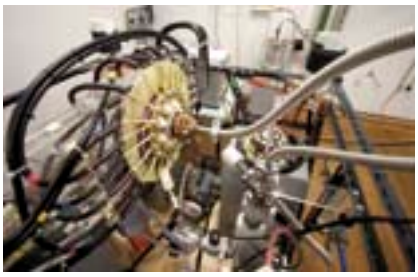
PLASMA PHYSICS

The DPF device is a relatively inexpensive, non-radioactive, compact and efficient source of plasma and radiation. With experienced guidance, it can be inexpensively reproduced in experimental laboratories around the world for use as a non-radioactive source of X-rays and neutrons for both applications and basic research. The DPF can produce very powerful pulses of fast neutrons and hard X-rays with a pulse-duration of tens of nanoseconds without using accelerators, radioactive materials or nuclear reactors.

ICTP's DPF device will be used in the field of radiation material sciences for testing and improving materials used in nuclear fusion chambers at facilities like ITER, the National Ignition Facility and LMJ. For these experiments, the DPF device will mainly use fast ion and electron beams as well as plasma streams due to their capacity to produce the strongest radiation impact on materials. In the course of these experiments, ICTP will collaborate with colleagues from other institutes to investigate the radiation effects on materials, during the irradiation, through diagnostics with nanosecond resolution time and through several analytical techniques. The DPF also will be used as a neutron/X-ray source for experiments in nuclear medicine, particularly Boron Neutron Capture Therapy (BNCT) of malignant tumors.

The uniqueness of ICTP and its existing programmes will serve as the catalyst for combining existing collaborations between Italy (including University of Trieste, INFN, ELETTRA, ENEA and Pirelli), Poland, Chile, Pakistan, Argentina, Egypt and others. Many of ICTP's training programmes such as the TRIL and Associates programmes, ICTP/IAEA STEP fellowships, OEA's support of the African-Asian Association for Plasma Training (AAAPT)

+ Dense Plasma Focus device at the ICTP Multidisciplinary Laboratory.

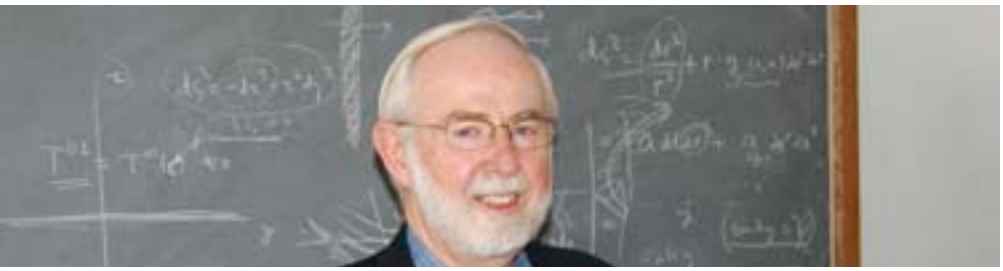


and ICTP's relationship with the Central European Initiative (CEI) will be integrated and leveraged to support the project, allowing young researchers from both developed and developing countries to bring their experiences and knowledge back to their home institutes, and form long-term collaborations. Finally, the project will also serve as a focal point for future ICTP-IAEA collaboration. The project is under the supervision of ICTP Assistant Director Claudio Tuniz and Vladimir Gribkov, Institute for Theoretical and Experimental Physics, Moscow, Russia, with the collaboration of Dr. Ryszard Miklaszewski, Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland.

Collaborating institutions:

- International Centre for Dense Magnetized Plasmas, Poland
- Moscow Physical Society and Institute for Theoretical and Experimental Physics, Russia
- Universities of Bologna and Ferrara, Italy
- National Atomic Energy Agency of Chile
- Buenos Aires and Tandil Universities, Argentina
- African-Asian Association for Plasma Training (AAAPT)
- INFN, ELETTRA, ENEA, and Pirelli, Italy

SNO director visits ICTP



+ Dr. Art McDonald, director of Canada's Sudbury Neutrino Observatory (SNO).

RESEARCHERS AT ICTP AND CANADA'S SUDBURY NEUTRINO OBSERVATORY (SNO) COMBINE THEORY AND EXPERIMENTATION TO STUDY SOLAR NEUTRINOS

NEUTRINOS

ICTP is part of an international effort combining theory and experiment to study solar neutrinos. In March, Dr. Art McDonald, director of Canada's Sudbury Neutrino Observatory (SNO), visited ICTP to give a lecture and to meet with ICTP researchers who specialise in neutrino physics. SNO houses a neutrino detector located 2 kilometres underground in a nickel mine, and is run by an international collaboration of researchers. In this interview, Dr. McDonald talks about future directions for SNO's new neutrino laboratory and what neutrinos can tell us about the universe.

What are the next steps for SNO?

The original SNO facilities have now been expanded into an underground space of 5,000 square meters, known as the SNOLAB. In addition to observing solar neutrinos and neutrinoless double beta decay, the new facility will look at topics such as cosmic dark matter and supernova neutrinos. The experiments we will be doing require a location deep underground to reduce cosmogenic backgrounds to acceptable levels. The heavy water that was the target for solar neutrino interactions in past SNO experiments will be replaced with a liquid scintillator that gives off more light than the heavy water when charged particles interact in it. Now we will be able to study neutrinos of much lower energy than before.

What else will SNOLAB's work be able to tell us about neutrinos?

The SNOLAB's work is important in terms of applying theories of how neutrinos fit into the standard model of elemental particles and also perhaps to help us understand the processes that led to a major transition at the birth of the universe, when antimatter was produced in approximately equal amounts to matter. Today's universe contains very little antimatter.

How does ICTP's theoretical work fit in with SNO's experiments?

ICTP's theoretical work on neutrinos has been an inspiration for the SNOLAB experiments. In particular, [ICTP scientist] Alexei Smirnov's model, which defines the interactions of neutrinos with matter in the sun, has provided a clear explanation for why processes affecting neutrinos are different at different energies. SNO and SNOLAB can test this model in great detail. Any deviations can possibly explain other neutrino properties or even explore a connection between neutrinos and dark energy. Alexei's model is a key to understanding neutrino properties in more detail.

Our future work will explore a number of cases that are pointed out to us by the extensive theoretical work that Alexei does. To maintain an opportunity to interact regularly is very valuable for us to do the right experiments and to understand the implications of our observations. It is a very nice experimental/theoretical collaboration.

A deeper look at particle physics

ICTP SCHOOL ON PARTICLE PHYSICS IN THE LHC ERA INTRODUCES STUDENTS TO LATEST DEVELOPMENTS

The field of particle physics is in a "dramatic phase", says Dr. Alexei Smirnov from ICTP's High Energy, Cosmology and Astroparticle Physics (HECAP) section. And to introduce students to the latest developments in the field he, along with HECAP's Dr. Goran Senjanovic and Dr. Bobby Acharya, organised a summer school on "Particle Physics in the LHC Era" that was held in June 2009. Dr. Gino Isidori (INFN, Frascati, Italy) and Dr. Georgi Dvali (New York University) were also involved as workshop organisers.

"Science cannot be learnt from just textbooks," says Dr. Smirnov. "Experts who are substantially contributing to the field conducted lectures at the school. The basic idea was to get students interested and provide them with ideas for their future research topics," he adds.

PARTICLE PHYSICS

Among the experts at the school were Dr. Cumrun Vafa of Harvard University, a recipient of the 2008 Dirac Medal (see related story on page 2).

The school addressed topics related to the forthcoming results from the Large Hadron Collider (LHC) at CERN and included courses on the Higgs Boson, electroweak symmetry breaking, supersymmetry, physics of extra dimensions, astroparticle physics and neutrino physics.

"The topic of the Higgs Boson was one of the major events of the school, with two courses dedicated to it," says Dr. Smirnov. The Higgs Boson (or Bosons) is believed to impart the mass to all known particles in the universe.

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+ Alexei Smirnov.
++ Magnets inside the LHC.
© CERN.

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The experimental detection of the Higgs Boson, it is thought, will help explain the origin of mass in the universe. But, as Dr. Smirnov points out, "we don't even know how many Higgs particles exist."

Courses also addressed questions on the properties of Higgs particles and their manifestations depending on the theory used.

"The Higgs Boson particle is the last undiscovered particle of the Standard Model. But we now know that this theory does not address many parts of particle physics satisfactorily, for example, the discovery of neutrino mass," he explains. According to the Standard Model, neutrinos have no mass; now however, experimental evidence has shown the contrary—neutrinos do have mass.

The courses helped students look at Beyond the Standard Model theory. "We have to look at the physics behind the neutrino masses," says Dr. Smirnov. "Some lectures touched upon questions about neutrino fluxes from the sun and detection of high energy cosmic neutrino fluxes. With this [cosmic neutrino fluxes], I think we will be looking through a new window to understanding the universe," he says.

Regional spotlight on **Africa**

Discussion on Science in Africa, ICTP, Trieste, 6 May 2009. + (left - right) Tahir Shah, editor, *African Physical Review*; K. R. Sreenivasan, ICTP Director; Sandro Radicella, head, ICTP Aeronomy and Radiopropagation Laboratory; and Mohamed Hassan, TWAS Executive Director.

Since ICTP's inception, one of its main goals has been the development of scientific and technological capacity in Africa. ICTP carries out this task in various ways:

- every year, more than 400 African scientists visit ICTP, for a total of 800 person-months;
- ICTP founded and is sponsoring six affiliated centres, eight networks and five Ph.D. programmes in African universities;
- ICTP organises and sponsors more than 80 scientific events in Africa every year.

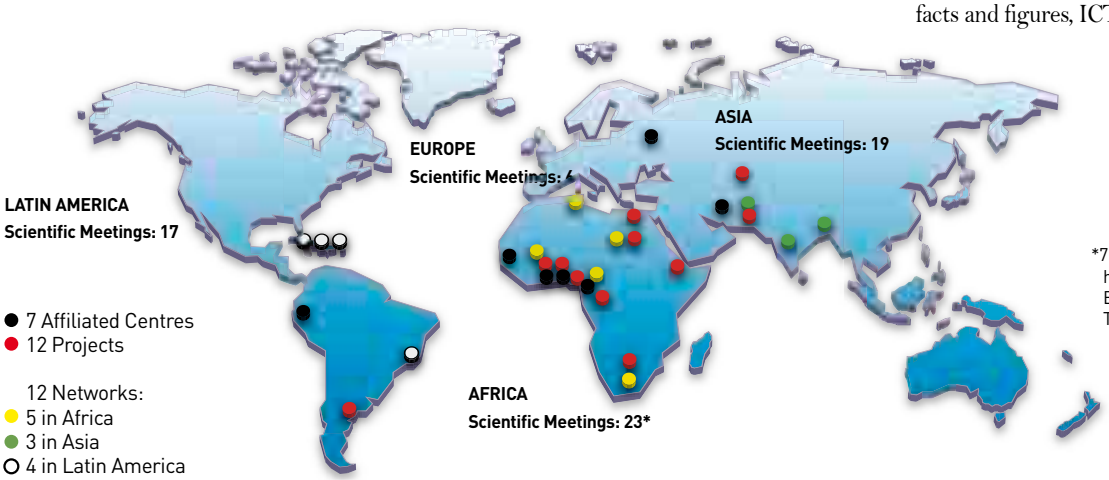
AFRICA

Furthermore, more than 10,000 African scientists have visited ICTP since its inception, staying from a couple of days to several months.

On 6 May, a group of African scientists and representatives of scientific institutions in Trieste joined a number of ICTP scientists to discuss ICTP's role in Africa. All agreed that in Africa, there is universal and strong appreciation of ICTP's work. Meeting participants explored ways that ICTP could improve its effectiveness on the continent, and several suggestions emerged to be discussed in more detail by ICTP's Scientific Council.

This centrefold highlights, through facts and figures, ICTP's impact on Africa.

ICTP International Activities 2008



*7 Scientific Meetings were held in the following LDCs: Benin, Ethiopia, Madagascar, Tanzania, Uganda, Zambia.

++ Hamadoun Touré, ITU Secretary-General.
+++Jean-Pierre Ezin, Commissioner for Human Resources, Science and Technology, African Union.
++++ Shaaban Said Khalil, Director, Centre for Theoretical Physics, the British University in Egypt. In foreground: El Hassan Saidi, Professor of Physics, University Mohammed V-Agdal, Rabat.

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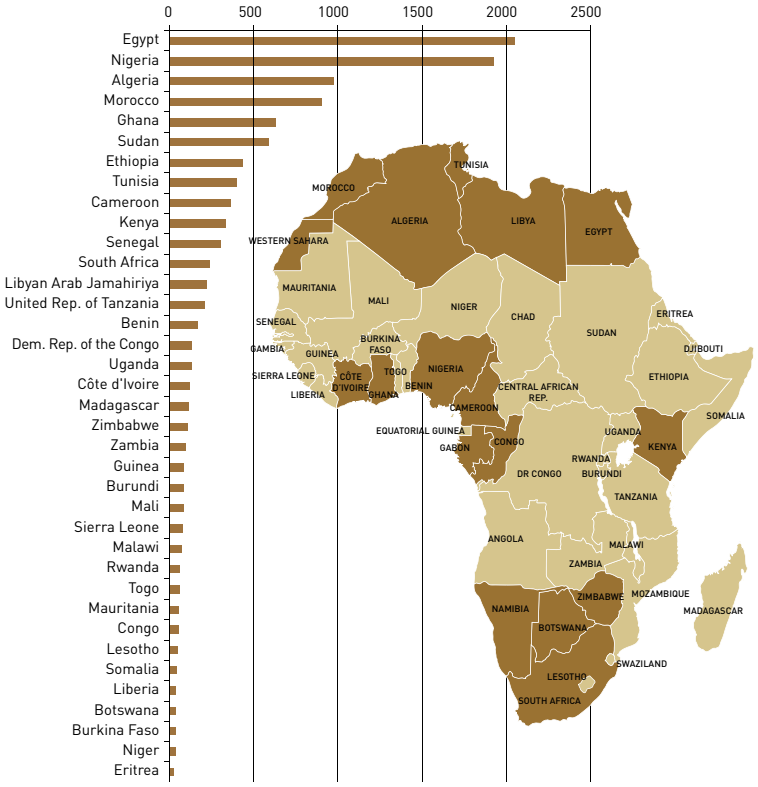
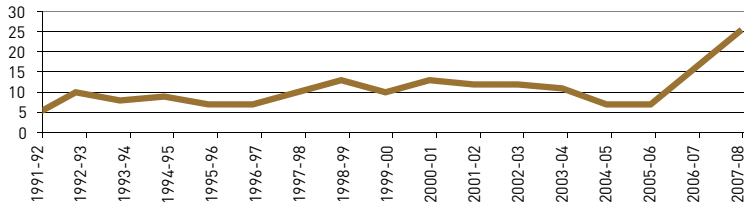
Visitors from Africa 1970-2008

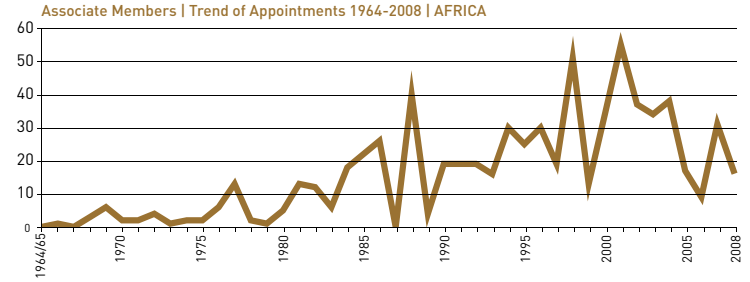
Least Developed Countries are in tan



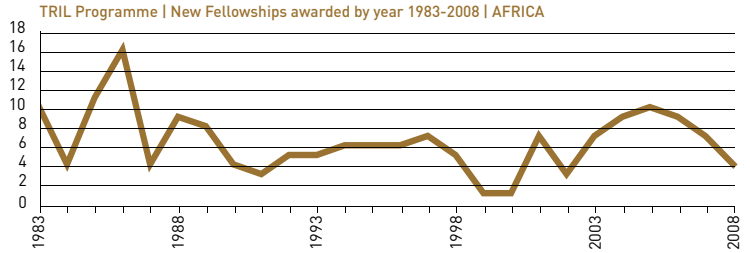
ICTP Diploma Course Programme | Number of Students | Academic years 1991-92 to 2007-08 | AFRICA



Associate Members | Trend of Appointments 1964-2008 | AFRICA



TRIL Programme | New Fellowships awarded by year 1983-2008 | AFRICA



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Research News Briefs

+ Low-cost, wireless networks like the one ICTP researchers developed for the Venice lagoon (pictured here) will be deployed to developing countries for environmental monitoring.

RESEARCH

ICTP AND VENICE LAGOON PROJECT

Low cost, wireless network deployed to measure water fluxes

ICTP's Aeronomy and Radiopropagation Laboratory has developed and deployed a low cost, wireless "mesh" network that provides Internet connectivity for water sensors in the Venice lagoon. The water sensors measure water speed, flux, temperature and salinity information that will be crucial for the success of Venice's planned flood protection barriers.

The network consists of five nodes spread over an area of about 14 square kilometers, with distances between nodes ranging from 7 km to 300 m. Three nodes are powered via solar panels. The water measurements gathered by the network, which was deployed at the request of Consorzio Venezia Nuova, are available online at Consorzio's website.

The Aeronomy and Radiopropagation Laboratory, headed by Dr. Sandro Radicella, aims to use the low-cost network for projects in developing countries as well.

Consorzio Venezia Nuova manages a programme of interventions to protect Venice against high waters and sea storms and to safeguard the lagoon's ecosystem environment •

LASER COLLABORATION BOOSTS OPTICS STUDIES

Synchrotron light laboratory offers hands-on experience

For several years now, ICTP has been offering a unique experience for students from developing countries to gain hands-on experience with advanced laser and optic equipment. Thanks to a collaboration with ELETTRA, the multidisciplinary synchrotron light laboratory in Trieste, the students have access to modern laboratory facilities that are used to investigate, for example, the applications of short pulse lasers—lasers for which the energy is output in pulses having a duration in the range of picoseconds (10^{-12}) or less.

"It is particularly important for ICTP to offer this kind of training, because there are many researchers from developing countries working in the field of optics," says Dr. Joseph Niemela, who, among other things, coordinates ICTP's optics and laser physics activities.

Students who are enrolled in ICTP's Sandwich Training Educational Programme (STEP), as well as those participating in the TRIL (Training and Research in Italian Laboratories) programme and ICTP Associates, can receive training or collaborate in experiments taking place in the laboratory.

Rim Cherif, a Ph.D. student from Tunisia, is one of the many ICTP STEP students who has been training and working at the laser laboratory under the supervision of Dr. Miltcho Danailov, who heads the laser laboratory at ELETTRA. Cherif's

++ ICTP STEP student Rim Cherif studying ultra-short pulse fibre lasers.
+++ Equipment at ICTP's Laser Laboratory

+++

initial work at the laboratory included numerical simulations and modelling of light pulse propagation in highly nonlinear photonic crystal fibres. She will return to the lab this summer to continue experiments on ultra-short pulse fibre lasers.

In addition to the cooperation between ICTP and ELETTRA, the laser laboratory also has fostered additional collaborations with two other Trieste research institutes: the International Centre for Genetic Engineering and Biotechnology (ICGEB) on the development of low-cost ultrafast lasers for DNA cross-linking studies, and with the Advanced Technology and Nanoscience (TASC) laboratory, to study laser "tweezers", used to manipulate microscopic biological objects. As a further collaborative activity, ICTP and TASC held a joint workshop on "Introduction to Optofluidics", in early June, where participants received hands-on training at the laser laboratory as well as TASC facilities •

ICTP AT ITALIAN RESEARCH AGENCY

TRIL participants highlight their work at joint workshop

A recent workshop held at the Italian National Agency for New Technologies, Energy and the Environment (ENEA) showcased ongoing research in Agency laboratories by visiting scientists from developing countries. Those scientists are participants of ICTP's Training and Research in Italian Laboratories (TRIL) programme.

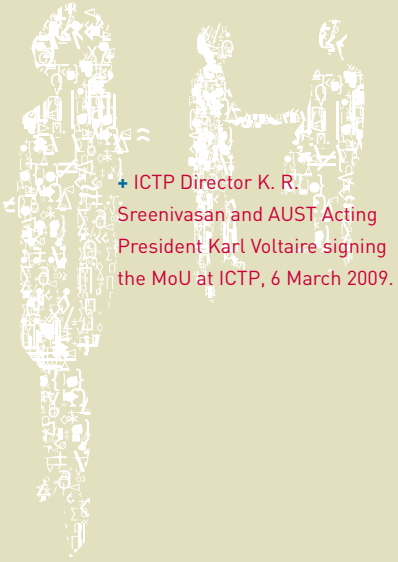
ENEA has collaborated with the TRIL programme since 1983. To date, ICTP has awarded 176 grants to 102 TRIL-ENEA fellows, who have spent a total of 1652 months in ENEA labs. The ICTP-ENEA collaboration was recently renewed in 2008.

Six ICTP TRIL participants presented their research at the workshop, which was attended by ENEA President Luigi Paganetto and other Agency representatives, along with TRIL programme directors Giuseppe Furlan and Daniele Treleani. Topics of the TRIL scientists' talks included:

- Laser detection technology applied to environment and cultural heritage
  Idris Nasrullah (Indonesia); ENEA lab: Frascati
- Materials for hydrogen storage
  Shivani Agarwal (India); ENEA lab: Casaccia
- High power free electron sources for terahertz radiation
  Lalit Gupta (India); ENEA lab: Frascati
- Dosimetry in radiation therapy
  Iordana Astefanoaei (Romania); ENEA lab: Casaccia
- Biofuels: esters from local crops in Nigeria
  Cosmas Anyanwu (Nigeria); ENEA lab: Trisaia
- Hydrogen absorption/desorption properties of metal hydrides
  Ankur Jain (India); ENEA lab: Casaccia

For more than two decades, ICTP's TRIL programme has helped scientists from developing countries gain hands-on experience in Italian laboratories. Since the programme's inception, more than 1000 fellows from 74 countries have benefitted from this initiative, whose goal is to strengthen the communities of scientists and technologists in the developing world. For more information, visit the TRIL website: www.ictp.it/pages/education/tril.html •

ICTP News Briefs



+ ICTP Director K. R. Sreenivasan and AUST Acting President Karl Voltaire signing the MoU at ICTP, 6 March 2009.

NEWS

ICTP SIGNS MEMORANDA OF UNDERSTANDING

Parties aim to establish ICTP-Romania

As a follow-up to an agreement signed last year between ICTP and the Horia Hulubei Foundation of Romania, ICTP Director K.R. Sreenivasan recently visited a number of prominent scientific institutions in Romania to lay the foundation for a planned ICTP branch in that country.

ICTP-Romania will be a scientific centre that will foster the growth of advanced studies and research in physics and related sciences, to provide an international forum and excellent research facilities for the exchange of information and ideas at the international level. ICTP will assist this new centre in its evolution.

Professor Sreenivasan visited the following Romanian institutions during his visit: Horia Hulubei Foundation; Horia Hulubei National Institute of Physics and Nuclear Engineering; Ministry of Foreign Affairs; Ministry of Education, Research and Youth; National Institute for Laser, Plasma and Radiation Physics; National Institute of Materials Physics; National Institute of Research and Development for Earth Physics; Faculty of Physics, University of Bucharest; and the Romanian Academy.

Also included in the visit was the UNESCO office in Bucharest, called the European Centre for Higher Education.

While in Romania, Professor Sreenivasan was awarded an honorary degree by the Romanian Academy •

ICTP and EBASI formalise joint activities

The Edward Bouchet Abdus Salam Institute (EBASI) and ICTP have signed a Memorandum of Understanding (MoU) formalising joint synergistic cooperation in scientific and technical collaborations among physical scientists, mathematicians, engineers, and technologists from America and Europe and their counterparts from developing countries, especially Africa.

The collaborative venture established by this document provides for comprehensive and multidisciplinary programmes designed to:

- enhance the impact of science and technology on the sustainable development of the countries on the African continent;
- increase the technical manpower pool working in Africa today by facilitating the training and education of African graduate students; and
- support the further sustainable development of both academic and public institutions that focus on physical science and high technology.

The MoU was signed on 11 February by ICTP Director K.R. Sreenivasan and Professor Milton D. Slaughter, founding EBASI council member and chairman •

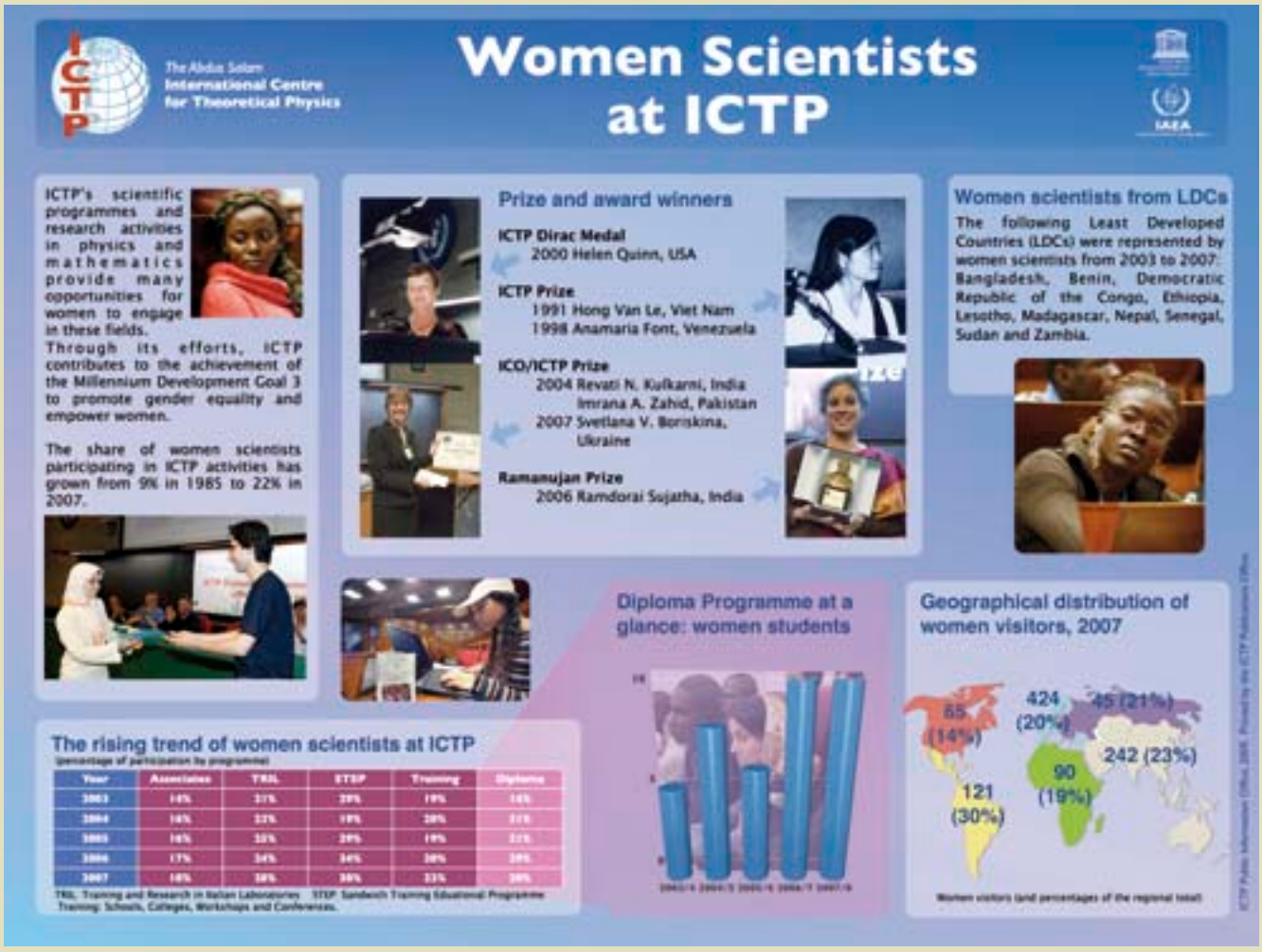
ICTP strengthens ties with AUST

ICTP and the African University of Science and Technology (AUST) have signed a Memorandum of Understanding to establish active collaboration in training activities. Under the agreement, ICTP will set aside up to two positions in its STEP programme for qualified AUST students, invite two qualified physics master's degree students from AUST to work on their thesis at ICTP, organise joint schools or colleges on topical subjects and assist with the delivery of physics courses at AUST •

NEW ICTP POSTER

Number of women scientists at ICTP steadily increasing

The share of women scientists participating in ICTP's training and research programmes has more than doubled over the past 20 years. A new poster titled "Women Scientists at ICTP" highlights this and other achievements about the rising trend of women scientists at ICTP. The poster is available on the Public Information Office website at http://pio.ictp.it •



NEW STAFF

+ Courtesy: S. Luzzatto

Stefano Luzzatto has joined the scientific staff of ICTP's Mathematics group. Luzzatto spent the first 17 years of his life in Ibadan, Nigeria and Napoli, Italy. After completing his undergraduate degree in Mathematics at Warwick University, UK, he spent three years at Marlboro College in Vermont, USA, as a teaching assistant and studying for his master's in the philosophy of mathematics education. He obtained his Ph.D. in 1995 from the Scuola Internazionale Superiore di Studi Avanzati in Trieste, Italy under the supervision of Jacob Palis and Marcelo Viana of the Instituto de Matemática Pura e Aplicada in Rio de Janeiro, Brazil. After a few years of post-doctoral fellowships at Warwick and a brief period as a lecturer at the University of Manchester Institute for Science and Technology, he took a permanent position as lecturer at Imperial College London in 2000 where he held a readership in applied mathematics before moving to ICTP. Luzzatto's research interests are in dynamical systems and ergodic theory, often popularly referred to as "Chaos Theory" •

++ Courtesy: M. Müller

Markus Müller has joined the scientific staff of ICTP's Condensed Matter and Statistical Physics (CMSP) group. After his graduation from ETH Zürich, he earned his Ph.D. at the Laboratoire de Physique Théorique et Modèles Statistiques in Orsay, France, working on statistical mechanics approaches to biopolymer folding. In 2003, Müller left for the USA for two postdocs, Rutgers (2003-2006) and Harvard University (2006-2008), during which he extended his field of interests towards condensed matter systems, such as electronic glasses, random magnets, dirty superconductors, and quantum phase transitions. One of his main interests is to understand the nature of disordered and complex systems, their collective low energy excitations and the impact of the latter on the physical properties of those systems. Recently, Müller has also been working on the physics of graphene. Before his recent appointment as staff researcher at ICTP, he taught the winter semester 2008/09 at Geneva University as a Förderprofessor of the Swiss National Fund for Scientific Research •

NEW STAFF

Antonello Scardicchio, also new to the CMSP group, is interested in field theory and statistical mechanics, with applications to condensed matter and high-energy physics and mathematics. He received his Ph.D. from the Massachusetts Institute of Technology in 2006. During his Ph.D. studies he worked on fluctuation induced (Casimir) forces, developing techniques for studying the dependence of the force on the shape of the conducting bodies. He has also worked on the signatures of parity symmetry in the mass spectrum of hadrons. He joined Princeton University as Junior Fellow of the Princeton Center for Theoretical Science, where he conducted research until January 2009. There he became interested in the theory of typical case complexity of decision problems (Computer Science), and in how it can be worked out for quantum-computing problems. To tackle this problem his team has developed a generalisation of the so-called cavity method. In 2008, he began to study the properties of determinantal point processes with a particular focus on their properties as possible efficient sphere-packings. He is also interested in integrability in field theory and in the predictions of AdS/CFT dualities of string theory for gauge theories and high-T_c superconductivity •

Mary Ann Williams is ICTP's new public information officer as of January 2009. Williams is an international science communicator with more than 20 years of experience. She has promoted research for a major US research university (Texas A&M), an international, interdisciplinary research institute (IIASA, Austria) as well as several international organisations devoted to the environment (International Geosphere-Biosphere Programme, Sweden and WWF-New Zealand). She also has lived and worked in developing countries. She is keenly interested in ICTP's research and training activities and looks forward to working with the Centre's scientists to promote their work •

ACHIEVEMENTS/PRIZES

2008 RAMANUJAN PRIZE

Prestigious math prize presented in Oslo

ICTP presented its 2008 Srinivasa Ramanujan Prize to Enrique R. Pujals, associate researcher at the Instituto Nacional de Matemática Pura e Aplicada (IMPA), Brazil, at a ceremony held at the Norwegian Academy of Science and Letters in Oslo on 20 May. The prize, which carries a US$15,000 cash award, is funded by the Academy through the Niels Henrik Abel Memorial Fund, with the cooperation of the International Mathematical Union.

Professor Pujals has been awarded the Prize in recognition of "his outstanding contributions to dynamical systems, especially the characterization of robust dynamics for flows and transformations and the development of a theory of generic systems." The ceremony was held during festivities honouring this year's Abel Prize winner. For more details about the Ramanujan Prize, please visit the ICTP website at http://prizes.ictp.it/Ramanujan •

+ Enrique Pujals receiving the Ramanujan Prize from 2009 Abel Laureate M.L. Gromov at the award ceremony held at the Norwegian Academy of Science and Letters, Oslo, 20 May 2009. (Courtesy: Knut Falch/Scanpix)

NUSSELT-REYNOLDS PRIZE 2009

ICTP Director honoured

ICTP Director K.R. Sreenivasan has been awarded the 2009 Nusselt-Reynolds Prize. The prize was established by the Assembly of World Conferences on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics to honour and commemorate Wilhelm Nusselt and Osborne Reynolds. The prize has been awarded since 1991 "for outstanding scientific and engineering contributions and eminent achievements in the fields of heat transfer, fluid mechanics and thermodynamics" •

ACHIEVEMENTS

SPIE FELLOW

ICTP scientist Dr. Zohra Ben Lakhdar elected

Zohra Ben Lakhdar, a long-time Associate of ICTP and editor of the Centre's *African Physical Review* scientific journal, has been elected as a Fellow of the International Society for Optical Engineering (SPIE). Maria Yzuel, SPIE president, presented a special plaque to Dr. Ben Lakhdar during the Winter College on Optics in Environmental Science, an annual school held at ICTP to expose young scientists from developing countries to recent achievements in optical techniques for assessing the environment.

The SPIE honour recognises Dr. Ben Lakhdar's specific achievements in applied atomic and molecular spectroscopy. She joins a group of some 550 SPIE Fellows who have made significant scientific and technical contributions in the multidisciplinary fields of optics, photonics and imaging.

Director of the Laboratory of Atomic-Molecular Spectroscopy and Applications at the University of Tunis, Dr. Ben Lakhdar was awarded the l'Oréal-UNESCO Award for Women in Science in 2005 for furthering the "development of optics and photonics as a scientific discipline in Tunisia and all of Africa," and "making a number of contributions to optical science and its applications."

In accepting her SPIE plaque, Dr. Ben Lakhdar acknowledged the influence of ICTP support on her scientific career. "This award is a result of ICTP. Their support over the past 10 years has made a big difference in helping me continue my career," she said •

++ SPIE president Maria Yzuel (left) awarding Zohra Ben Lakhdar the SPIE Fellow plaque during the Winter College on Optics in Environmental Science, ICTP, Trieste, 10 February 2009.

SUCCESS FOR FORMER ICTP ASSOCIATES

Academic, research honours for three physicists

Isaac Asuzu, professor of Veterinary Pharmacology at the University of Nigeria, Nsukka, has been elected by the University's Senate as the new Deputy Vice Chancellor (Academic). Professor Asuzu was an ICTP Associate from 1995 until 2007 in the areas of biophysics and medical physics.

Moulay Brahim Sedra, a mathematical physicist from Morocco, has received the 2008 Rammal Award from Euroscience, the European Association for the promotion of science and technology. The medal is awarded each year to an outstanding personality of strong scientific stature from one of the Mediterranean countries. Professor Sedra was an Associate from 1997 to 2008 in the area of high energy physics.

In addition, Professor Shyam S. Nandwani, an ICTP Associate from 1986 until 2007, has crowned a long career at the Laboratory of Solar Energy of Universidad Nacional, Heredia, Costa Rica, by receiving the prestigious Energy Globe Award for his project "Thirty years of research, dissemination and uses of solar cookers for both rural and urban areas to conserve human and planet health". His project was the national winner for Costa Rica, and was selected from among a total of 769 projects from 111 nations. The national awards were presented by high-ranking representatives of the European Union during a ceremony held in Prague on 13 April •

SLOAN FELLOWSHIP

Former Diploma student receives prestigious award

Gerard Awanou, an assistant professor of mathematical sciences at Northern Illinois University, USA, has won an Alfred P. Sloan Research Fellowship, one of the most significant awards for promising young scientists and researchers in the US. Awanou, born in Benin, obtained the ICTP Diploma in mathematics in 1998. He later earned his Ph.D. in mathematics from the University of Georgia. He spent two years as a postdoctoral associate at the Institute for Mathematics and its Applications at the University of Minnesota, before joining Northern Illinois University. Awanou's research interests are primarily in the numerical analysis of partial differential equations. Renowned mathematicians who have received Sloan Fellowships in the past include John Milnor, John Nash, Isadore Singer and Steve Smale •

SOLID STATE COMMUNICATIONS

ICTP Diploma student's thesis published

The results of the dissertation thesis by Tuan Anh Pham, Diploma student in the Condensed Matter class of 2007-2008, have been published in *Solid State Communications*. Pham is first author, together with Ralph Gebauer and Sandro Scandolo—both from the Condensed Matter section and his former teachers—of the paper titled "Magnetism and vibrations in the phase ε of oxygen" (*Solid State Communications*, vol. 149, January 2009, pp. 160-162). Pham came to ICTP from Hanoi University of Education, Viet Nam. He is now studying for his Ph.D. at the University of California at Davis •

+ Tuan Anh Pham receiving his diploma from Sandro Scandolo at the 2008 diploma award ceremony.

RECENT PUBLICATIONS

ICTP RESEARCH PUBLISHED IN *PNAS*

Research related to flux states in metabolic networks, carbon dioxide

Matteo Marsili of ICTP's Condensed Matter and Statistical Physics (CMSP) section, along with a group of interdisciplinary researchers, published results of their research on "Identifying essential genes in *Escherichia coli* from a metabolic optimization principle."

The research proposes a constraint-based model of cellular metabolism in order to characterise flux states in metabolic networks, which is able to reproduce the correct statistics of fluxes and whose results compare well with the available experimental evidence on individual fluxes. Essential genes in *E. coli* are found to correspond to reaction with strongly constrained fluxes.

The research was published in the 24 February edition of the *Proceedings of the National Academy of Sciences (PNAS)*.

Sandro Scandolo and Erio Tosatti of ICTP's CMSP section are among a group of international scientists who published a paper that appeared in the 30 March issue of *PNAS*. The paper, titled "High-pressure polymeric phases of carbon dioxide", provides insight into the structural transformations of solid carbon dioxide under high pressure.

Carbon dioxide transforms at high pressure from the molecular phase into a hard solid that may have important technological applications. The paper describes the microscopic mechanisms of the transformation and provides hints about the possible crystal structure of the hard phase •

PUBLICATIONS

CLOSING THE DIGITAL DIVIDE

SDU activities in physics journal

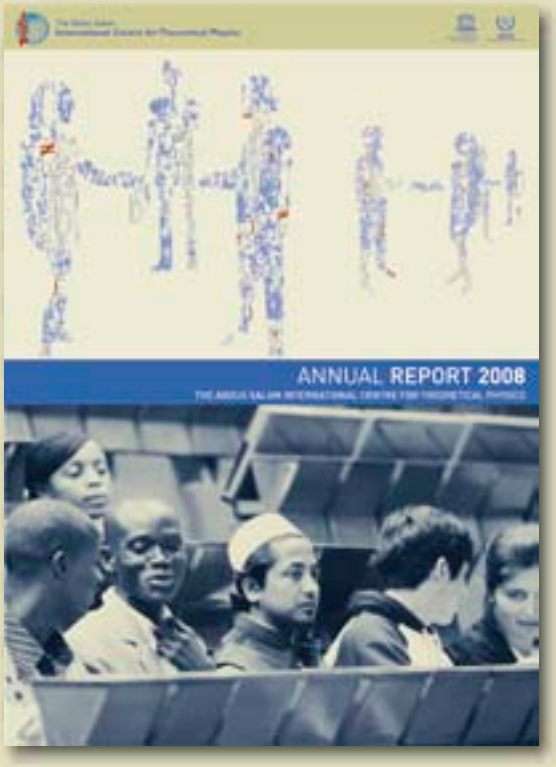
ICTP's Science Dissemination Unit (SDU) is carrying out several projects on information and communication technologies for development as well as training activities in collaboration with ICTP's Aeronomy and Radiopropagation Laboratory, Diploma Programme and Marie Curie Library, and the Stanford Linear Accelerator Center, among others.

An article in the 13 April online version of the *European Journal of Physics* by SDU staff members Enrique Canessa, Marco Zennaro and Carlo Fonda reviews these activities, and underscores the importance of wide and immediate access to knowledge not only to science but also to the sustainable development of society.

The article is titled "Supporting science in developing countries using open technologies" and can be viewed at: http://stacks.iop.org/0143-0807/30/651•

NEW ANNUAL REPORT AVAILABLE

ICTP's annual report for 2008 has been published. This year's report is available in two formats: a printed version that highlights the Centre's research and training activities, and a more detailed, technical report available on a CD as a searchable PDF document. To vew a PDF copy of the report, visit the ICTP website at http://pio.ictp.it •



UPCOMING SCIENTIFIC ACTIVITIES

For more details, visit the ICTP web page: http://calendar.ictp.it/2009/

10 - 14 August
Workshop on High Resolution Climate Modelling

10 - 28 August
Summer College on Plasma Physics

17 - 28 August
Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa

31 August - 18 September
Advanced School and Workshop on p-adic Analysis and Applications

7 - 25 September
First Workshop on Open Source and Internet Technology for Scientific Environment: with case studies from Environmental Monitoring

21 - 25 September
Pseudochaos and Stable-Chaos in Statistical Mechanics and Quantum Physics

28 September - 2 October
Joint ICTP/IAEA School on Nuclear Knowledge Management

28 September - 10 October
Advanced School on Non-linear Dynamics and Earthquake Prediction

5 - 8 October
Workshop on High-Impact Weather Predictability and Information System for Africa and AMMA-THORPEX Forecasters' Handbook

5 - 9 October
Joint ICTP/IAEA Workshop on Alternative Response Actions to Climate Change and Energy Options

ICTP ON THE WEB: www.ictp.it
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 bi-annual 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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