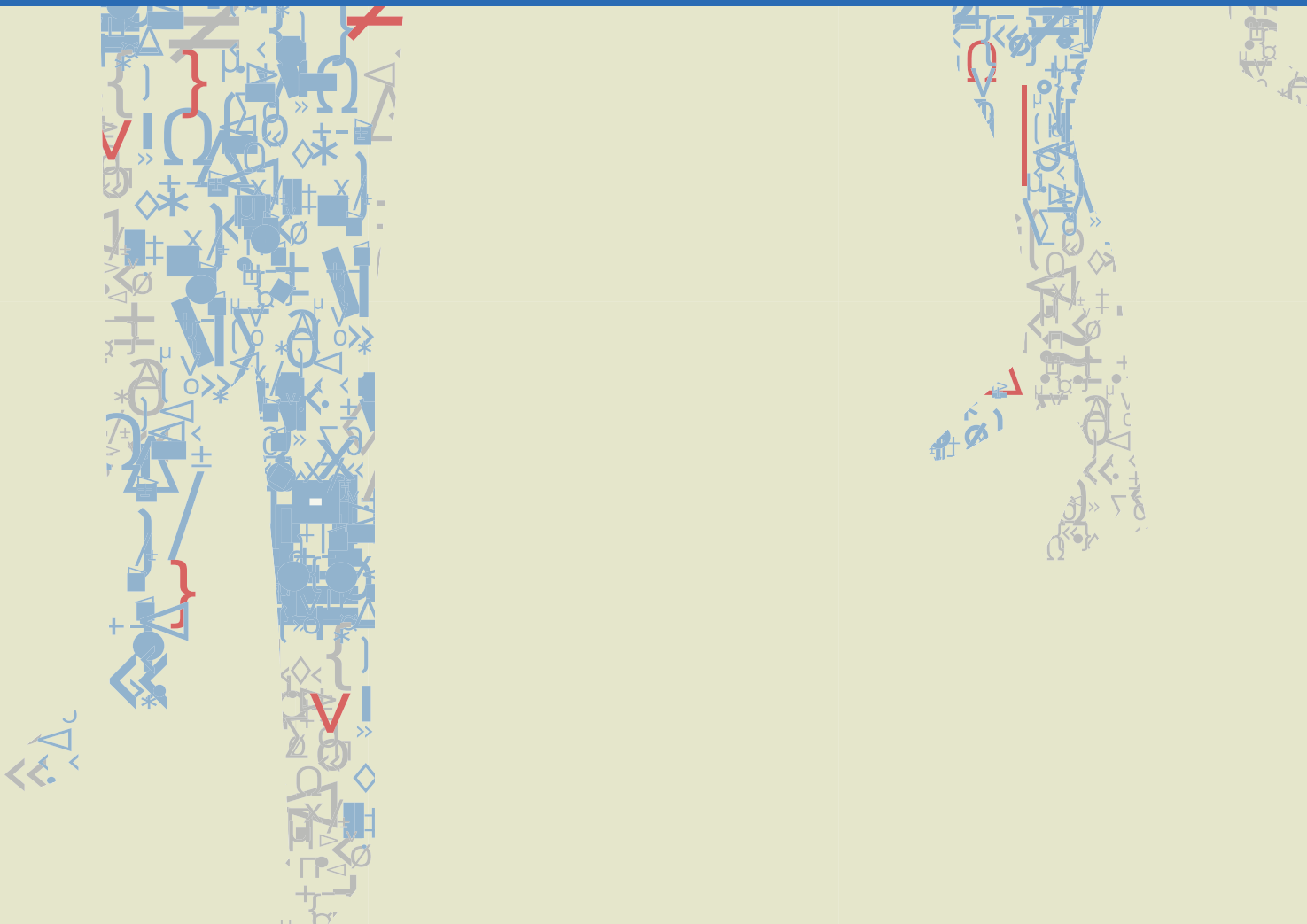




Full Technical REPORT 2009

THE ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS



THE ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
FULL TECHNICAL REPORT 2009

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INTRODUCTION

This electronic document is the full technical report of ICTP for the year 2009.

For the non-technical description of 2009 highlights, please see the printed book to which this CD is attached.

For easy reference, this pdf file contains bookmarks of sections and chapters. To go directly to the topics of your interest, scroll the bookmarks navigation bar and click on the page or its link.

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RESEARCH

HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS (HECAP)

Introduction

There are three broad research areas in the High Energy Section:

- I. Phenomenology of Particle Physics,
- II. Cosmology, and
- III. String and Higher Dimensional Theories.

Phenomenology of Particle Physics

The research activity in 2009 covered the following areas: neutrino phenomenology, physics at the LHC and other high energy colliders, flavor physics and astroparticle physics.

1. *Neutrino phenomenology*

- a) Theory of oscillations of very low energy atmospheric neutrinos (one of still missing elements of the neutrino phenomenology) has been elaborated.
- b) A novel approach to calculation of the neutrino oscillation probabilities in the wave packet picture, based on the summation conventions different from the standard one has been developed. It gives a new insight into the oscillation phenomenology. A number of subtle points and “paradoxes” are clarified.
- c) Phenomenon of multiple spectral splits of supernova neutrinos has been uncovered. Collective oscillations of supernova neutrinos swap the electron neutrino and antineutrino spectra with those of another flavor in certain energy intervals bounded by sharp spectral splits. This phenomenon can lead to interesting observational consequences.
- d) High energy cosmic neutrino fluxes can be produced inside relativistic jets under the envelopes of collapsing stars. A comprehensive (both analytic and numerical) description of the flavor conversion of these neutrinos is developed.

2. *Astroparticle physics*

- a) New model of dark matter (DM) has been proposed where the dark sector is an identical copy of the standard model (SM).

In addition to gravity, the SM and DM sectors are connected by heavy right-handed Majorana neutrinos. The out of equilibrium decay of these neutrinos produces equal lepton asymmetries in both sectors via resonant leptogenesis which later get converted to baryonic and dark baryonic matter. This explains why they have relic abundance of the same order. The lightest nucleon in the dark (mirror) sector is a candidate for dark matter.

- b) Constrained minimal supersymmetric model (CMSSM) is considered with addition of the right-handed neutrino superfields which have masses close to the GUT scale. The effects of these right-handed neutrinos on the low energy SUSY spectrum is explored. It is shown that the light (left-handed) sneutrino can be the next-to-lightest supersymmetric particle with either the neutralino or gravitino as the lightest supersymmetric particle. In this scenario there are new ‘sneutrino coannihilation regions’ which yield the desired thermal neutralino relic density.
- c) The leptogenesis scenario, so called “annihilating leptogenesis”, is proposed where the lepton asymmetry is generated through annihilations, rather than decays, of heavy particles.

- d) The generic leptogenesis constraints on the symmetry breaking scale of global lepton number are obtained.
- e) Various connections of the leptonic dark matter suggested by the ATIC and PAMELA results on cosmic electron and positron excesses to the neutrino mass generation are proposed.

A double type-II seesaw model is constructed for generation of neutrino masses and baryon asymmetry. The Higgs triplet can remain light and be accessible at the LHC. It can mostly decay into the leptons which can explain the positron and electron excesses observed by PAMELA through the annihilation of dark matter into the Higgs triplet. A lepton asymmetry is produced and stored in the Higgs triplet to account for the matter-antimatter asymmetry in the universe.

- f) The origins of dark and visible universe are unified in a variant of seesaw model: The dark matter relic density is a dark matter asymmetry emerged simultaneously with the baryon asymmetry from leptogenesis; the dark energy is due to a pseudo-Nambu-Goldstone-Boson associated with the neutrino mass-generation.

3. Phenomenology at LHC and other high energy colliders

- a) The minimal realistic SU(5) grand unified theory predicts the seesaw through weak fermion triplets with a mass below TeV. An in-depth study of consequences of this theory for colliders such as Tevatron and LHC has been performed. Of particular interest is LHC which offers a great hope of observing these particles with a spectacular signature of direct Lepton number violation. This can serve to probe the CP violating phases of the leptonic sector.
- b) Phenomenology of extended Higgs sector with various non-minimal couplings has been explored. In particular, the low energy constraints on “leptophilic” two Higgs doublet model and its tests at the LHC and ILC have been studied.
- c) Production of the Higgs bosons with lepton flavor violating (LFV) couplings at electron-photon collider (ILC option) have been considered. The collinear enhancement of the process $e + \gamma \rightarrow H + l$ has been uncovered.
- d) Effects of the anomalous Higgs couplings (in particular, due to dimension-six operators) on the Higgs boson production at the Large Hadron Collider are explored.
- e) Cross-section of the Higgs boson pair production at a photon-photon collision is computed in the two Higgs doublet model. Detection of this process will allow one to determine the Higgs self-coupling constant. It is shown that the cross-section can be enhanced for several reasons.

4. Flavor physics

- a) Information on the leptonic CP-phases can be obtained by studying correlations between the polarization of the initial muon state scattered of nuclei and the final state particles, the so-called triple product correlations. These P, CP and T violating triple correlations have been studied for muon to electron conversion in nuclei. It was found that in the simple seesaw mechanisms of all three types the correlations are negligible. In contrast, in the left-right symmetric theories, the effects can be observable in future experiments, as long as the scale of left-right symmetry breaking lies below 10-30 TeV. This provides a further boost for muon to electron conversion experiments which could help probe the theory behind neutrino mass.
- b) Collider (in particular, the LHC) signatures of flavon models based on global U(1) flavor symmetry have been studied. Flavons which have FCNC Yukawa interaction affect low energy observables. Production rate and the decay branching ratios of the flavons have been computed.
- c) The constraints on the Higgs triplet model from LFV processes such as tau rare decays and the muonium conversion have been found.
- d) It is shown that the problem of mass ratios of the lighter fermion generations within the minimal SU(5) GUT can be resolved in supersymmetry with large soft A-terms. One can

achieve simple unification for lighter generations without additional Higgs multiplet, while having sfermions lighter than 1 TeV. The presence of such large A-terms makes the sfermion mass spectrum distinct from the universal SUSY breaking sector. The implications of these splittings are studied in K- and D-meson oscillations and in rare processes $D \rightarrow \pi + \nu + \text{anti-}\nu$ and $K \rightarrow \pi + \nu + \text{anti-}\nu$, and in the latter case the effect is found to be important.

Cosmology

In 2009 the activities in the Cosmology group have been mainly in the following directions:

1. Clustering dark energy. The energy component responsible for the observed acceleration of the Universe, the so-called dark energy, is usually assumed to be smooth across the Universe and not actively participating in the formation of astrophysical objects. The ICTP Cosmology group has proposed a model (quintessence with zero speed of sound) where dark energy participates in the gravitational collapse which leads to the formation of structures in the universe. The phenomenology of this model is very rich and various experimental signatures are under investigation, particularly the effect on the physics of galaxy clusters.
2. Non-Gaussianity. This is a quite hot topic in the field and it encompasses all the phenomena which are not captured by the linear approximation to cosmological perturbations. It has been a main line of research for the ICTP group in the last few years. This year the group calculated the model independent contribution to the Cosmic Microwave Background Non-Gaussianities on large angular scales, generated by General Relativity. This represents an important theoretical input for the forthcoming Planck satellite results. The group is also actively involved in the planning of the future experimental satellite missions, especially regarding the discovery of non-Gaussianity.
3. Eternal Inflation. It describes the regime of inflation where an infinite amount of space is created, giving rise to so-called parallel universes. In 2009, the ICTP Cosmology group has organized a successful conference on this subject gathering all the experts of the field and it has studied quantitatively the conditions for the existence of this primordial cosmological phase.

String Related Topics

- 1) In 2009, the main activities in String related areas was centered around holographic QCD and holographic hydrodynamics. The idea here is to understand a particularly strong coupling phenomenon on the boundary of AdS space-time by using the holographic description in terms of the bulk gravity theory. Among the various results, a study of the Z_N vacua in the presence of fundamental quarks was carried out and it was shown that at temperatures higher than the mass scale of the quarks these Z_N vacua are lifted and the corresponding energy difference are calculated. Another work was computing the Nucleon-Delta electromagnetic form factors using holographic QCD and the results obtained were in good agreement with the experimental results.

Non-linear hydrodynamics with the aim of application to QCD plasma incorporating abelian and non-abelian global symmetries was studied using holography. Another set of papers were devoted to studying the effects of the Chern-Simons terms in 5-dim. gauged supergravity which is holographically responsible for chiral anomalies in 4-dimensional gauge theories. The results included a study of chiral magnetic conductivity as well as chiral dependence on the hydrodynamic waves in the presence of $U(1)$ R-charge chemical potential.

- 2) Another direction of work was in topological string theory. A new class of $N=2$ topological amplitudes was obtained generalizing the well known F_g . The novel feature of these new topological quantities is that they depend both on vector and hyper multiplets. The differential equations that characterize these new F-terms are obtained and include the usual holomorphicity w.r.t. vector moduli as well as harmonicity equations w.r.t. hyper moduli.

- 3) A consistent formulation of an interacting theory of massive spin-2 particles is a long-standing unsolved problem. A model with dynamical torsion has been studied in detail and has been shown to pass some consistency checks which the generalizations of the well known Fierz-Pauli theory have failed to pass. It has been shown that in a wide class of curved backgrounds the spectrum is ghost and tachyon free. The massive spin-2 particle originates from torsion and satisfies a generalization of Fierz-Pauli equation which reduces to the latter when the background is flat. A novel aspect of this model is that even a symmetric conserved energy momentum tensor can give rise to torsion degrees of freedom. This may have interesting astrophysical relevance. Gravity is expected to be modified in the infrared with possible application to the study of some of the unsolved problems of cosmology. More work is in progress to show the full consistency of such models.
- 4) A thorough investigation of the spectrum of a class of brane solutions in minimal gauged supergravity in 6 dimensions has been carried out. This is a completion of a work which had been initiated in previous years and now the full spectrum has been completed. This includes spin zero, one and 2 sectors as well as a large part of fermionic sector.

Training Activities

Spring School on Superstring Theory and Related Topics, 23-31 March. Organizers: J. de Boer, E. Gava, S. Kachru, N.S. Narain, S. Randjbar-Daemi

International Workshop: QCD from Colliders to Super-High Energy Cosmic Rays, 25 - 29 May. Organizers: Y. Dokshitzer, M. Strikman, D. Treleani

Workshop: Eternal Inflation, 8 - 12 June. Organizers: P. Creminelli, M. Musso

Summer School on Particle Physics in the LHC Era, 15 - 26 June. Organizers: B. Acharya, G. Dvali, G. Isidori, G. Senjanovic, A. Smirnov

Joint ICTP-INFN-SISSA Conference: Topical Issues in LHC Physics, 29 June - 2 July. Organizers: B. Acharya, M. Cobal, G. Kane, A. Romanino, A. Vacchi

Workshop Towards Neutrino Technologies, 13 - 17 July. Organizers: G. Fiorentini, J. Learned, M. Lindner, A. Smirnov

Outside Activity

5th Regional Meeting on String Theory - Kolymbari, Greece, 28 June - 6 July. Organizers: F. Ardalan, I. Bakas, E. Kiritsis, K.S. Narain, E. Rabinovici, S. Wadia, E. Witten

Participation in International Programmes

E.U. Network "The quest for unification: theory confronts experiment"

E.U. Network "Supersymmetry and the Early Universe"

ESF Scientific Network.

European Contract "UNILHC" - "Unification in the LHC Era"

Services

B.S. Acharya Trained/collaborated with 5 Post-docs and trained 9 students, including 3 STEP students.

Lectured on Lie Groups & Lie Algebras for the Diploma Programme.

Examiner for thesis defence of Diploma Programme students and SISSA PhD students.

- Manages ICTP's programmes on LHC physics and the ICTP's participation in the ATLAS experiment at the CERN LHC.
 Founded P(articles).A(stro).C(osmo).T(rieste) - a common forum for physicists in Trieste and the surrounding region to exchange ideas and collaborate.
 Organizer of the Joint ICTP-INFN-SISSA Workshop on Topical Issues in LHC Physics.
 Organizer of the Summer School on Particle Physics in the LHC Era.
 Organizer of the Informal Workshop for ICTP Associates on LHC physics.
 Serves on ICTP Procurements Committee.
 Committee Member for the SISSA Elementary Particle sector PhD entrance examinations.
- P. Creminelli Lectured on General Relativity for the Diploma Programme.
 Lectured on Inflation for the PhD programme at SISSA.
 Organizer of the Workshop: Eternal Inflation.
 Supervised 2 Diploma Programme students and examiner for thesis defence.
 Supervised 1 ICTP Associate.
 Supervisor of 2 PhD students from SISSA.
 Member of the Astroparticle Sector of SISSA.
- T. Enkhbat Tutorials on Introduction to Particle Physics for the Diploma Programme.
 Co-supervisor of 2 Diploma Programme students' projects.
- E. Gava Organizer of the Spring School on Strings.
 Lectured on Relativistic Quantum Mechanics and on Supersymmetric Field Theories for the Diploma Programme.
- P.-H. Gu Tutorials on The Standard Model for the Diploma Programme.
- M. Musso Arranges Cosmology Group seminars.
 Organizer of the Workshop: Eternal Inflation.
 Tutorials on General Relativity for the Diploma Programme.
- K.S. Narain Lectured on Quantum Field Theory for the Diploma Programme.
 Lectured on Mathematical Methods for the Basic Physics Diploma Programme.
 Supervised one Diploma Programme student and one PhD SISSA student.
 Organizer of the Spring School on Strings.
 Organizer of the 5th Regional Meeting on String Theory - Kolymbari, Greece.
- S. Randjbar-Daemi ICTP Assistant Director and Head, High Energy, Cosmology and Astroparticle Physics Section.
 Head of Diploma Programme and supervisor of the Head of the Library.
 Chairman of the SAC for the Cosmology position.
 Lectured on Quantum Electrodynamics for the Diploma Programme.
 Lectured on Relativistic Quantum Mechanics for the Basic Physics Diploma Programme.
 Organizer of the Spring School on Strings.

- Served on ICTP Committees, as well as on the joint ICTP-INFN Committee and several international Committees.
Chairman of the Committee of the IBM Project.
Supervised 1 ICTP Associate.
- B. Sahoo Supervised tutorials for Quantum Field Theory for the Diploma Programme.
- G. Senjanovic Member of the Steering Committee of COSMO09 and Member of the International Organizing Committee of the Planck series.
Organizer of the Summer School on Particle Physics in the LHC Era.
ICTP Representative of the Trieste node of the UniverseNet: European Community's Network, Sixth Framework Programme.
Lectured on The Standard Model for the Diploma Programme.
Supervised 2 Diploma Programme students and examiner for thesis defence. Supervision of one PhD student and two ICTP Associates.
Member of the Steering Committee for the Croatian Membership at CERN.
Member of the International Advisory Committee of the SEENET-MTP: Southeastern European Network in Mathematical and Theoretical Physics.
Received the Senior Scientist Award from the Ministry of Science and Technology of Slovenia.
- A. Smirnov Lectured on Introduction to Particle Physics for the Diploma Programme.
Supervised three Diploma Programme students and examiner for thesis defence.
Supervision of one PhD student, one post-doc and 1 ICTP Associate.
Organization of the Phenomenology activities within the High Energy Section.
Organization of visiting programme for scientists from L'Aquila.
Organizer of the Summer School on Particle Physics in the LHC Era.
Organizer of the Workshop: Towards Neutrino Technologies.
Editor of JHEP, JCAP and Divisional associated editor of PRL.
- K. Suruliz Tutorials on Lie Groups and Lie Algebras for the Diploma Programme.
- G. Thompson Head of ICTP Office of External Activities.
Lectured on Quantum Mechanics for the Basic Physics Diploma Programme.
Chairman of the ICTP Computer Committee.
Member of the Committee coordinating the IBM Project.
Member of the SAC for the EPS position.
- M. Torabian Arranges String Theory/Group Theory seminars.
Tutorials on Quantum Electrodynamics for the Diploma Programme and Relativistic Quantum Mechanics for the Basic Physics Programme.
- K. Tsumura Arranges Phenomenology Journal Club seminars and Phenomenology Group seminars.
Scientific Secretary for the Summer School on Particle Physics in the LHC Era.

| | |
|--------------------|--|
| L. Velasco-Sevilla | Arranged Phenom. Journal Club seminars and Phenomenology Group seminars. Tutorials on Quantum Mechanics for the Basic Physics Diploma Programme. Scientific Secretary for the Workshop: Towards Neutrino Technologies. |
| H-U. Yee | Tutorials for Mathematical Methods for the Basic Physics Diploma Programme. |
| Y. Zhang | Tutorials for Quantum Mechanics for the Basic Physics Diploma Programme. |

Staff and Long-Term Visitors

Professional Staff

S. Randjbar-Daemi, Iran
B. Acharya, UK
P. Creminelli, Italy
K.S. Narain, India
G. Senjanovic, Croatia
A.Yu. Smirnov, Russia
G. Thompson, Australia

Consultants

E. Gava, Italy

Post-doctoral Fellows

S. Abdussalam, Nigeria
T. Enkhbat, Mongolia
P.-H. Gu, China
M. Musso, Italy
A. Paranjape, India
B. Sahoo, India
K. Suruliz, Bosnia and Herzegovina
M. Torabian, Iran
K. Tsumura, Japan
L. Velasco-Sevilla, Mexico
H.-U. Yee, Korea
Y. Zhang, China

Visiting Scientists (3 months or more)

E. Akhmedov, Russia
Z. Berezhiani, Russia
V. Berezhinsky, Russia
K. Li, China
M.M. Sheikh-Jabbari, Iran
Z.-T. Wei, China

Funding

Spring School on Superstring Theory and Related Topics

Italian Istituto Nazionale di Fisica Nucleare (INFN): €6,000

Asia Pacific Center for Theoretical Physics (APCTP): USD10,000 (€7,756)

International Workshop: QCD from Colliders to Super-High Energy Cosmic Rays

Italian Istituto Nazionale di Fisica Nucleare (INFN): €6,000

Workshop: Eternal Inflation

Italian Istituto Nazionale di Fisica Nucleare (INFN): €6,000

Summer School on Particle Physics in the LHC Era, 15 - 26 June

Italian Istituto Nazionale di Fisica Nucleare (INFN): €10,000

Joint ICTP-INFN-SISSA Conference: Topical Issues in LHC Physics, 29 June - 2 July
Università degli Studi di Udine: €300
Scuola Internazionale Superiore di Studi Avanzati: €2,400

Workshop Towards Neutrino Technologies
Italian Istituto Nazionale di Fisica Nucleare (INFN): €5,000

Postdoc: M. Musso
INFN: €12,385

CONDENSED MATTER AND STATISTICAL PHYSICS (CMSP)

Introduction

The permanent staff of the Condensed Matter and Statistical Physics Group consisted of 7 staff members (see Annex). The two new staff members Dr. A. Scardicchio and Dr. M. Müller have been appointed by the ICTP Director and started service in 2009.

The total number of postdoctoral fellows and long-term (> 3 months) visiting scientists in 2009 was 25 (23 in 2008). 14 of them were nationals of developing countries, 3 were nationals of Eastern European countries, and 8 were nationals of developed countries (including a EC and a Democritos fellow, not paid by ICTP). The total number of months spent at ICTP by this category of scientists was 195 (222 in 2008), so that the average number of temporal staff was 16 (18 in 2008).

216 (197 in 2008) scientists (104 of them from developing countries, including 18 scientists from Africa, 32 from East European countries and 80 from developed countries, including 33 from Italy) made short (< 3 months) visits to CMSP Group in 2009 and took part in research and training activities.

An active part in the research and training activities has been also taken by 5 consultants, 3 staff associates and the long-term visiting scientist Dr. A. Silva.

Traditionally, the scientific activities of the CMSP Group follow three major directions:

1. Physics of Disordered and Strongly Correlated Electron Systems, including theoretical nano-physics, localization, quantum systems out of equilibrium, low-dimensional systems with interaction, strong electron correlations in new materials, disordered superconducting and superfluid systems, cold bosonic and fermionic atoms.

This direction was represented by the activities of staff members V.E. Kravtsov, M.N. Kiselev, M. Müller; staff associates A. Nersesyan and V. Yudson, a long-term visiting scientist A. Silva; consultants B.L. Altshuler, M. Fabrizio, G. Santoro, E. Tosatti and a number of post-doctoral fellows (A. Andreev, A. Das, O. Dimitrova, F. Franchini, A. Garcia-Garcia, T.K.T. Nguyen, G. Söyler, N. Surendran.)

2. Statistical Mechanics and Applications, including cooperative phenomena in complex adaptive systems, statistical mechanical description of complex networks and financial market, application of statistical mechanics to computer science, optimization problems in genetics and biophysics, non-equilibrium statistical mechanics, quantum computing.

This direction was represented by the activities of staff members M. Marsili and A. Scardicchio, consultant G. Mussardo, long-term visiting scientist A. Silva and a number of postdoctoral fellows (K. Anand, G. Bianconi, A. Chatterjee, L. Dall'Asta, A. Das, P. Vivo).

3. Electronic Structure and Condensed Matter Computer Simulations, including simulations of condensed matter at high pressures, new materials, ab-initio calculations of properties of nano- and bio- systems, catalysis and surface physics, simulations of fast processes of energy transfer, energy conversion and storage research, physics of friction and lubrication.

This direction was represented by the activities of staff members R. Gebauer, S. Scandolo; consultants E. Tosatti, G. Santoro and a number of postdoctoral fellows (O. Akin-Ojo, S. Bhattacharya, P. Ghosh, L. Giacomazzi, F. Inam, M.S. Lee, G. Longo, A. Smogunov).

Research activities

Publications

The research activities along the above directions resulted in 81 publications (75 in 2008) in the major peer-reviewed journals in 2009. They include 1 paper published in *Science*; 2 papers published in *Nature Materials*; 1 paper published in *Review of Modern Physics Colloquium*; 12 papers published in *The Physical Review Letters*; 3 papers published in *Proceedings of National Academy of Sciences of USA*; 3 in *Europhys. Letters*; 22 in *The Physical Review*; 3 in *Journal of Statistical Mechanics*. 36 papers written in 2009 are in press or submitted to be published.

Seminars

The intensity and diversity of scientific life inside the group is illustrated by the number (77 in 2009) and subjects of research seminars: seminars on Disorder and Strongly Correlated Systems (23 in 2009), Joint ICTP-SISSA seminar on Statistical Physics (32 seminars in 2009), Joint ICTP-SISSA Condensed Matter Seminars (11 in 2009). In addition there were 11 informal seminars and journal club seminars.

Invited talks

The members of the Faculty (Staff members and local consultants) of the CM & SP Group gave 53 plenary or invited talks in major international Meetings in 2009 highlighting the results of the Group's research.

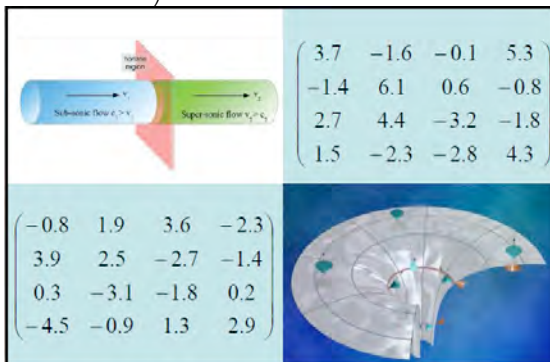
Main research results

The main results obtained in 2009 in the field of Physics of Disordered and Strongly Correlated Electron Systems are:

1. Is the Kondo screening a must? (E. Tosatti and M. Fabrizio)

It is well known and commonly accepted that the Kondo effect leads to screening of the impurity spin by spinful conducting electrons, thereby removing the Curie divergence of magnetic susceptibility at temperatures below Kondo temperature. The new method that combines the ab-initio calculations with the numerical renormalization group approach of Wilson has been developed and applied to the case of nano-junctions of nearly ferromagnetic metals. It appeared that at certain conditions the ferromagnetic Kondo effect may arise in this system with numerous physical implications which are drastically different from those of the more common antiferromagnetic Kondo effect.

2. What is common in cold atoms, black hole physics and random matrices? (V.E. Kravtsov and F. Franchini)

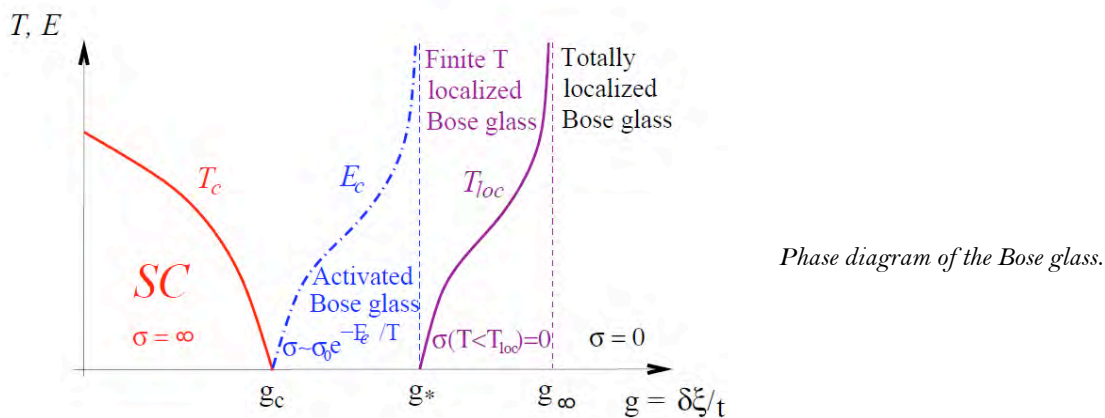


It is shown that correlation of eigenvalues in certain (unconventional) invariant random matrix ensembles (with log-normal probability measure) is similar to the density correlations of Hawking phonons in a sonic analogy of black holes in a flow of cold atoms. The sonic analogy of black holes in 1+1 space-time arises when the sound velocity in a quasi one-

dimensional system of interacting cold atoms is set (by detuning interaction by magnetic field) smaller than the their flow velocity in the half-space $x>0$, while it is larger than the flow velocity for $x<0$. The point $x=0$ is analogous to an event horizon, with the entire region $x>0$ representing the interior of a black hole, where no phonon can escape from. The random matrix- black hole analogy allows to predict oscillations in the density-density correlations of the sonic analogy of Hawking radiation and points out at the intimate relation between this random matrix theory, conformal field theory and geometry of the curved space-time with the event horizon (AdS-CFT analogy).

3. Bose glass: How many quantum phase transitions? (M. Müller)

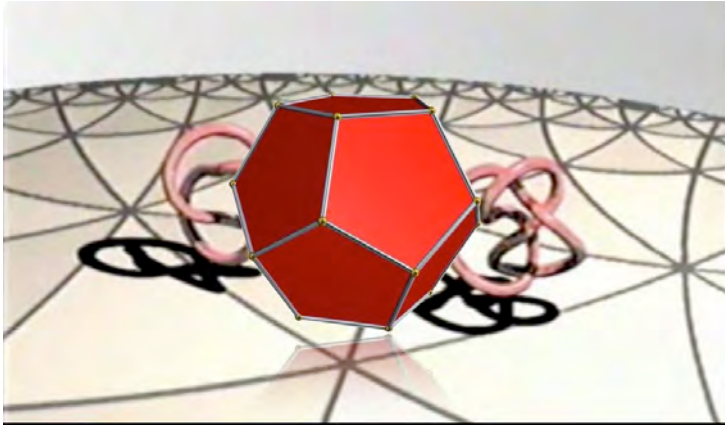
Superfluidity of cold bosons in disordered optical lattices and certain models of superconductivity in bad metals reduce to a problem of bosons in a disordered environment, so called Bose glass. The main problem here is: what does the disorder do to superfluidity and superconductivity of weakly interacted bosons and how many phases arise as the parameter (disorder strength)/(interaction) increases at very low temperature. At very weak disorder the system is superfluid. At strong enough disorder it is predicted (B.L. Altshuler, D. Basko, I.L. Aleiner) to become a perfect insulator with the activation gap proportional to the volume. The question that is currently under vigorous discussion in the community is whether or not there is only one quantum critical point g_c that separates superfluid and the perfect insulator. According to the scenario suggested by M. Müller in three-dimensional systems there is an intermediate imperfect insulating phase (and likely the second quantum critical point g^*) where the resistance at low temperatures is exponentially small, however, the activation energy is finite in the thermodynamic limit (activated Bose glass).



4. Fundamentals of hardware for quantum computations: Noise in a driven two-level system and topologically protected qubits in anyon quantum chains. (M.N. Kiselev, G. Mussardo).

Quantum computations and the corresponding read/write protocols imply an efficient time-dependent control of the quantum mechanical system. However, in many realizations of the quantum qubit (e.g., in a double quantum dot device used as a spin qubit) noise is inevitable (e.g., slow fluctuations of nuclear spins in a quantum dot) and it influences a lot the behavior of the system. In particular, such slow noise is shown to lead to a “blockade” of the qubit in a given state. The corresponding optimal read/write protocols to avoid such a blockade are formulated using the new representation of the solution to Landau-Zener problem (M.N. Kiselev).

Another rout to drastically reduce the effect of noise is to use topological quantum objects (which are not sensitive to small fluctuations in the same topological sector) in quantum computations. In particular, using a class of topological objects, the Fibonacci anyons, represented by a product of icosahedral group elements, could be a perspective direction in topologically protected quantum computations (G. Mussardo).



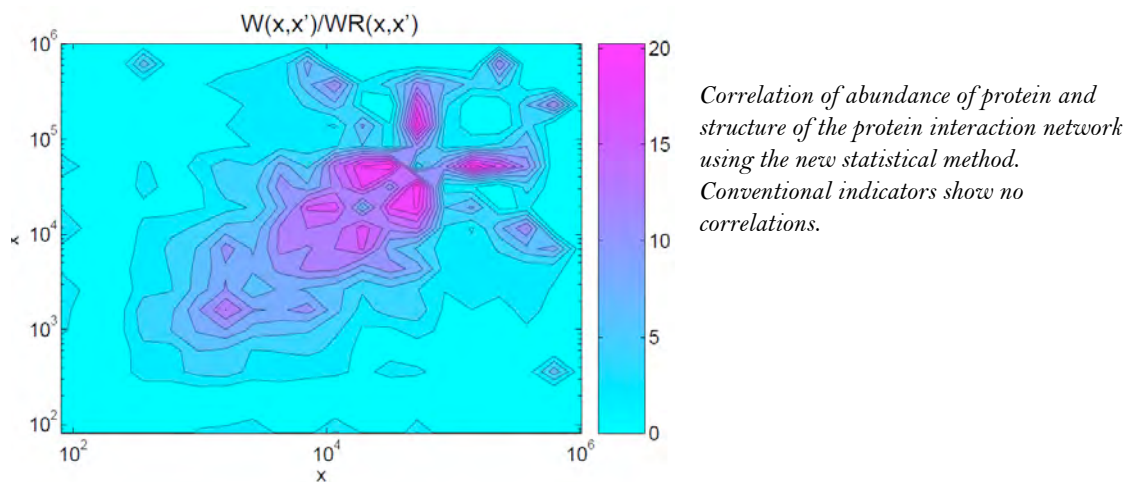
The main results in 2009 in the field of Statistical Mechanics and Applications are:

1. The Nash equilibria: What the Game Theory may give to financial market stability? (L. Dall'Asta, M. Marsili, A. Ramenzapour, P. Pin).

The Game Theory is the mathematical tool for constructing and studying the general trends in self-organizing systems of interacting agents which are the simplified versions of free market. One of the most important concepts of the Game Theory relevant for stability of free market economy is the notion of the Nash equilibria, in particular its character, existence and statistics. The optimization version of this problem is known to be one of the most difficult NP-hard optimization problems in computer science. The onset and reason for such hardness is a subject of intense current research. Using the cavity approach, the authors were able to get the exact statistics of the Nash equilibria and to unveil the reason of the hardness as hidden in the structure of the solution-space of the problem.

2. Essential genes and the architecture of the protein folding networks: A view from new statistical methods of feature extraction. (M. Marsili).

One of the main puzzles in molecular biology is how genes which control reactions locally can determine the global architecture of the protein interaction network. The authors proposed a new statistical method based on the entropy of the randomized network ensembles, to estimate how much of a particular feature, defined on the nodes of a graph, is relevant for the architecture of the network. This has led to the identification of essential genes in particular biological functions. The study was published in *Proc. Nat. Acad. Sci. USA* (see attached list).



3. From classical to quantum computer science: Quantum satisfiability problem. (A. Scardicchio, S.L. Sondhi (Princeton), R. Mössner (Dresden)).

The classical satisfiability problem which has numerous applications, including finding the ground state of a classical spin system with complex (not pair) interactions, is one of the most fundamental problems in computer science.

Of particular interest are the SAT/UNSAT transitions which indicate the onset of complexity and computational hardness. Its quantum analogue which is relevant for the emerging field of quantum computation, is currently of great interest.

This work was aimed at identifying the parameter space in which hard problems for quantum computation may arise and at studying the behavior near the quantum SAT/UNSAT transitions. The behavior was shown to be characterized by a number of unusual features, including the metastability for negative temperatures.

4. Exact many-body correlation functions in the Lieb-Linger model: Application to one-dimensional systems of cold atoms. (G. Mussardo).

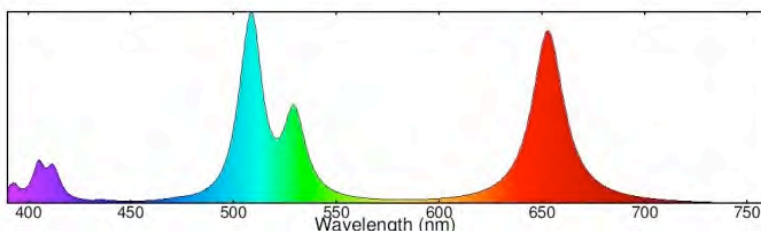
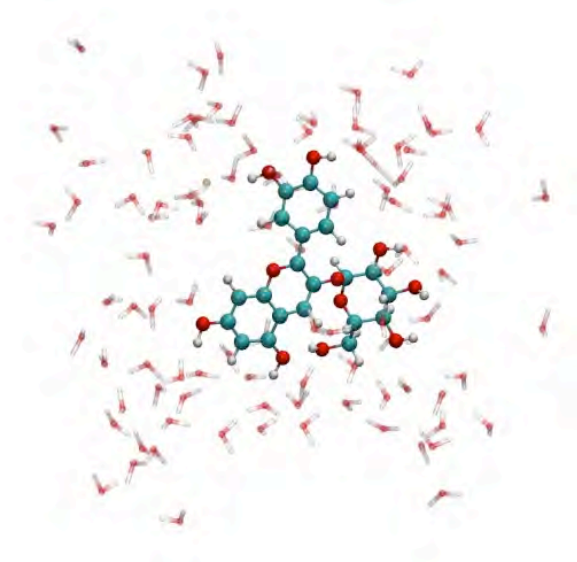
Based on the non-relativistic limit of the Sinh-Gordon model and Thermodynamic Bethe Ansatz, a method to obtain exact expression for many-body correlation functions in a one-dimensional quantum system with the Lieb-Linger Hamiltonian was developed. It has a broad range of applications in the systems of cold atoms.

The main results in 2009 in the field of Electronic Structure and Computer Simulations are:

1. “Quantum-Espresso” and its application to photovoltaic materials. (R. Gebauer, S. Scandolo)

Density-functional theory (DFT) is one of the most powerful methods of electronic structure computations. Unfortunately, it is literally applied only to the ground state. At the same time a growing demand from biology and energy production/transfer phenomena is a possibility to describe fast time-dependent processes, which require taking into account many excited states as well. This is in principle possible in the framework of the time-dependent DFT, however it is very expensive in terms of the computation time. A considerable methodological effort undertaken by an ICTP-SISSA team in which R. Gebauer and S. Scandolo took an active part has lead to the development of a new recursive technique which reduces considerably the numerical complexity involved in time-dependent DFT and allows to compute optical properties in large (up to 500 atoms) systems. This technique, called “Quantum Espresso” opens the door to computations in biological systems and systems where the effect of the environment is significant. That is why it is rapidly gaining popularity in the community.

In particular, one of the possible applications is photovoltaic materials where an initial electronic excitation (by light) is followed by a fast separation of the thus generated electron-hole pairs.

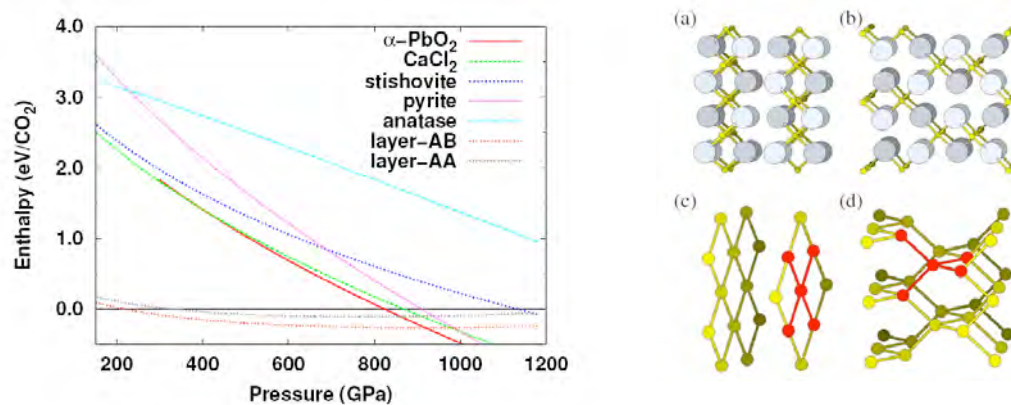


The flavylum (biological dye) molecule together with the surrounding solvent water. In the bottom of the picture, you find the calculated photoabsorption spectrum.

2. Non-molecular phases of CO₂ at high pressure: The mysterious phase VI (S. Scandolo, M.-S. Lee, E. Tosatti).

The recent discovery that molecular CO₂ transforms under compression into extended nonmolecular phases that are structurally similar to the ambient-pressure phases of silica opens unique scenarios on the solid-state chemistry of carbon oxides. In particular, the structural analogy of nonmolecular CO₂ with isoelectronic compounds SiO₂ and GeO₂ raises important questions regarding the tetrahedral or octahedral nature of the carbon coordination with oxygen. Metadynamics simulations starting from the molecular CO₂-II phase yielded, at 60 GPa, a fully tetrahedral, layered structure. Based on the agreement between calculated and experimental Raman and X-ray patterns, the recently identified phase VI was interpreted as the result of an incomplete transformation of the molecular phase into a final layered structure [1]. Based on static calculations at higher pressure, it was showed that a similar layered structure with carbon in tetrahedral coordination is thermodynamically stable between 200 and 900 GPa. The Raman spectrum for this phase also agrees with that measured for CO₂-VI.

[1] J. Sun et al., Proc. Natl. Acad. Sci. USA, **106**, 6077 (2009)



Figures (left) Calculated relative enthalpies per CO_2 molecular unit for a number of CO_2 structures, with respect to *b*-cristobalite; (right) Atomic arrangement in layer-AB and *b*-cristobalite structures. The big spheres represent oxygen atoms and the small spheres represent carbon atoms. Notice, in (a) and (b), the fcc close-packed structure of the oxygen sublattice. Panels (c) and (d) show the carbon sublattice in the two structures.

The red-dark-colored connection in (c) and (d) is representative of the only two types of local arrangement of carbon atoms in a fcc oxygen sublattice.

Participation in International Programmes

The group staff members are involved in a number of international scientific projects/networks:

- EU-STREP FP6 project GENNETEC (M. Marsili)
- EU Marie Curie Outgoing Fellowship (V.E. Kravtsov, A. Garcia-Garcia)
- CNR grant in context of ESF project “EuroMinSci” (S. Scandolo)
- EU-FP7 Collaborative Project “ADGLASS” (S. Scandolo)
- I2CAM programme (V.E. Kravtsov, M. Kiselev, S. Scandolo)
- Large Scale Facility (LSF) project with Weizmann Institute, Israel (M.N. Kiselev)
- EU DEI SA extreme computing project SOLARDYE on “Dye-Sensitized Solar Cells” (R. Gebauer)
- ESF grant “INSTANS” (G. Mussardo)

Training Activities

ICTP training activities:

The condensed matter related training activities in 2008 included 14 Schools and Conferences (14 in 2008), including 4 held in developing countries (see appended list). In 13 of them members of CMSP Group acted as Directors or Local organizers.

Teaching at ICTP:

7 staff members (R. Gebauer, V. Kravtsov, M. Kiselev, M. Marsili, M. Müller, S. Scandolo, A. Scardicchio), 2 consultants (G. Mussardo, G. Santoro), 1 Staff Associate (A. Nersesyan), 1 long-term visiting scientist (A. Silva) and postdoctoral fellows took part in teaching (A. Chatterjee, L. Dall’Asta, F. Franchini) and tutoring (K. Anand, T. Nguyen, N. Seriani, P. Vivo) in the ICTP Diploma Programme and the Joint ICTP-SISSA PhD Programme on Statistical Physics.

Teaching in Africa, Asia and Latin America:

The CMSP Section organized 2 Regional Schools in developing countries and took part in the teaching:

Latin American School on Computational Materials Science (Santiago-Chile)

Regional School on Physics at the Nanoscale: Theoretical and Computational Aspects (Hanoi-Vietnam)

R. Gebauer gave several lectures in Brazzaville, Congo at the “Meeting on renewable energy” (February 2009).

Services outside ICTP

G. Mussardo is nominated Chief Editor of JSTAT

S. Scandolo served as:

Member, Editorial Board, *Solid State Communications*, Elsevier;

Member, Editorial Board, *High Pressure Research*, Taylor & Francis

Member, Editorial Board, *African Physical Review*

Member, Steering Committee, Psi-K European Network

Summary in Numbers:

| | |
|--|-----|
| Publications in peer-review journals | 81 |
| Invited talks (excluding seminars) | 53 |
| Schools, Workshops and Conferences organized | 14 |
| Short-term visitors (excluding lecturers and participants of training activities) | 216 |

Funding

ICTP funding in 2009 was at the same level as in 2008: total of 600 K Euro for the Condensed Matter and Statistical Physics activities.

Scientific Staff and Long-term Visitors

Professional Staff

R. Gebauer, Germany

M. Kiselev, Russian Federation

V.E. Kravtsov, Russian Federation

M. Marsili, Italy

M. Müller, Switzerland, as of 27 Feb. 2009

S. Scandolo, Italy

A. Scardicchio, Italy, as of 19 Jan. 2009

Consultants

B.L. Altshuler, USA

M. Fabrizio, Italy

G. Mussardo, Italy

G. Santoro, Italy

E. Tosatti, Italy

Staff Associates

N. Kumar, India

A.A. Nersesyan, Georgia

V.I. Yudson, Russian Federation

Long-Term Visiting Scientist

A. Silva, Italy

In addition, there were 25 post-doctoral fellows & visiting scientists (over 3 months' stay).

Condensed Matter Related Activities 2009

8 - 10 January

14th International Workshop on Computational Physics and Materials Science: Total Energy and Force Methods

Co-sponsor: the International School for Advanced Studies (SISSA), the INFN DEMOCRITOS National Simulation Center, the International Center for Materials Research (ICMR), the Psi-k Network, and the Centre Européen de Calcul Atomique et Moléculaire (CECAM)

Organizers: R. Gebauer, F. Mauri, D. Vanderbilt

4 - 8 May

Conference on Research Frontiers in Ultra-Cold Atoms

Co-sponsor: MIT-HARVARD Center for Ultracold Atoms (CUA)

Organizers: C.A.R. Sa de Melo, H. Stoof, S. Yip, W. Ketterle; Local Organizer: M. Kiselev

18 - 23 May

Conference on Superconductor-Insulator Transitions

Organizers: Directors: M. Feigelman, M. Muller, Z. Ovadyahu, M. Sanquer; Local Organizer: V. Kravtsov

1 - 5 June

Conference: From DNA-Inspired Physics to Physics-Inspired Biology

Co-sponsor: Wellcome Trust, London, U.K.

Organizers: A.A. Kornyshev, W.K. Olson, V.A. Parsegian; Local Organizer: R. Gebauer

1 - 5 June

2nd Conference on Drug Development for the Third World: from Computational Molecular Biology to Experimental Approaches

Co-sponsor: ICS-UNIDO (Trieste), IAEA (Vienna), ICGEB (Trieste) and INFN-DEMOCRITOS (Trieste). In cooperation with ICS-UNIDO (Trieste) and INFN-DEMOCRITOS (Trieste).

Organizers: W.G.J. Hol, E. Lattman, S. Miertus and P. Carloni (also Local Organizer)

8 - 12 June

School and Conference: From Biological Networks to Cellular Function: Evolution, Dynamics and Spatial Organization

Co-sponsor: GENNETEC - Genetic Networks: Emergence and Complexity

Organizers: M. Aguiar, W. Banzhaf, G. Bianconi, R. Dilao, S. Franz, F. Képès, M. Lässig, O. Martin, D. Segré, M. Weigt; Local Organizer: M. Marsili

6 - 24 July

Summer College on Nonequilibrium Physics from Classical to Quantum Low Dimensional Systems

Organizers: L. Cugliandolo, L. Glazman, G. Mussardo; Local Organizers: M. Kiselev and A. Silva

21 - 25 September

Pseudochaos and Stable-Chaos in Statistical Mechanics and Quantum Physics

Organizers: R. Artuso, A. Kolovsky, R. Livi, T. Prosen, A. Vulpiani; Local Organizer: M. Marsili

19 - 24 October

Joint ICTP/FANAS Conference on Trends in Nanotribology

Co-sponsor: FANAS (European Science Foundation), Università di Milano, SPECS-Zurich

Organizers: O. Gulseren, N. Manini, A. Vanossi; Local Organizer: E. Tosatti

26 - 27 October

Structure and Dynamics of Hydrogen-Bonded Systems

Co-sponsor: Centre for Molecular Structure and Dynamics, STFC, UK

Organizers: J. Kohanoff, S. Koval, R. Senesi; Local Organizer: E. Tosatti

HELD OUTSIDE TRIESTE

19 - 30 January

Latin American School on Computational Materials Science (Santiago - Chile)

Co-sponsor: Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), Programa Bicentenario de Ciencia y Tecnología

Collaboration(s): Universidad Andrés Bello (UNAB), Santiago, Chile and Project Anillo ACT/24/2006 - Universidad de Chile "Computer Simulation Lab in Nanobio Systems"

Organizers: S. Cozzini, P. Giannozzi, E. Menendez-Proupin, W. Orellana, S. Scandolo

Co-Organizing Institutions: Universidad Andrés Bello (UNAB), Santiago, Chile; Project Anillo ACT/24/2006 - Universidad de Chile "Computer Simulation Lab in Nanobio Systems"; INFM - DEMOCRITOS National Simulation Center

29 June - 4 July

Advanced Workshop on Spin and Charge Properties of Low Dimensional Systems (Sibiu - Romania)

Organizers: M.E. Flatté, M. Polini, I. Tifrea, G. Vignale, M. Kiselev

23 - 30 August

Workshop on Trends in Nanoscience: Theory, Experiment, Technology (Sibiu - Romania)

Co-sponsors: EOARD, ANCS, IFIN-HH, ULB

Organizers: A. Aldea A. Safrany and S. Scandolo

14 - 25 December

Regional School on Physics at the Nanoscale: Theoretical and Computational Aspects (Hanoi - Viet Nam)

Organizers: B.L. Altshuler, M.N. Kiselev, V.E. Kravtsov, N.V. Lien, S. Scandolo; Local Organizer: N.H. Quang

CONDENSED MATTER AND STATISTICAL PHYSICS

SYNCHROTRON RADIATION RELATED THEORY

Introduction

The aim of the group is to perform theoretical research and training in areas of condensed matter physics that are experimentally investigated by synchrotron radiation (SR). There is close collaboration with experimentalists at the nearby SR source Elettra and at other similar facilities.

Within the relatively large scope of problems that fall under this description, the group has two main focusses of activities. The first field of activities is the investigation of the electronic, magnetic, and structural properties of systems with strong electron correlations, including transition-metal oxides and related materials. The second, more recent, area of interest is the physics of low-dimensional systems and nanostructures.

Research Activities

Structural and electronic properties of strongly correlated paramagnetic materials

A computational scheme has been developed in the group for the investigation of complex materials with strongly interacting electrons, which is able to treat atomic displacements, and hence structural relaxation, caused by electronic correlations. This scheme combines ab-initio density-functional calculations and dynamical-mean-field theory and is implemented with a plane-wave pseudopotential approach. The new scheme has been applied successfully to the challenging problem of determining the structural changes induced by orbital degeneracy in the paramagnetic phase of Jahn-Teller-distorted perovskite materials.

Surface stress and self-assembly at metal surfaces

Experiments using low-energy electron microscopy at the Nanospectroscopy beamline at Elettra demonstrated self-organization of Pd into stripes on a W surface and the critical influence of oxygen on the direction and width of the Pd stripes. In order to understand the underlying physical mechanisms, we have investigated by means of first-principles calculations the competition between elastic and boundary energy, and the influence of their anisotropies, on the stripe patterns. The ab-initio study of the boundary energy and surface stress for this system points to a strong dependence of the stripe pattern on the surface stress variations, and provides an explanation for the change in orientation of the stripes with oxygen deposition.

Local magnetism at metal surfaces and interfaces

The availability of experimental techniques such as x-ray magnetic circular dichroism, x-ray magnetic scattering, and polarized neutron reflectivity has made possible the observation of the magnetic properties of transition-metal and/or rare-earth-metal thin films and heterostructures with element specificity and monolayer sensitivity. In particular, such experiments have shown that vanadium, which is nonmagnetic in the bulk, can acquire a magnetic moment in V/Gd bilayer structures, with the V moment aligned antiparallel to that of the Gd ferromagnetic film. We have investigated by means of first-principles calculations the magnetic properties of V(110)/Gd(0001) layered structures and the microscopic mechanisms responsible for the induced V moment. The V moment and its antiparallel coupling to the Gd moment could be understood in terms of the Gd-V 5d-3d hybridization at the interface and the Gd 5d magnetic polarization by the 5d-4f intra-atomic exchange. The study also showed that atomic intermixing at the interface plays an important role in explaining the large V moment observed experimentally.

Training Activities

Joint ICTP/IAEA School on Novel Synchrotron Radiation Applications, organizers: F. Mulhauser, N. Binggeli, March 16- 20.

Staff and Long-Term Visitors

Professional Staff

N. Binggeli, Switzerland

Long-term visiting scientist

N. Stojic, Croatia

Post-doctoral Fellows

C. Wang, P. R. China

B. Zheng, P.R. China

PhD Student

L. Mouketo, Congo, STEP student

MATHEMATICS

Introduction

The year was one of transition. The section saw the retirement of Professor Le Dung Trang from the Headship. Professor Charles Chidume also retired and is now Senior Vice President/Provost of AUST; Professor Li Jiayu left to rejoin the Institute of Mathematics, Academy of Mathematics and Systems Science, Beijing. In April, we saw the arrival of Professor Stefano Luzzatto from Imperial College, London. Professor Luzzatto works in ergodic properties of dynamical systems, and is also interested in the use of computer-assisted proofs in the field.

At the end of the year, the section was left with three members, and was in the process of recruiting a Head, as well an analyst/geometer to fill Professor Li Jiayu's position.

We continued to be invested in Africa: in Nigeria with the Sub-Saharan PhD Programme, and in East Africa with the East African Universities Mathematics Programme. We were also involved in the organization of a conference in Gharian (Libya).

The themes of 2009 were p -adic analysis and low-dimensional topology. In keeping with this, a major school/conference was organized in each field (on p -adic analysis and knot theory respectively). The other major activities focused on advanced linear algebra and integrable systems.

A highlight of the research was the proof (by Göttsche and collaborators) of a conjecture of Witten (in the case of algebraic surfaces).

Research Activities

Staff

C.E. Chidume

Continued work on approximations to solutions of nonlinear equations defined on Banach spaces.

L. Göttsche

Continued his work on the generating functions of sections of line bundles on moduli spaces of sheaves on surfaces.

In joint work with H. Nakajima and Kota Yoshioka, the Nekrasov partition function (instanton counting) was used to prove, in the case of algebraic surfaces, the Witten conjecture expressing Donaldson invariants in terms of Seiberg-Witten invariants.

D.T. Lê

Together with D. Cheniot, was engaged in a study of S. Lefschetz' proof of the Hard Lefschetz Theorem, in an attempt to overcome the (known) problems in this purely topological approach to a cornerstone of algebraic geometry.

In joint work with G. Barsegian, obtained an estimate of the length of level sets of a real polynomial in two variables. This finds application to a conjecture by Erdős.

Jiayu Li

Studied symplectic critical surfaces in a Kähler surface, and the energy identity during blowing up for approximation harmonic maps.

S. Luzzatto

Continued to investigate the relation between the geometric structure of dynamical systems and their ergodic properties.

In joint work with, P. Pilarczyk, laid the foundations for a rigorous approach to computer-assisted proofs in the field.

Ramadas T. Ramakrishnan

Continued to work on Hodge conjecture for abelian four-folds and the unitarity of Hitchin connection.

Staff Associates

O.A. Laudal

Continued the study of models—using non-commutative algebraic geometry—for quantum physics.

J. Seade Kuri

Research was primarily concerned with the topology of real and complex singularities. Continued work on foliations with Bott-Morse singularities and on discrete groups acting on complex projective spaces.

Post-doctoral fellows and visitors

The post-doctoral fellows and visitors in the Section represent a wide variety of interests and come from around the world. The Section has always made a particular effort to promote diversity, while at the same time striving to maintain a vibrant research community.

In 2009 our post-doctoral fellows worked on Frobenius manifolds (Yassir Dinar, Sudan), hyperplane arrangements, braid groups and dynamical systems (Shaheen Nazir, Pakistan), contact and symplectic geometry (Dishant Pancholi, India) moduli problems on algebraic surfaces (R. Parthasarathi, India), dynamical systems and planar Jacobian maps (Roland Rabanal, Peru), Nevanlinna theory (Van Tan Tran, Vietnam), nonlinear elliptic equations (Akila Yechoui, Algeria), harmonic maps and the Skyrme model (Xiangrong Zhu, China).

Our other visitors studied Khovanov cohomology (Ahmad Zainy Al-Yasry, Iraq), mean field equations (Meng Wang, China), spectral theory (M. Boumazgour, Morocco), Suslin matrices (Selby Jose Nalleparambil, India), rational points on elliptic curves (Carlos Castaño-Bernard, Mexico), functional differential equations (Mohammed Abdalla Darwish, Egypt), hardy inequalities (Alnar L. Detalla, Philippines), quivers (Hhua-Lin Huang, China), and spectral theory of operators on Fock space (Tulkin H. Rasulov, Uzbekistan).

Training Activities

Advanced School and Conference on Knot Theory and its Applications to Physics and Biology (11 - 29 May). Organizers: S. Jablan, L.H. Kauffman, S. Lambropoulou, J. Przytycki

Co-sponsored School and Workshop on Integrable Systems and Scientific Computing (15 - 20 June). Organizers: B. Dubrovin, T. Grava, C. Klein, A. Kuijlaars

Summer School and Advanced Workshop on Trends and Developments in Linear Algebra (22 June - 10 July). Organizers: R. Bhatia, J. Holbrook, S. Serra Capizzano

Advanced School and Workshop on p-adic Analysis and Applications (31 August - 18 September).
Organizers: Ha Huy Khoai and V. Berkovich

External School in Samarkand, Uzbekistan: International School and Conference on Foliations,
Dynamical Systems, Singularity Theory and Perverse Sheaves (6 - 21 October). Organizers: F. El
Zein, S. Gusein-Zade, R. Langevin, D.T. Lê, D. Massey, A. Narmanov, A. Soleev

Participation in International Programmes

L. Göttsche

Invited talks:

Conference on Arithmetic Geometry and Moduli Spaces in Algebraic Geometry, 24–28 August
2009, Hangzhou, China.

International Workshop on Mirror Symmetry, Hausdorff Center for Mathematics, Bonn,
Germany, 2-5 June 2009.

Conference on Mock theta functions and applications in combinatorics, algebraic geometry, and
mathematical physics, Max-Planck Institute for Mathematics, Bonn, 25–29 May 2009.

University of British Columbia (Vancouver).

University of Trieste, October 2009.

D.T. Lê

Invited talks:

Abdus Salam School of Mathematics, Lahore, Pakistan, March 2009

Worldwide center of Mathematics in Cambridge, May 2009

Franco-Japanese meeting in Strasbourg, August 2009

Singularity meeting in Münster, September 2009

International conference on Topology and Geometry, University of Hue, September 2009.

Lecture in honour of H. Kurke at Humboldt University (Berlin), October 2009.

Harvard University, November 2009.

Jiayu Li

Invited talks:

Beijing University Summer School, 12 July-2 August 2009

Warwick University, 28 October-1 November 2009

Max-Planck Institute for Mathematics in Leipzig in Germany, 25-30 November 2009.

Workshop on geometric analysis at Yunnan, China, 21-29 June 2009.

S. Luzzatto

Invited talks:

Conference on Basic Science, Gharian (Libya), April 2009.

International Conference on Dynamical Systems, Corinaldo, Italy, 8-12 June 2009.

University of Udine, Italy, 25 June 2009.

Dynamical Systems Session, ISAAC conference, Imperial College London, 13-18 July 09.

Workshop on Computational Geometry, Topology and Dynamics. Fields Institute, Toronto, Canada, 16-21 November 2009.

Ramadas T. Ramakrishnan

Invited talk:

3rd Conference on Basic Sciences, AL-Jabal Al-Gharbi University, Faculty of Science, Gharian (Libya) 25-27 April 2009

Services

Within ICTP

L. Götsche

Gave two courses at the Diploma Programme: (second half of) Algebra and Algebraic Geometry

Supervised PhD student Yao Yuan (China, SISSA)

Supervised Diploma students Mohammad Salah Uddin and Cristian Martinez.

Supervised post-doctoral fellow Parthasarathi Rangasamy.

Local Organizer of the Advanced School and Workshop on p-adic Analysis and Applications (31 August - 18 September).

Coordinator of Diploma Course in Mathematics.

Jiayu Li

Course on Differential Geometry in the Diploma Programme.

Supervised Diploma students: Malva Asaad and Stephane Happi Kwemo

Supervised Post-doctoral fellow Dr. Zhu Xiangrong, STEP student Mr. H. Franck Djideme, and long-term visitor Prof. Wang Meng.

S. Luzzatto

Organized a series of one-day conferences in Dynamical Systems in May and July.

Supervised Diploma students Sylvia Agwang and Alex Behakanira Tumwesigye.

Collaborated with visitors Carlangelo Liverani (University of Rome "Tor Vergata", Italy) May 09, Vaughn Climenhaga (Pennsylvania State University, USA) 25 July-1 August 09, Sandro Vaienti (CPT, Marseille, France) 30 July - 5 August 09, and Oliver Butterley (UFRJ, Rio de Janeiro) 14 -20 Sep 09, 15-22 Oct 09.

Service activities: Adriatico Guesthouse Catering bid committee

Public presentation in Trieste for Researchers' Night. 25 September.

R.T. Ramakrishnan

Oversight of the Associates Office at ICTP.

Organizer of the Mathematics Seminar at ICTP.

Helped organize the Africa discussion meeting on 6 May.

Chair, Ramanujan Prize Committee.

Served on two Special Advisory Committees (as Chair in one.)

Course in the ICTP Diploma Programme (Abstract Algebra, Part II). Supervised PhD student Alberto Celotto (SISSA).

Supervised Diploma students Le Thanh Hieu and Azizeh Nozad.

Supervised post-doctoral fellows Dishant Pancholi and Shaheen Nazir.

Organized and lectured in the East African School on Linear Algebra (and advanced topics) during 16-30 August 2009 at Dar-es-Salaam, Tanzania.

Initiated and served as Local Organizer of “Summer School and Advanced Workshop on Trends and Developments in Linear Algebra” at ICTP (22 June - 10 July)

Outside ICTP

L. Göttsche

Editor of the journal *Geometry and Topology*.

Member of the scientific advisory Board of the Max-Planck-Institut for Mathematics, Bonn.

Member of the Programme Committee: ICMS Edinburgh.

Member of the Board, International Centre for Mathematical Sciences (ICMS), Edinburgh.

Lê D.T.

Editor of *International Journal of Mathematics* and of *Acta Mathematica Vietnamita*.

Attended a meeting in Oman financed by ICTP

Attended a meeting in Lahore, Pakistan also financed by ICTP

Jiayu Li

Organized a workshop on “Geometric Analysis” at Yunnan, China from 21 to 29 June 2009.

S. Luzzatto

Co-organizer, Dynamical Systems Session, ISAAC conference, Imperial College London, 13-18 July 2009.

PhD Thesis examination committee for Marie Philippe, Univ. of Marseille, 2 Dec 09.

Member of the Editorial Board of the journal *Rendiconti dell'Istituto di Matematica dell'Università di Trieste*.

R.T. Ramakrishnan

Helped organize the 3rd Conference on Basic Sciences, Al-Jabal Al-Gharbi University, Faculty of Science, Gharian (Libya) 25-27 April 2009.

Represented ICTP at the meeting on IMU-UNESCO cooperation (Budapest, 5 November).

Member, Editorial Board, *Mathematical Proceedings of the Indian Academy of Sciences*.

Member, Editorial Board, *Rendiconti dell'Istituto di Matematica dell'Università di Trieste*.

Seminars

Thirty Mathematics seminars were organized during the year.

Joint ICTP/SISSA Colloquia in Mathematics: Tristan Rivière (ETH, Zurich, Switzerland) and Ermanno Lanconelli (University of Bologna, Italy).

Staff and Long Term Visitors

Professional Staff

Lê Dung Tráng, Vietnam/France
C.E. Chidume, Nigeria
L. Göttsche, Germany
J. Li, P.R. China
S. Luzzatto, Italy
R.T. Ramakrishnan, India

Consultants

A. Ambrosetti, Italy

Staff Associates

O.A. Laudal, Norway
J. Seade Kuri, Mexico

Post-doctoral Fellows

Y. Dinar, Sudan
S. Nazir, Pakistan
D. Pancholi, India
R. Parthasarathi, India
R. Rabanal, Peru
Tran Van Tan, Vietnam
A. Yechoui, Algeria
X. Zhu, P.R. China

Long-term Visiting Scientists

A.Z. Al-Yasry, Iraq
M. Boumazgour, Morocco
C. Castaño-Bernard, Mexico
M.A. Darwish, Egypt
A.L. Detalla, Philippines
H.-L. Huang, P.R. China
S. Jose, India
T.H. Rasulov, Uzbekistan
M. Wang, P.R. China

Additionally, there were 63 short-term visitors. The total number of research visitors during 2009, including ICTP Associates and Affiliates, was 114, of whom 96 were from developing countries. The number of Associates was 30.

Research Travel Grants from External Sources

Within the framework of existing agreements, the following travel grants were provided in connection with research:

| <i>Source</i> | <i>Travel grants</i> |
|---|----------------------|
| Commission on Development and Exchanges of the International Mathematical Union | 2 |
| National Natural Science Foundation of China | 3 |

Miscellaneous

The Ramanujan Prize for 2009 was announced. It will be awarded to Professor Ernesto Lupercio, researcher at CINVESTAV, Instituto Politécnico Nacional, Mexico.

EARTH SYSTEM PHYSICS (ESP)

Introduction

The ESP section conducts research and organizes educational activities in both solid and fluid Earth physics (atmosphere and ocean). Two main research lines are conducted in fluid earth physics: Climate Change and Impacts (CCI) and Natural Climate Variability and Predictability (NCVP). Within the solid Earth's physics area the main line of research is in Mechanics of Earthquakes and Tectonophysics (MET). The ESP section currently includes 5 P-staff members and additional 15-20 members on term contracts (post-doctoral fellows and scientific visitors). An additional P-Staff member will join the section in April 2010. Differently from other ICTP sections, ESP relies heavily on external funding, with 7 grants (five from the EU) active in 2009. External funding currently provides about half of the general expenditure budget of the section and several post-docs and long term visitors are working on grant projects.

The CCI research line aims at improving the understanding of anthropogenic climate change and its impacts on human societies and natural ecosystems. Within this area, the section investigates 1) the global and regional climate response to increased atmospheric greenhouse gas concentrations and its effect on hydrology, agriculture and human health; 2) the climatic effects of aerosol and pollution emissions of natural and anthropogenic origin (chemistry-climate interactions); and 3) the effects of land use modifications (biosphere-atmosphere interactions). These issues are addressed with a range of modeling tools, the central one being the regional climate modeling system RegCM, which has been developed for over a decade and is maintained for community use. The ESP section also maintains the Regional Climate Research NETWORK, or RegCNET, a network of scientists mostly from developing countries involved in regional climate research which has grown in 2008 to include over 700 participants.

The NCVP research line focuses on fundamental research on natural climate variability and predictability at temporal scales from intra-seasonal/seasonal to multi-year/multi-decadal. Particular attention is devoted to tropical variability processes, such as the El-Niño Southern Oscillation, the Madden-Julian Oscillation and the monsoon systems, and how they interact with extratropical variability and flow regimes (e.g. the North Atlantic Oscillation). The section utilizes a range of modeling and observational tools and products (e.g. the SPEEDY and EC-EARTH global climate models). A major line of research concerns seasonal climate prediction. This is aimed at improving both process understanding and forecast performance of seasonal prediction tools in order to provide potential users (e.g. farmers or water managers) useful predictions at intra-seasonal to seasonal scales. The CCI and NCVP research lines are deeply intertwined, since an understanding of anthropogenic climate change requires an understanding of natural climate variability.

The MET research line investigates the way earthquake faults develop in time and of how the Earth Interior deforms, with emphasis on the physics of crust-upper mantle interactions. This research line relies on geophysical methods blending space geodesy, seismology and tectonics, tied through realistic physical numerical modeling. This, along with pattern recognition - based earthquake prediction algorithms and wave field modeling developed by the Structure and Non-Linear Dynamics of the Earth (SAND) group, contributes to the physical understanding of the length and time scales of earthquakes and to a more realistic simulation of earthquake hazards. On a long run, this research line may find room for collaboration with the fluid Earth lines in studying the mutual relationships between climate and tectonics, for example through changes in glacier mass, and the effects of global change on natural hazards. ESP also includes the SAND group as a hosted activity, for which a separate report is presented.

The approach followed in ESP to transfer methodologies and know-how to developing country scientists is to complement the traditional ICTP educational and outreach activities with joint research efforts on specific projects. In addition, the ESP section maintains a range of models and datasets for use by visitors and the community at large.

Research Activities

A. Climate Change and Impacts (CCI)

A.1 Regional climate modeling (Giorgi, Bi, Coppola, Rauscher, Im, Diro, Mariotti + associates/visitors)

During 2009 work has continued on the development, testing and application of the regional climate model RegCM, which is maintained for use by a wide community of scientists. In particular, work has begun on the development of a new version of the model, RegCM4, planned to be released during the fifth ICTP regional modeling workshop in June 2010. The new version of the model will have several new features: 1) a much better optimized, multi-tasking, architecture-independent and user-friendly code. This effort is ongoing as part of a collaboration with the Democritos group at SISSA and a sub-contract with external computing experts; 2) Capability of coupling with two ocean models, the MIT ocean model (collaboration with ENEA, Artale et al. in press) and the ROM ocean model (collaboration with the EU-India grid European project, Ratnam et al. 2009); 3) Capability of coupling with the new land surface / interactive biosphere model CLM (Collaboration with the U. Michigan); 4) Capability of coupling with different atmospheric chemistry modules; 5) Introduction of semi-lagrangian advection which will allow an improvement in model accuracy and computational efficiency (collaboration with the Politecnico di Milano). These features will place the ESP section at the forefront of regional climate modeling, opening the perspective for a wide range of new applications with the RegCM.

On the application side, continuing previous efforts, in 2009 at ICTP the model was mostly run over Africa, Europe, Asia and Central America for multi-decadal simulations of present day and future climate at grid spacings of 10 to 50 km. Of particular interest, in collaboration with external groups from Hungary, Czech Republic, Romania, Austria and Greece, high resolution simulations at 10-15 km grid spacing were conducted over different European sub-domains (Alps, Carpathian Basin, central Europe, southeast Europe), which allowed the development of a high resolution version of the model. Substantial work, resulting in various publications (Sylla et al. 2009 and JGR in press), was carried out on the evaluation of the model performance over Africa. It was shown that the RegCM is capable of simulating the main dynamical features affecting the West Africa monsoon, such as the Africa Easterly Jet, the Tropical Easterly Jet and the Easterly Wave Activity. Many RegCM applications are carried out as part of European projects (ENSEMBLES, CECILIA, ACQWA, WATCH, MEGAPOLI), and this model also participates in the important new international project CORDEX described below.

A.1.1. The International CORDEX project (Giorgi, Bi, Coppola, Gao, Rascher + associates/visitors)

The COordinated regional climate Downscaling EXperiment, or CORDEX (Giorgi et al. 2009), is a new international initiative promoted by the World Climate Research Programme (WCRP) with the threefold purpose of 1) evaluate and improve regional climate downscaling techniques (both regional climate models, or RCMs, and statistical downscaling methods, or SD); 2) produce a new generation of multi-model based future regional climate projections over regions worldwide for use in impact and adaptation studies; 3) foster a greater involvement of the developing country scientific community in climate change research. CORDEX is a landmark programme because it represents the first time the regional climate model community coordinates internationally into a broad programme. ESP staff members have played an active and central role in the design and implementation of the CORDEX initiative. The RegCM model will participate to this programme through the involvement of different scientists from developing countries involved in the ICTP RegCNET network.

A.2 Climate change (Giorgi, Bi, Rauscher, Gao, Coppola, Mariotti, Piani + associates/visitors)

In collaboration with various institutes outside ICTP, and as part of different European projects (ENSEMBLES, AMMA, ACQWA, WATCH) multi-decadal high resolution climate change simulations for the period 1950–2100 were performed for Europe, Africa and East Asia. Two such studies are highlighted here. In the first, high resolution runs (15 km grid spacing) were completed over the Alpine/central Mediterranean region using the so called “surrogate climate change” approach and a version of the model employing a sub-grid land surface scheme reaching a resolution of 3 km (Im et al., GRL, in press). This study led to the discovery of a new local feedback mechanism by which decreased spring snow cover and soil moisture due to greenhouse gas warming leads to reduced summer precipitation over mountainous areas (Figure A.1). In the second, for the first time a modeling study focused on the regional climate effects of the deforestation of the Congo Basin (Figure A.2, next page). This study showed that the heat source and moisture reduction due to deforestation can affect not only local precipitation and temperature, but also the development of the West Africa monsoon during the boreal summer and the distribution of precipitation over southern equatorial Africa during the austral summer.

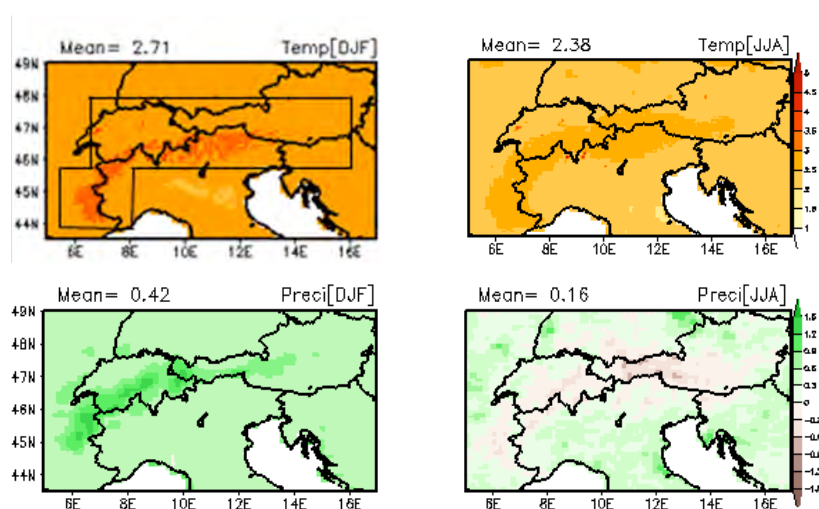


Fig. A.1: Change in temperature (upper panels) and precipitation (lower panels) for Winter (DJF, left panels) and summer (JJA, right panels) over the Alpine region in the surrogate climate change scenario simulations of Im et al. (in press). Local feedback mechanisms produce a decrease of precipitation over the Alps in the summer even though an increase in precipitation should be expected warmer and wetter conditions imposed in the surrogate climate change scenario.

Two studies focused on the post-processing of regional climate model output for application in impact research. In the first a bias correction technique for daily temperature and precipitation was developed to downscale climate model output to the hydrological catchments scale (Piani et al. 2009). This technique is used as a base for producing climate information for hydrological modeling in the European project WATCH. In the second study a weighting technique based on the model performance in reproducing the topography-induced sub-GCM scale mesoscale signal was developed for optimal combination of ensembles of model results (Coppola et al., CR submitted).

Finally, Giorgi and Coppola (2009), Faggian and Giorgi (2009) and Coppola and Giorgi (2010) completed extensive assessments of climate change projections over the European region and the Italian peninsula, respectively, analyzing the most recent available ensembles of global and regional climate model projections. (Figure A3a,b). To date the work by Coppola and Giorgi (2010) represents the only extensive assessment of climate change projections over Italy.

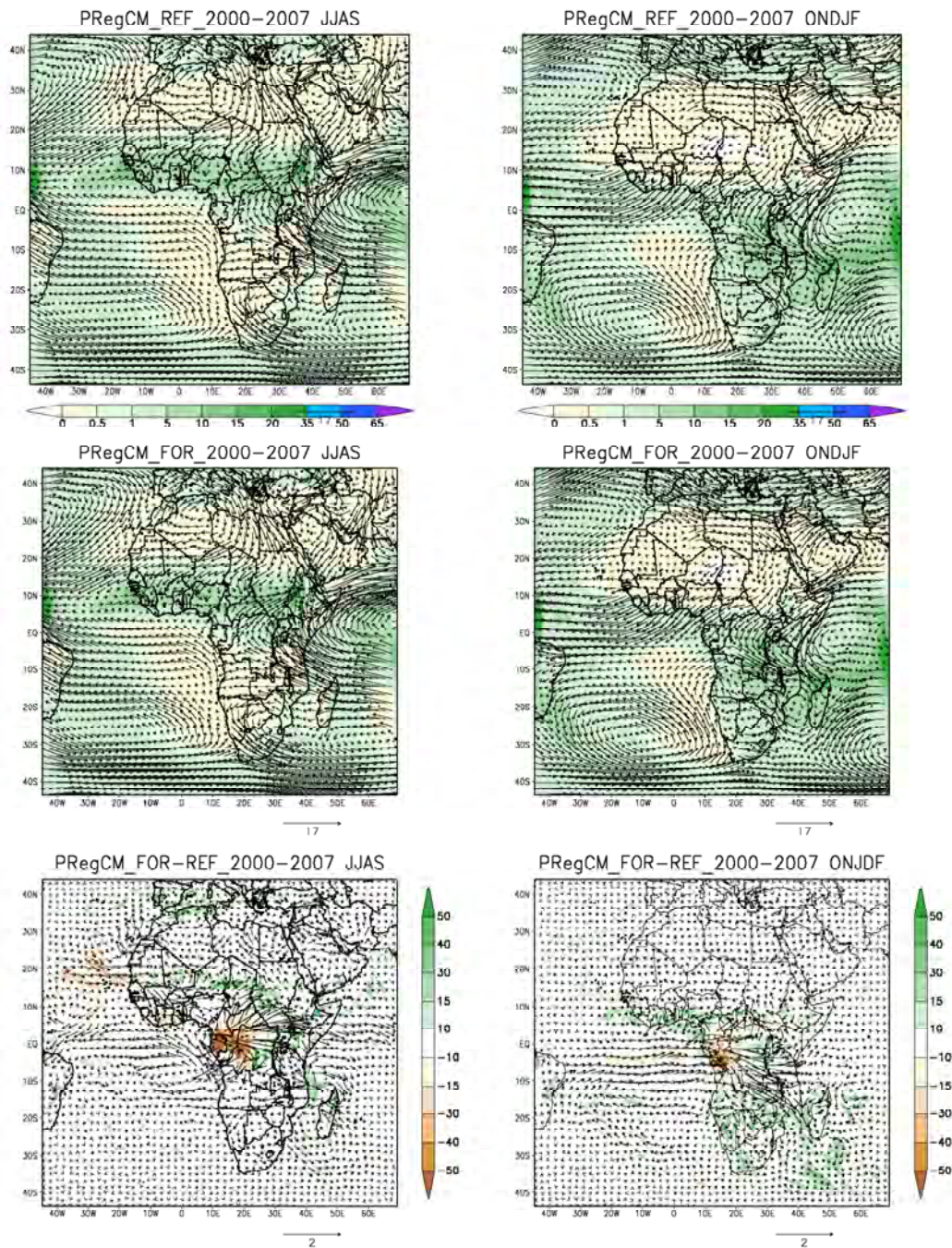


Fig. A.2: Precipitation (color shading) and 850 mb wind (arrows) in the reference simulation (top panels) and the Congo deforestation simulations (middle panels). Bottom panels show the difference between deforested and reference run precipitation and 850 mb wind. Left panels are for June–September (JJAS), right panels are for October–February (ONJDF). The deforestation of the Congo basin intensifies the Somali Jet in JJAS and the Zaire Air Boundary in ONJDF, causing changes in precipitation patterns.

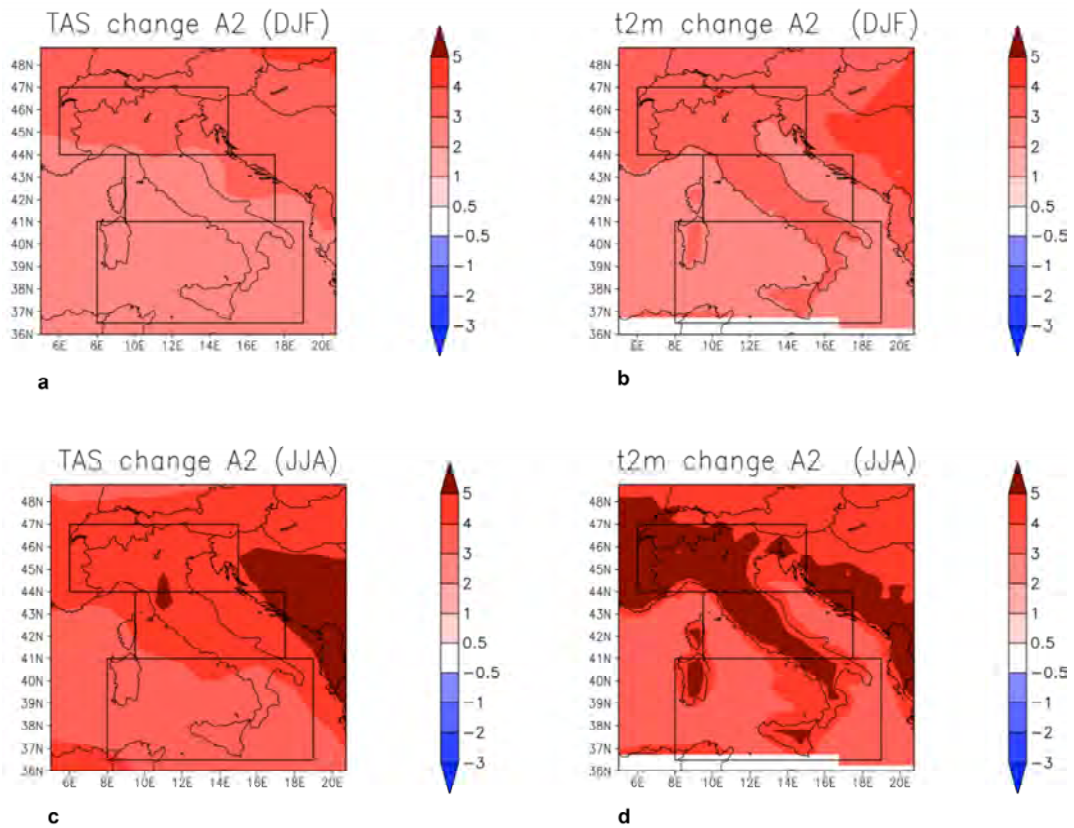


Fig. A.3a. Simulated change in surface air temperature over Italy for 2071-2100 compared to 1961-1990 for the A2 greenhouse gas emission scenario in winter (DJF, upper panels) and summer (JJA, lower panels) for the CMIP3 ensemble of global model simulations (left panels) and the PRUDENCE ensemble of regional model simulations (right panels). Units are degrees K.

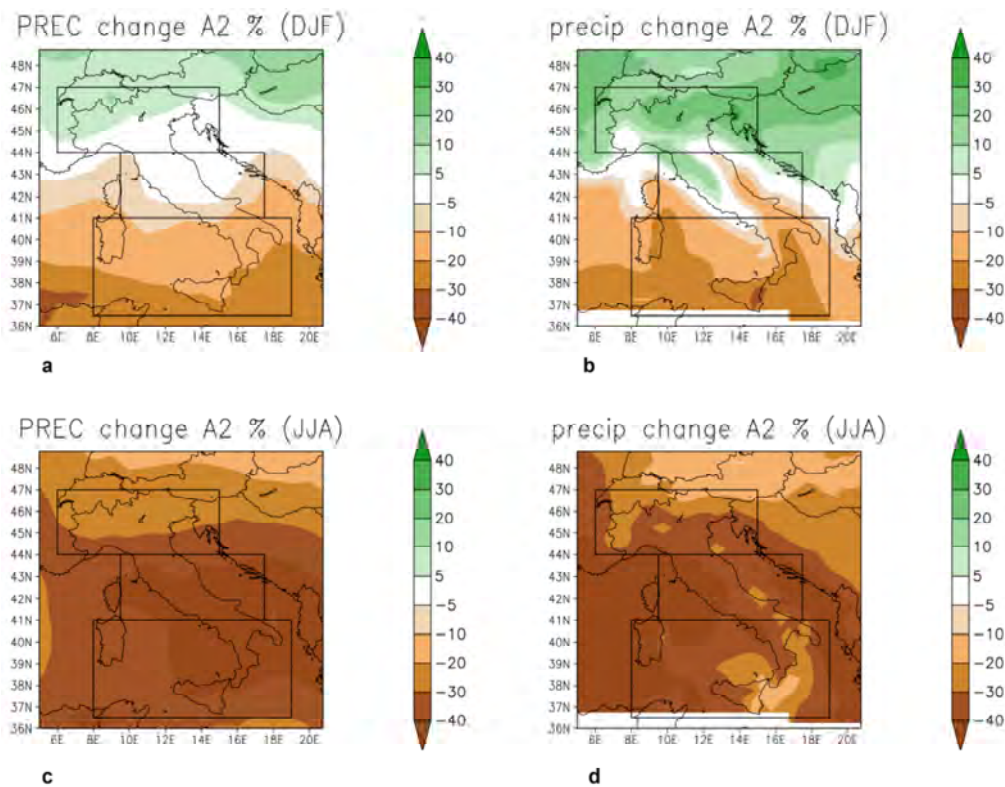


Fig. A.3b. Same as Figure A2a but for the simulated change in precipitation. Units are % of present day precipitation.

A.3 Chemistry-climate interactions (Zakey, Giorgi, Shalaby + associates/visitors)

Extensive work was completed in this research activity, particularly in the area of chemistry-climate coupling towards the development of a RegCM-CHEM coupled system. Specifically, in 2009 the following tasks were completed: 1) Development of an emission pre-processor for RegCM3 which can account for all of the available global emission inventories; 2) Coupling of an online biogenic Volatile Organic Carbon (VOC) emission module (MEGAN) to the land surface model of RegCM, enabling an interactive treatment of natural biogenic emissions; 3) Coupling of a suite of gas phase chemical mechanisms to RegCM3 and evaluation of these mechanisms for the case of the summer 2003 heat-wave over Europe. In this regard, four chemical mechanisms were coupled to the RegCM system corresponding to a hierarchy of chemical and computational complexity (from a few tens to over a hundred species and from less than 100 to several hundreds chemical reactions). This makes the RegCM system the most advanced and versatile in the World in terms of chemistry coupling for air quality and climate applications. The test case of the European summer 2003 heat wave indicated that the coupled RegCM-CHEM system simulated well the ozone concentration during this event. Further testing of the system is ongoing to optimize its performance for a variety of situations. The RegCM-CHEM model is being used in the EU project MEGAPOLI and in a related proposal (ACACIA) for future funding.

A.4 Climate change impacts (Tompkins, Coppola, Sanai, Mariotti, Giorgi + associates/visitors)

One of the areas that expanded greatly in 2009 is that of climate impacts on hydrology, agriculture and health. On the hydrological impact side, the hydrology model CHYM was interfaced with RegCM and is currently used within ESP for a variety of applications. These range from the calculation of climate change impacts on the Po and Rhone river flows (within the EU project ACQWA) to the analysis of the response of the hydrology of African large catchments (e.g. the Niger and Congo rivers) to climate variability and human induced climate change (within the EU WATCH and ENSEMBLES projects).

A new development in the area of climate impacts was the acquisition of the crop model GLAM. This is a flexible model that can be used from the regional to the local scale in order to calculate the response of different crop yields (e.g. wheat, peanut) to varying meteorological and climate conditions. It was for example used to investigate the effect of global warming on wheat yields in China by Sanai et al. (AMS, in press). GLAM is currently being interfaced with RegCM in order to explore the effects of climate variability and change on crops in Ghana and Ethiopia as well as China. It is expected that this model will provide an important resource for ESP to study the interactions between climate and crop productivity in different contexts, from intra-seasonal and seasonal prediction to multidecadal climate changes.

Climate variability can also influence health through its impact on the spread of vector borne diseases. For example, malaria is a major killer with over 2 million annual deaths. Other diseases such as Rift Valley fever, Dengue, and sleeping sickness have major health and socio-economic implications. Climate variations can impact these diseases by determining the availability of breeding sites (rainfall) and the growth and death rates of disease vectors and pathogens. ESP successfully co-lead a proposal design in 2009 which received over 3 million in European Union funds and will aim to use leading forecast centre models to drive dynamical disease models for malaria and rift valley fever to produce monthly to seasonal predictions for Senegal, Ghana and Malawi.

B. Natural Climate Variability and Predictability (NCVP)

B.1 Intraseasonal variability and predictability of the Asian monsoon (Yoo, Shukla, Yadav, Kucharski + associates/visitors/PhD students)

Based on historical observations and statistical methods (Hidden Markov Model, Extended EOF, etc), the intraseasonal variability of south Asian monsoon rainfall was examined with an emphasis

on the ENSO-Monsoon relationship (Yoo et al., JC submitted). It was found that the ENSO influences high frequency rainfall variability in a nonlinear manner: There are particular preferred phases of Intra-seasonal Oscillation (ISO) according to the ENSO condition. In addition, there is a seasonally persisting pattern only during the El Niño period (Fig. B.1).

In addition to the large scale ISO phenomena, a regionally specific study of intra-seasonal rainfall variations was performed in collaboration with F. Syed of Stockholm University. The region of interest (the northwestern areas of south Asia) is where the conventional northward propagating ISO vanishes. A predictive signal of active rainfall events over this region was found and a thermodynamic mechanism was proposed (Syed et al., AR submitted). The initial development of a warm anticyclone is enhanced by surface warming due to clear sky shortwave radiation in the stabilized atmosphere and maintains unfavorable conditions for convection. On the other hand, the lagged baroclinic response in the low level atmosphere causes surface moisture convergence, it overcomes convective inhibition and leads active rainfall events over the region.

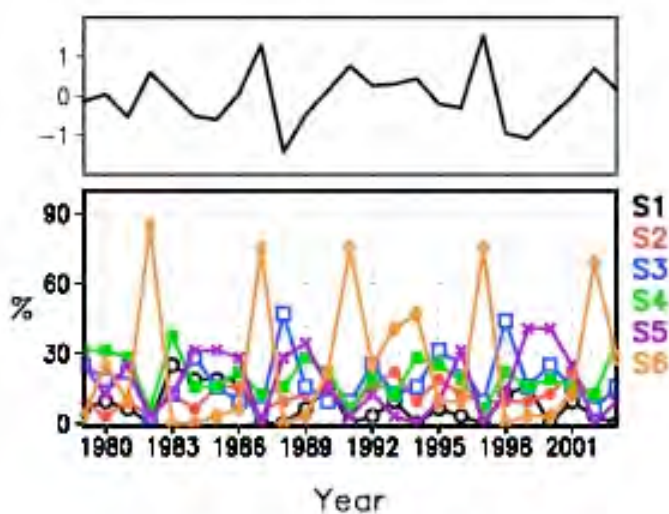


Fig. B.1: Lower panel: Interannual variation of the frequency of occurrence for each state in the Nonhomogeneous Hidden Markov Model of 5day mean Indian summer monsoon rainfall. The frequency of states is represented by percentage. Colors of states are marked on the right side of panel. Upper panel: JJA mean Niño 3.4 SST anomaly [deg].

B.2 Predictability of the African monsoon (Tompkins, Feudale, Diro + associates/visitors)

This research activity focuses on the assessment and improvement of seasonal predictability in different areas of Africa based on multi-model hindcast data and downscaling tools. In fact, extended-range predictions of the development of monsoon rain, like active and break phases of monsoons and intra-seasonal variability, could provide extremely useful information for farmers and water managers in developing countries and enable them to react timely to optimize their harvest strategies. Focusing on precipitation during the West African Monsoon, several studies have revealed a strong correlation with local SST in the Atlantic, Mediterranean Sea, Indian and Eastern Pacific oceans. Nevertheless actual seasonal forecasts using dynamical models have not historically performed reliably in these regions relative to other parts of the globe.

This research activity (Tompkins and Feudale, WF, in press) examined one of the dynamical models used for the “PRESAO” seasonal predictions (PRÉvisions Saisonnières en Afrique de l’Ouest), namely the system 3 seasonal forecast of ECMWF (SYS3). An Evaluation was conducted of SYS3 in terms of its precipitation forecasts for the West Africa monsoon at a lead time of 2 to 4 months in a 48 year (1960-2007) hindcast dataset. SYS3 reproduces the progression of the West Africa monsoon, but with a number of systematic errors, most notably a southerly shift of the tropical rain band (TRB) in the main monsoon season from July to September (Fig. B.2) and the lack of pre-onset rainfall suppression and sudden onset jump.

Different hypotheses of the TRB displacement were formulated and tested, such as the poor model performance in reproducing the tropical Atlantic SST annual cycle and the excessively strong two-way coupling between this area of the Atlantic Ocean and the atmosphere, which can lead to positive feedbacks that amplify the effect of an incorrectly represented atmospheric physics. The AMMA Special Observation Period (SOP) of 2006 was taken in consideration as

case study to test the above hypotheses. Although SST biases definitely play a role in this TRB shift, a clear conclusion on the dominant effects has not yet been reached.

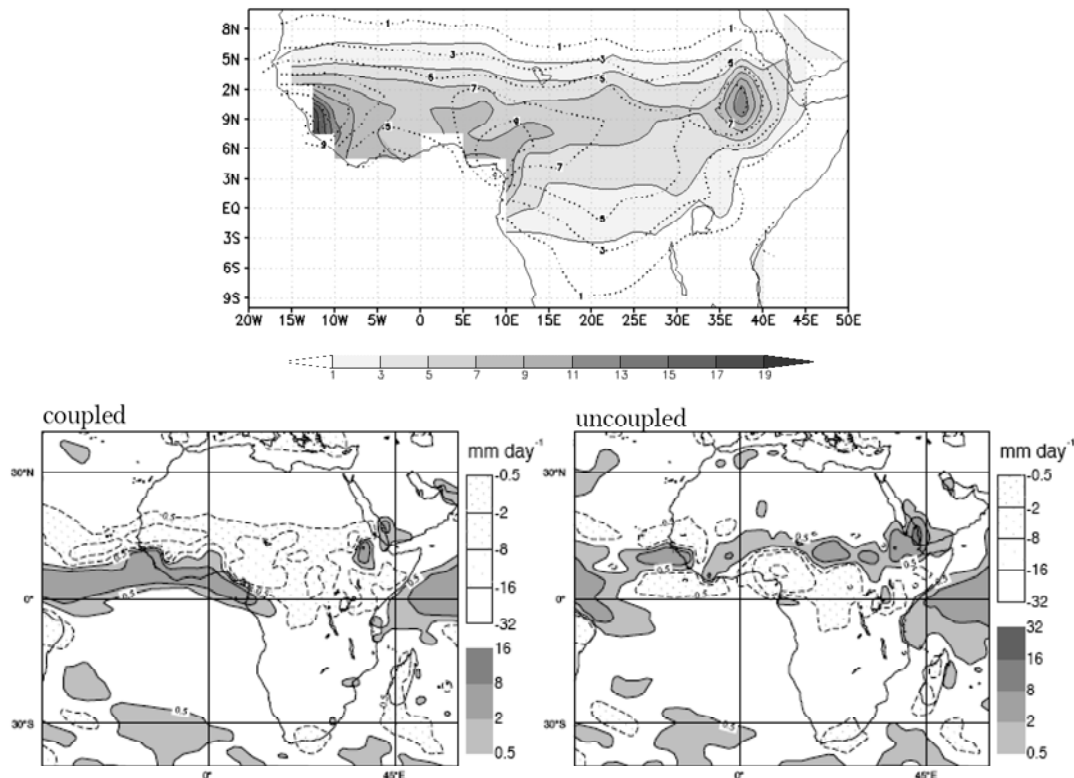


Fig. B.2: Upper panel: JAS ensemble mean total precipitation 1980-2007 (shadings) by the SYSS3 system compared with GPCP observations (dashed line). Lower panel: Model precipitation bias (model ens. mean - GPCP observations) for JAS 2006: coupled version (left) and un-coupled version (right) of the SYSS3 system.

A separate effort started in 2009 in which seasonal forecasting of East African rainfall is being analyzed and work is being conducted to downscale ECMWF ensemble hind casts over eastern Africa and examine whether high resolution downscaled information provide an 'added value' towards the use of seasonal forecasts in forcing crop and hydrological models.

B.3 Interannual variability of the tropical ocean-atmosphere system. (Kucharski, Yoo, Yadav, Feudale, Tompkins, Shukla + associates/visitors/PhD students)

In 2009, research on the effect of the Atlantic Ocean on the variability of the African and Indian Monsoons, as well as on the Indian and Pacific Oceans continued (Fig. B3, Kucharski et al. CD 2009). Building on previous work the control integrations of the CMIP3 dataset were analyzed regarding their ability to realistically reproduce the Atlantic influences on the African and Indian monsoons (work performed mainly by PhD student Rondrotiana Barimalala). It was found that the warm bias in the south tropical Atlantic, which is present in all coupled simulations, presents a substantial obstacle for the simulation of the influence of the sea surface temperature (SST) variability in the south tropical Atlantic on remote regions. Furthermore, a regional ocean model (ROMS) is currently used by the same PhD student in the Indian Ocean to further test the hypothesis of an atmospheric bridge from the Atlantic Ocean to the Indian Ocean.

How does Indian Ocean respond to tropical Atlantic warming?

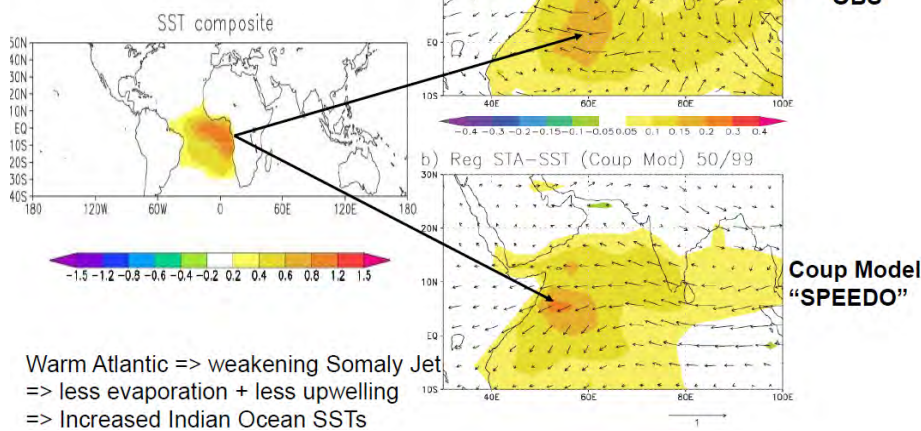


Fig. B.3: Influence of the tropical Atlantic on the Indian Ocean. Shown are sea surface temperatures in K (shaded) and wind vectors with the unit length 1 m/s.

In a collaborative work lead by K. Yadav, the mechanisms behind the increasing influence of ENSO on North-west Indian winter precipitation were analyzed using observational data and targeted numerical simulations using the ICTP AGCM SPEEDY. It was found that the modestly increased ENSO amplitude and SST response in the western Pacific in the last few decades lead to a strong increase of the ENSO influence on the South Asian region (Yadav et al., J Climate, 2010, in press).

The basic mechanisms for the maintenance of the South Asian monsoon system were analyzed using the ICTP SPEEDY model, focusing on the possibility that the large-scale east-west heating contrast between the warm western Pacific and the cooler African continent/Atlantic Ocean may play a role in modulating the Indian monsoon. It was found that indeed this mechanism contributes to the South Asian monsoon climatology in addition to the more commonly known land-sea contrast mechanism. While the land-sea contrast is mainly responsible for the inland precipitation maximum in the northern Indian region, the east-west heating contrast controls the surface cyclone and precipitation maximum in the Bay of Bengal and in southern India. This finding has important implications for the ENSO influence on inter-annual Indian rainfall variability (Kucharski et al., *Clim. Dyn.*, submitted).

In collaboration with S. Rauscher, the impact of relatively small spatial variations in SST response to climate change scenarios on the predicted drought conditions in Central America were investigated using the ICTP SPEEDY. It was found that the reduced warming in the Atlantic Sector compared to the Pacific one contributes substantially to the very robust drying signal in the Central American region, which has been classified as a climate change 'hot-spot' (Rauscher et al., J. Climate submitted).

Finally, in a collaboration with the PhD student L. Zamboni the connection of ENSO with the South East South American climate variability was investigated using observations and the DEMETER model dataset. It was found that this connection is seasonally dependent and that state-of-the-art coupled models are currently not able to reproduce it realistically. This has important implications for seasonal prediction of rainfall in this region. (Zamboni et al., J. Climate, submitted).

C. Mechanics of earthquakes and tectonophysics (MET)

C.1 Time-variable gravity: hydrology vs. solid-Earth processes (Aoudia, Barletta)

Space gravity missions (GRACE, GOCE) provide us with the unique opportunity to measure mass redistribution within the Earth and at its surface due to geophysical phenomena involving the solid Earth, the atmosphere, the hydrosphere and the cryosphere. GRACE, launched in 2002,

was expressly designed to detect the time-dependent gravity field, it revealed the Earth's hydrological cycle, but also evidenced secular trends due to the slow and continuous upwarping of the crust in North America and Scandinavia due to the Post Glacial Rebound (PGR) (Figure C1). After more than 6 years of data a more elaborate analysis of the GRACE time series can be undertaken. However, the data have to be pre-processed in order to yield an un-biased geophysical interpretation, since the quality of the signal is not uniform worldwide and gravity is the superposition of contributions from the solid Earth and climate-related phenomena which cannot be easily distinguished. This study shows that mass changes cannot be classified simply as trends or periodic signals. Variations in long term behavior and periodicities higher than the usual annual (or semi-annual) cycles indeed occur, related to geophysical phenomena, climate and even human activities. An alternative way is proposed to separate periodic and non periodic signals without losing information. This will provide useful tools to discriminate signals from different possible sources mostly in the low latitude regions, such as Africa, where the hydrological cycle is most intense.

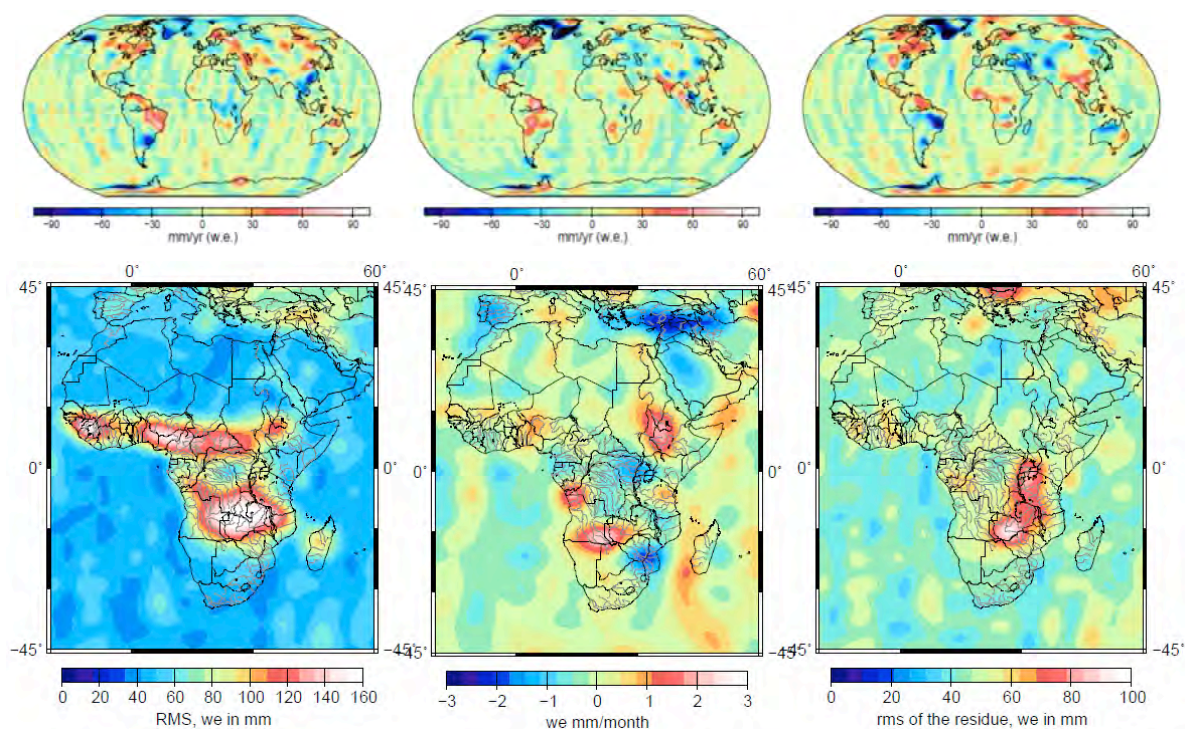


Fig. C.1: Gravity field trend in mm/yr relative to three different time intervals since the beginning of the GRACE mission: August 2002 - November 2004 (left), December 2004 - December 2006 (middle), and December 2006 - December 2008 (right) for the whole Earth. Zoom over Africa: RMS on the left, trend in the center, and residue on the right.

C.2 An impending earthquake visible in GPS data and the missed L'Aquila earthquake forecasting (Aoudia, Barzaghi, Sabadini)

Pre-earthquake changes in rates of geodetic crustal deformation could warn of impending earthquakes and shed light on the earthquake generation process. This study reported on a clear acceleration in rates of deformation from available continuous GPS data prior to the Mw 6.3 April 2009 L'Aquila earthquake. Regional changes of the two-dimensional horizontal strain were analyzed on a fifteen day basis, showing since 2006 a series of compressional and extensional "deformation pulses" intermingled by "silent" phases (Figure C2). Three months prior to the earthquake, a net acceleration of the extensional deformation ending up with a larger extensional pulse in March clearly showed up. The kinematics of the deformation was in agreement with the steady state tectonics and the earthquake main shock. Its regional extent argued for a distributed pre-earthquake strain model to complement the classical localized deformation model within the

down-dip extension of the seismic rupture reported for the most credible published pre-earthquake examples. The GPS data, by complementing the localized anomalous increase in the seismicity around the city of L'Aquila as well as the changes in radon concentration could have been decisive for an operational earthquake forecast.

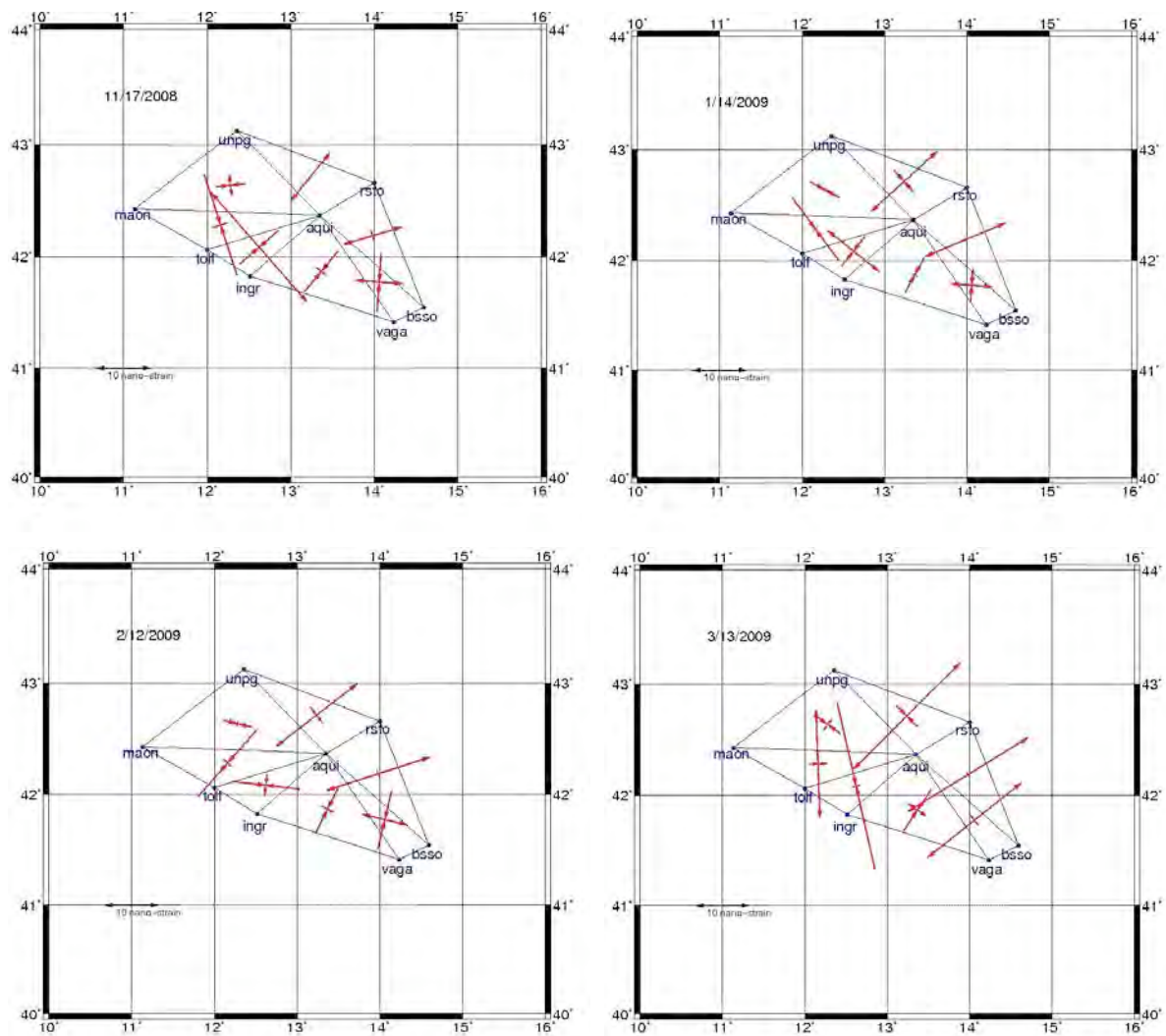


Fig. C.2: Mean strain averaged over a six month time interval providing the strain changes with respect to the steady state. Aquil stands for the city of L'Aquila.

C.3 Earth structure across Afar (northern Ethiopia) from surface wave tomography (Guidarelli)

In the remote Afar depression of northern Ethiopia the African continent is slowly splitting apart and a new ocean is forming. In September 2005, a series of fissures opened along the Afar Depression. During a period of about a week, the rift pulled apart by eight meters and dropped down by up to one meter. This process of ocean formation normally occurs in the deep seas, but the Afar is the only place on Earth where the split occurs on land. The lithospheric structure of the Afar region was studied by analyzing the group velocities of surface waves and applying a methodology for surface wave tomography for about 250 earthquakes recorded in the period 2007-2009 by the NERC Afar Consortium experiment and the NSF Rochester University seismic networks deployed in northern Ethiopia. The resulting tomographic maps (Figure C3) depict the lateral variations of group velocities at different periods, showing significant low velocity anomalies in the upper crust which correlate well with the volcanic areas that have been active in the past decade (e.g. Dabbahu and Hararo magmatic segments). The tomographic maps describe

only the horizontal distribution of group velocities but the next step of the study, a non linear inversion of surface wave velocities, will provide shear wave velocity models and therefore a better description of the Afar crust.

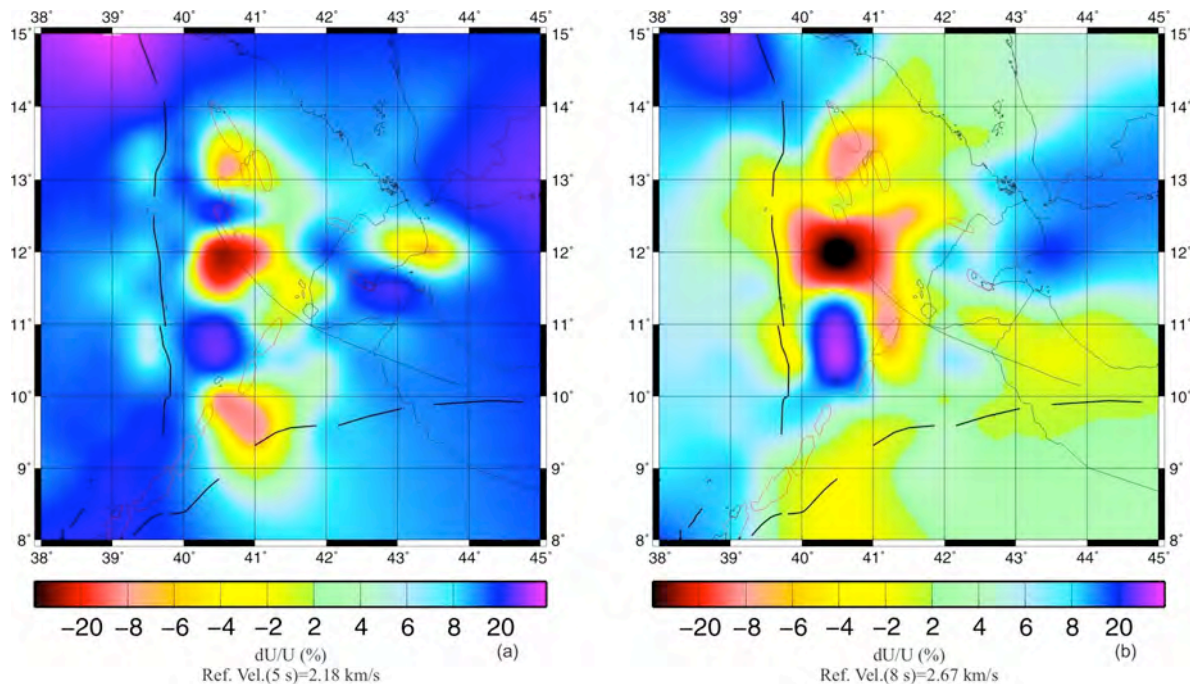


Fig. C.3: Rayleigh wave group velocity maps at the indicated period presented as percent deviation from the average. Major border faults are shown schematically: red circle areas indicate magmatic segments.

Training Activities

At ICTP

Diploma Course in Earth System Physics (**Aoudia** coordinator)

Workshop: Theoretical Ecology and Global Change
3 -13 March 2009

Organizers: O. Canziani, G.A. De Leo, A.P. Dobson, M. Pascual, **F. Giorgi**

Workshop: Water resources in Developing Countries: Planning and Management in a Climate Change Scenario.

27 April – 8 may 2009

Organizers: S. Sorooshian, **E. Coppola and S. Rauscher**

Co-Sponsors: Kuwait Foundation for the Advancement of Sciences (KFAS)

Workshop: From Core to Crust: Towards an Integrated Vision of earth's Interior

20 – 24 July 2009

Organizers: **A. Aoudia**, S. Scandolo, J. Niemela

Targeted Training Activity: Predictability of Weather and Climate: theory and Applications to Intraseasonal variability

4 -15 August 2008

Organizers: **J. Shukla**, D. Straus, V. Krishnamurty, **J.H. Yoo**

Workshop: High Resolution Climate Modeling

10 – 14 August 2009

Organizers: S. Schubert, I.-S. Kang, **J. Shukla**, **F. Kucharski**

Co-Sponsors: Center for Ocean, Land and Atmospheres (COLA), NASA, USA

Advanced Workshop: Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa

17 – 28 August 2009

Co-sponsor: IAVCEI, IASPEI, NSF, UNAVCO, USAID

Organizers: **A. Aoudia**, E. Calais, C. Ebinger, M. Miller, T. Wright, G. Yirgu

Advanced School: Non-linear Dynamics and Earthquake Prediction

28 September – 10 October 2009

Organizers: V.I. Keilis-Borok, **G.F. Panza**, **A.A. Soloviev**

Workshop: High-Impact Weather Predictability and Information System for Africa and AMMA-Thorpex Forecasters Handbook.

5-8 October 2008

Co-sponsors: World Meteorological Organization, GEO Programme, RIPIESCA programme

Organizers: A. Diongue-Niang, A. Kamga, D. Parker, **A. Tompkins**

Workshop and Conference on Biogeochemical Impacts of Climate and Land-Use Changes on Marine Ecosystems

2 November - 10 November 2009

Organizer(s): Directors: A. Bracco, L.T. Cang and J. Montoya, **E. Coppola**

Outside Activities

Workshop on How to Build a Habitable Planet and Conference on Operational Modeling of Oceanographic Coastal Zones

8-22 July 2009 – Cape Town, South Africa

Organizers: G. Philander, Y. Chao, N. Pinardi, C. Roy

Summer School on Climate Science,

13-16 June 2009 - Turunc, Turkey

ICTP Lecturers: **T. Diro**, **E. Coppola**, **X. Bi**

Training workshop on Regional Climate Modelling application in Arab countries

18-22 October 2009 - Damascus, Syria.

Organizers: Arab Centre for Studies of Arid Zones

ICTP Lecturers: **A. Zakey**, **J.H. Yoo**, **T. Diro**

The first regional climate and impact modelling workshop for Eastern Africa

26-31 October, 2009 - Addis Ababa, Ethiopia

Organizers: ICTP, SISSA

ICTP Lecturers: **T. Diro**, **X. Bi**, **L. Mariotti**, **A. Tompkins**

Hosted Activities

Kick-off meeting for Egypt-USA project

Organizer(s): ESP-ICTP (**A. Zakey**)

27 – 30 April

Participation to international conferences

Berg, P.; Haerter; J. O.; **Piani, C.**; Thejll P.; Hagemann S.; Christensen J. S. 2009. The relationship between daily precipitation and temperature in the European domain. Geophys. Res, Abs., vol. 11, EGU2009-11201, EGU general assembly. 2009.

Hagemann, S.; Haerter, J. O.; **Piani, C.**; Usage of a global statistical bias correction to enhance simulations of the current and future hydrological cycle. *Geophys. Res. Abs.*, vol. 11, EGU2009-7050, EGU general assembly. 2009.

Haerter, J. O.; **Piani, C.**; Hagemann, S.; Berg P.; 2009. Is there a time-scale where the Clausius-Clapeyron relation describes precipitation rate changes?. *Eos Trans. AGU, 90(52), Fall Meet. Suppl., abstract H31D-0822.*

Im, E.-S. et al, 2009. Effects of a subgrid-scale topography and land-use simulation for the Alps region. European Geosciences Union General Assembly 2009, Austria Center Vienna, Austria, 19-24 April.

Im, E.-S. et al, 2009. Potential changes of future dryness over Korea from a regional climate projection. *Water Resources in Developing Countries: Planning and Management in a Climate Change Scenario.* International Centre for Theoretical Physics, Trieste, Italy, 27 April-8 May.

Im, E.-S. et al, 2009. Local vs. remote effects of climate change over the Alpine region. *Atmospheric Composition Changes: Climate-Chemistry Interactions 2009*, Lecce, Italy, 2-4 November.

Mariotti, L.; Sylla, M. B.; Coppola, E.; Rauscher, S. A.; Piani, C.; Giorgi, F. 2009. Dynamical downscaling of climate change projection over the African region using the regional climate model (RegCM3). *Eos Trans. AGU, 90(52), Fall Meet. Suppl., abstract A33A-0205.*

Mariotti, L. ; Coppola E.; Gao X.; Im ES.; Giorgi F. Climate change impact on water resources for several river basins: a European; Asian and African case study. *Geophysical Research Abstracts; Vol. 11; EGU2009-10732; 2009; EGU General Assembly 2009*

Mariotti L.; Sylla M.B.; Coppola E.; Rauscher S.A.; Piani C.; Giorgi F. Dynamical Downscaling of Climate Change Projection over the African Region using the Regional Climate Model (RegCM3). *GEWEX 2009*

Mariotti L.; Sylla M.B.; Coppola E.; Piani C.; Giorgi F. Landuse change experiment over the African Region using the Regional Climate Model (RegCM3). *WATCH General Assembly 2009*

Piani, C.; Coppola, E.; Haerter, J. O.; Mariotti, L.; Hagemann, S.; A statistical bias correction for climate model data: parameter sensitivity analysis. *Geophys. Res. Abs.*, vol. 11, EGU2009-8034, EGU general assembly. 2009.

Piani, C.; Haerter, J. O.; **Mariotti, L.;** Hagemann, S.; **Tomkins, A.;** 2009. Statistical bias correction of multi decadal global simulated daily precipitation. *Eos Trans. AGU, 90(52), Fall Meet. Suppl., abstract H31D-0823.*

Yoo, J. H. et al. 2009. Relationship between Northward and Eastward propagating ISOs in the south Asian summer monsoon. *EGU General Assembly, 19-24 April 2009, EGU2009-6860*

Zakey A.S. 2009. Climatic feedback of carbonaceous aerosols over the Mediterranean and North African regions, MeNA, *Geophysical Research Abstracts, Vol. 11, EGU2009-1303, General Assembly, Assembly 2009 Vienna, Austria.*

International Projects and External Funding

Ensemble-based Predictions of Climate Changes and their Impacts - ENSEMBLES, funded by the EU, 2004-2009, 205,500 Euro. (**Giorgi, Coppola, Rauscher, Bi, Mariotti, Kucharski**)

Central and Eastern Europe Climate Change Impact and Vulnerability Assessment - CECILIA, funded by the EU, 2006-2009, 132,840 Euro. (**Giorgi, Coppola**)

Water and Global Change - WATCH, funded by the EU, 2006-2010, 415,600 Euro. (**Piani, Mariotti, Coppola**)

Megacities: Emissions, Urban, Regional and Global Atmospheric Pollution and Climate Effects and Integrated Tools for Assessment and Mitigation - MEGAPOLI, funded by the EU, 2008-2011, 107,00 Euro. (**Zakey, Giorgi**)

Assessing Climatic Change and Impacts on the Quantity and Quality of Water - ACQWA, funded by the EU, 2008-2013, 208,000 Euro. (**Coppola, Giorgi, Im**)

Quantifying weather and climate impacts on health in developing countries - QWECI, funded by the EU, 2010-2014, 372,000 Euro. (**Tompkins, Piani**)

Contract with the Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), 2008-2011, 200,000 Euro. (**Giorgi, Coppola, Im**)

Socioeconomic Consequences of Climate Change in Sub-equatorial Africa - SoCOCA, funded by the Norwegian Research Council, 2009-2011, 102,000 Euro. (**Giorgi, Sylla**)

Network for Africa Community Access to Regional (Seasonal and Climate) Predictions for End-user Groups - AFRICARP, funded by the Italian ministry of Foreign Affairs, 2008-2011, 300,000 Euro. (**Tompkins, Giorgi, Coppola**)

MedFood: 200,000 Euro, proposal submitted to the EU FP7 programme Marie Curie Initial Training Networks (ITN). (**Coppola, Giorgi**)

Health, environmental change and adaptive capacity: mapping, examining and anticipating future risks of water-related vector-borne diseases in eastern Africa – HEALTHY FUTURES, 229,000 Euro, proposal submitted to the EU FP7 Programme. (**Tompkins, Giorgi**)

Towards an integrated system to detect and predict drought risks in Sub-Saharan Africa – WATCH AFRICA, 343,000 Euro, proposal submitted to the EU FP7 programme. (**Tompkins**)

Climate Local Information in the Mediterranean region: Responding to User Needs – CLIMRUN, 270,000 Euro, proposal submitted to the EU FP7 programme. (**Giorgi**)

Atmospheric Chemistry and Climate Change interactions – ACACIA, 280,000 Euro, proposal submitted to the EU FP7 programme. (**Giorgi**)

Intergovernmental Panel on Climate Change (IPCC) (**Giorgi**)

Coordinated regional climate Downscaling EXperiment (CORDEX) – WCRP (**Giorgi, Coppola, Mariotti, Sylla**)

Climate of the 20th Century (C20C) Project, CLIVAR (**Kucharski**)

INGV-DPC Programme on Seismogenesis and mechanics of transient deformation, 2007-2009, 10,000 Euro. (**Aoudia**)

Contract with the Regione Friuli Venezia Giulia, GPS geodesy for continental deformation, 2008-2009, 8,000 Euro. (**Aoudia**)

Italian funds in trust with UNESCO, sub-project Building Environmental Networks in Africa, 2008-2011, 150,000. (**Aoudia**)

Co-PI NSF Award OISE- 0913230 Earthquake and Volcanic Hazards in the East-African Rift, co-PI. (**Aoudia**)

Natural Environment Research Council (UK) Afar Rift Project, 2007-2012. (**Aoudia**)

Staff and long term visitors (3 months or more)

Professional Staff

F. Giorgi, Italy, Senior Research Scientist (head)
A. Aoudia, Algeria, Research Scientist
X. Bi, China, Assistant Research Scientist
F. Kucharski, Germany, Research Scientist
A. Tompkins, U.K., Research Scientist

Consultants

J. Shukla, USA

Staff Associates

C. Brankovic, Croatia
I.-S. Kang, Korea

Long-term Visiting Scientists

M. Borghi, Italy
C. Piani, Italy
B. Sylla, Senegal

Post-doctoral Fellows

E. Coppola, Italy
G.T. Diro, Ethiopia
L. Feudale, Italy
M. Guidarelli, Italy
E.-S. Im, Korea
J.-H. Joo, Korea
S. Rauscher, USA
R.K. Yadav, India
A. Zakey, Egypt

M.Sc. Student

R. Nogherotto, U. Trieste, Italy

PhD Students

M. Shalaby, Egypt (STEP programme)
B. Terefe, Ethiopia (STEP programme)
E. Ngatchou, Cameroon, (STEP programme)
E. Rindrahariasona, Madagascar, (STEP programme)
L. Mariotti, Italy
R. Barimala, Madagascar
G. Tumolo, Italy
L. Zamboni, Italy
S.F. Saeed, Sweden

EARTH SYSTEM PHYSICS
HOSTED ACTIVITY
**STRUCTURE AND NONLINEAR DYNAMICS
OF THE EARTH (SAND)**

Introduction

SAND's research activities are divided into two main lines: *Nonlinear Dynamics of the Earth's Lithosphere* (led by Prof. V.I. Keilis-Borok, International Institute of Earthquake Prediction Theory and Mathematical Geophysics, IIEPT, Russian Academy of Sciences, Moscow, Russia) and *Structure of the Earth with Application to Seismic and Volcanic Risk Mitigation* (led by Prof. G.F. Panza, DST-UNITS (Department of Geosciences, from 01/01/2010), University of Trieste, Italy).

The activities within the framework of the first line are aimed at the fundamental study of the evolution and dynamics of the Earth lithosphere and its instability based on considering the Earth lithosphere as a hierarchical non-linear complex system with special attention to earthquake prediction. Earthquakes are considered, along with other natural disasters, as extreme events in complex systems of different nature. This general approach gives the possibility to search for analogues between precursors to extreme events of different types. The activities for 2009 year spanned from numerical modelling of the lithosphere dynamics to prediction of extreme events in complex systems and earthquake prediction studies.

The activities within the framework of the second line aim at the development of theoretical grounds for seismic and volcanic risk mitigation on the basis of 3D modeling of Earth structure and earthquake sources through the study of wave propagation in three-dimensionally heterogeneous, inelastic, and anisotropic media. We have shown that: a) Adriatic-Ionian (African) lithosphere at a pressure greater than 4 GPa (130 km) represents an efficient mean for carbon cycling into the upper mantle and into the exosphere; b) the global asymmetry across oceanic ridges; c) in plate tectonics the classic mantle convection is complemented and polarized by the steady-state torque provided by the tidal bulge misalignment; d) fully formalized and automatic procedures have been developed for the routine updating of the intermediate-term middle-range earthquake predictions (CN and M8S) in Italy; e) the epicentre of the L'Aquila earthquake (6 April 2009) was localized just outside (about 10 km) the alerted region. Nevertheless, the predicted neo-deterministic ground shaking scenario correctly predicted the macroseismic intensities observed for this earthquake; f) in collaboration with the University of Milan and Politecnico di Milano, a fully formalized system integrating Earth Observation data and new advanced methods in seismological and geophysical data analysis, is currently under development. An extension of this activity to Uranium monitoring is planned for 2010 in collaboration with INFN.

Developed methodologies are transferred to scientists from developing countries through joint research, with special attention to training potential leaders, and combining the workshops with subsequent individual projects.

Research Activities

Line of research: Nonlinear Dynamics of the Earth's Lithosphere

Numerical models of the lithosphere dynamics

The study of the block structure model developed for the junction zone of Alps and Dinarides has been continued. The spatial distribution of synthetic seismicity, obtained by block structure modelling, has been compared with the distribution of the nodes prone to earthquakes with $M \geq 6.0$ (seismogenic nodes). The results of block modelling and MSZ node recognition differ only

for 17% of the outlined nodes. This rate is well comparable with the performances obtained by prospective testing of seismogenic nodes recognition in several regions worldwide, where only 16% of the observed earthquakes took place outside the previously recognized nodes. A set of numerical experiments with the block structure dynamics model of the Southern Bulgaria region for different values of the structure depth (20, 30, and 40 km) has been made. In all experiments a frequency-of-occurrence plot for synthetic seismicity is linear and close to the observed one. The largest synthetic earthquakes (with magnitude greater than 7) are obtained nearby locations of epicenters of large historical earthquakes. The synthetic seismicity is in the best accordance with the observed one when the structure depth is 30 km.

Morphostructural zonation and recognition of earthquake prone areas

The preliminary morphostructural zoning map of Madagascar has been compiled. The morphostructural map of the Bulgarian region has been compiled on a scale of 1:1 000 000. The MZ map was used for recognition of earthquake prone areas ($M \geq 5.0$) in the Bulgarian region. The morphostructural map of Ecuador has been compiled and used for recognition of earthquake prone areas ($M \geq 6.0$) in Ecuador. The seismogenic nodes defined in the Italian region by means of pattern recognition have been associated with active faults.

Prediction of extreme events in complex systems

Patterns of background activity preceding extreme events have been analyzed for four complex systems: the U.S. economy, a megacity (Los Angeles), the Earth magnetosphere, and the Earth lithosphere. Economic recessions, surges in homicides in a megacity, magnetic storms, and strong earthquakes are considered as extreme events in these systems. Indicators describing the system's behavior are used as a starting point. Rather than analyze the whole time series of an indicator, sufficiently strong changes in an indicator's trend are identified. Those changes constitute background events (BE). A premonitory pattern common to all four systems considered has been demonstrated: relatively large magnitude BEs become more frequent before an extreme event.

Analysis of seismic catalogue for CSEP earthquake prediction testing in Italy

A detailed analysis of the instrumental seismic catalogues provided by the Italian National Institute of Geophysics and Vulcanology (INGV) as the authoritative database for earthquake prediction experiment in the framework of the Collaboratory for the Study of Earthquake Predictability - Testing Region Italy (CSEP-TRI), has been carried out to evaluate their homogeneity and completeness. It has been proved that the set of catalogues provided by INGV is hardly a unified one acceptable for the necessary tuning of models/algorithms, as well as for running any rigorous prospective predictability test. The catalogue problem disclosed in this study appears to be complex, involving not only some systematic magnitude shifts at specific times, but also a number of territorial inconsistencies. An effective solution to the problem very likely requires a uniform, systematic re-compilation of the catalogue starting from the original seismograms.

A revised earthquake catalogue for Eastern Algeria

A new revised earthquake catalogue for Eastern Algeria [$22^{\circ}\text{N}-38^{\circ}\text{N}-4^{\circ}\text{E}-9.5^{\circ}\text{E}$], from 419 to 2008, has been compiled as a starting point for a catalogue dealing with the whole country. The re-evaluation has been carried out following a critical method, and formal criteria have been adopted in the parameterization of the earthquake catalogue. Two digital versions have been produced: (a) a basic version (published also as ICTP report), including all the compiled data, the authors of each quoted parameter and the quality rank of the macroseismic information; (b) a second version, obtained after removing doubtful events and parameters, has been produced in order to carry out a preliminary statistical analysis. The newly compiled earthquake catalogue provides a more reliable picture of the seismicity in Eastern Algeria than the previous ones as shown by the comparison of the recent catalogues over the common territory and time span.

Mapping the maximal expected earthquakes intensity from the USLE

A practical approach to time-dependent seismic hazard and risk assessment from the viewpoint of the Unified Scaling Law for Earthquakes, USLE, is being developed. A new method for mapping the maximal expected intensity based on the local USLE coefficients A, B, and C has been introduced. Following this method, the Italian seismic data was used to provide a seismic hazard map in terms of the maximum expected intensity in 30, 50 and 100 years at a 10 % level probability of exceedance. Comparison of results obtained with the maps based on the neo-deterministic (NDSHA) and probabilistic (PSHA) seismic hazard assessments suggests that the USLE approach may complement the existing seismic hazard assessment methods.

Analysis of hot and cold spots in Italian macroseismic data

A search for effects, which are related to local fault geometry rather than soil conditions, has been made in the macroseismic data of Italy. A list of towns and villages liable to amplify (+) or reduce (-) the level of shaking in comparison with the nearby settlements has been given. Relief and soil conditions cannot always account for the anomalous sites. Furthermore, there are sites where both (+) and (-) effects are observed depending on the earthquake. The opposite effects can be generated by events from the same seismotectonic zone and along the same direction to the site. Anomalous sites may group themselves into clusters of different scales.

Line of research: Structure of the Earth with Application to Seismic and Volcanic Risk Mitigation

Seismic source studies

A new programme package created for analysis and reduction of non-uniqueness of moment tensor inversion from long period surface waves in case of shallow source was tested by application for study of the Andaman Islands recent earthquake, $M_w = 7.5$, occurred on 10.08.2009. The U.S. Geological Survey reported results on three different inversions for this event, and three corresponding solutions differ from each other significantly. The analysis performed explains this by the fundamental uncertainty of moment tensor inversion from long period surface waves in case of shallow source. To reduce the uncertainty observed P-wave polarities has been used as additional data and a unique solution describing the source in double-couple approximation has been finally determined. Only one of three USGS solutions is close to this double-couple solution.

Radiation by an extended seismic source: tsunami and ground motion modeling

The generation of the seismic and tsunami waves by an extended fault is modeled approximating the seismic source with a distribution of multiple sub-sources over the fault plane where the main nucleation occurs. The seismograms and the tsunamigrams are calculated by the sum of all the single contributes for each sub-source with the correct time delays, according to the rupture propagation, and weighted according to the energy release on the fault. The related codes are used as a component of an improved package capable of efficient and realistic calculation of both the tsunami and ground motion. The related tsunami and seismic hazard assessment, that can then include the full scenario event simulation, has been applied to the Mediterranean area (e.g. the Adriatic Basin, Algeria) to the Valparaiso (Chile), Delhi and Talchir (India) urban area, and is going to be applied to the Vietnamese coasts and to the Vietnamese megacities.

Carbon cycling into the upper mantle and into the exosphere

Proven that melting of sediments and/or continental crust of the subducted Adriatic-Ionian (African) lithosphere at a pressure greater than 4 GPa (130 km) represents an efficient mean for carbon cycling into the upper mantle and into the exosphere in the Western Mediterranean area. Melting of carbonated lithologies, induced by the progressive rise of mantle temperatures behind the eastward retreating Adriatic-Ionian subducting plate, generates low fractions of carbonate-

rich (hydrous-silicate) melts. Due to their low density and viscosity, such melts can migrate upward through the mantle, forming a carbonated partially molten CO₂-rich mantle recorded by tomographic images in the depth range from 130 to 60 km. Upwelling in the mantle of carbonate-rich melts to depths less than 60 - 70 km, induces massive outgassing of CO₂. Buoyancy forces, probably favored by fluid overpressures, are able to allow migration of CO₂ from the mantle to the surface, through deep lithospheric faults, and its accumulation beneath the Moho and within the lower crust. The present model also explains CO₂ enrichment of the Etna active volcano. Deep CO₂ cycling is tentatively quantified in terms of conservative carbon mantle flux in the investigated area.

An asymmetric Earth

The “tectonic equator” (TE) describes the fastest flow of plates relative to the mantle, and it undulates relative to the geographic equator. The best fit for the tectonic equator has a pole of rotation at latitude -56.4° and longitude 136.7° , with an angular velocity of $1.2036^\circ/\text{Ma}$. Along a slightly perturbed path (TE-pert) an ubiquitous asthenosphere has been detected, capable of decoupling drifting lithosphere from underlying mantle. The generalized asymmetry across oceanic ridges shows that the lithosphere (0-100 km) in the western side of the rift is faster than in the eastern or northeastern side, whereas the upper asthenosphere (LVZ, 100-200 km) is slower in the western side with respect to the conjugate counterpart.

Earth's rotation and tidal despinning drive plate tectonics?

The distribution in space and time of global seismicity ($M_w \geq 7$) is latitude dependent. As the Earth slows down (increase of LOD) the seismicity increases and vice versa. We speculate that similar periodicities should also affect GPS velocities when a sufficient time span of measurements will be covered, i.e., plates should move with similar periodicities, due to oscillating tidal torques and Earth's oblateness acting on the lithosphere. The horizontal permanent torque exerted by the misalignment of the tidal bulge and the Earth-Moon gravitational trajectory provides a rather relevant amount of energy sufficient enough to contribute significantly in moving plates, particularly if a ultra-low viscosity layer is present at the top of the asthenosphere, allowing the relative W-ward decoupling of the lithosphere. The lithosphere and underlying mantle represent a self-organized system in a critical state - SOC system - open to external perturbations; plate tectonics is an example of a self-organizing complex system of hierarchical blocks in a critical state. The Gutenberg-Richter law shows that large magnitude earthquakes are very rare events, thus the energy released by one big earthquake seems to deplete temporally the energy budget of plate tectonics, i.e. a slab interacting with the surrounding mantle is not an isolated system, but it participates in a global expenditure of the stored energy. Plate tectonics is an Earth's scale phenomenology, and the energy source for its activation is not concentrated in limited zones (e.g., subduction zones), but it acts contemporaneously over the whole Earth's lithosphere, like the Earth's rotation. Only the global seismicity follows the Gutenberg-Richter law, while this simple SOC relation does not hold when considering smaller portions of the Earth. Our model supports an origin of plate tectonics in which the classic mantle convection is complemented and polarized by the steady-state torque provided by the tidal bulge misalignment. The horizontal component of the Earth's tide pumps the system; the vertical component of tides excites gravity oscillations, which locally load and unload the tectonic features. Low solid tide (larger gravity) favors extensional tectonics, whereas high solid tide (lower gravity) triggers compressional tectonics.

Comparative analysis of NDSHA and PSHA for Italy

The estimates of seismic hazard obtained according to the neo-deterministic (NDSHA) and to the probabilistic (PSHA) approaches are compared for the Italian territory. The NDSHA provides values larger than those given by the PSHA in high-seismicity areas and in areas identified as prone to large earthquakes, while lower values are provided in low-seismicity areas. These differences suggest the adoption of the flexible, robust and physically sound NDSHA approach to overcome the proven shortcomings of PSHA, thus allowing for a reliable seismic hazard

estimation, especially for those areas characterized by a prolonged quiescence, i.e. in tectonically active sites where only moderate size events took place in historical times.

Prospective testing of integrated NDSHA: the 6 April 2009 L'Aquila earthquake

In the framework of the Pilot Project SISMA funded by ASI (Italian Space Agency), fully formalized, automatic procedures have been developed for the routine updating of the intermediate-term middle-range earthquake predictions by M8S (in three magnitude ranges M5.5+, M6.0+ and M6.5+) and CN algorithms in Italy. With these results acquired, an experiment was launched in July 2003, aimed at a real-time test of M8S and CN prediction for earthquakes with magnitude larger than 5.4 in the Italian region. The results of the intermediate-term middle-range predictions in Italy are regularly updated every two months and are made accessible to a number of scientists (a complete archive of predictions is available via the ICTP website), thus allowing real-time testing of the predictive capability of the applied algorithms. This experiment is particularly advanced at an international level, where some international projects, aimed at the validation of forecasting methodologies, have been only recently launched or are still under definition (e.g. CSEP - Collaboratory for the Study of Earthquake Predictability; <http://us.cseptest.org/>). Along with CN and M8S real-time predictions, the associated neo-deterministic scenarios of ground motion are routinely updated and made available to the Civil Defence of the Friuli Venezia Giulia Region. A strong earthquake ($M=6.3$) hit L'Aquila on 6 April 2009. The epicentre was localized inside a seismogenic node, i.e. inside an area previously identified as prone to earthquakes with $M>6.0$ according to the morphostructural analysis. The earthquake occurred outside the areas alerted by CN and M8S algorithms for the corresponding magnitude interval, therefore it turns out to be a failure in prediction. In the framework of the earthquake prediction experiment for the Italian territory, however, on April 6 2009 there was an ongoing alarm in the CN Northern region, which started on 1 March 2009. The epicentre of the L'Aquila earthquake was localized just outside (about 10 km) the alerted region. Consequently the neo-deterministic ground shaking scenario associated to the Northern region, as defined for the period 1 March 2009 – 1 May 2009, correctly predicted the macroseismic intensities observed for this earthquake.

Integrating Geophysical Modeling and Earth Observation for time dependent seismic hazard assessment

In collaboration with the University of Milan and Politecnico di Milano, a fully formalized system integrating Earth Observation data and new advanced methods in seismological and geophysical data analysis, is currently under development within the framework of the Pilot Project SISMA, funded by the Italian Space Agency (ASI). The synergic use of geodetic Earth Observation data (EO) and Geophysical Forward Modeling (GFM) deformation maps at a national scale complements the space and time dependent information provided by real-time monitoring of seismic flow (performed by means of the earthquake prediction algorithms CN and M8S), so as to permit the identification and routine updating of alerted areas. This unprecedented effort towards the establishment of solid physical bases to earthquake prediction will be extended, in 2010, to U monitoring, in collaboration with INFN National Commission V. Thus all precursors of earthquakes currently included in the IASPEI list of significant precursors are considered: crustal deformation, water chemistry and seismicity pattern. At a small spatial scale (tens of km) of seismogenic nodes identified by pattern recognition analysis, both GNSS (Global Navigation Satellite System) and SAR (Synthetic Aperture Radar) techniques, coupled with expressly developed models for inter-seismic phases, allow us to retrieve the deformation style and stress evolution within the seismogenic areas. The displacements fields obtained from EO data provide the input for the geophysical modeling, which permits to indicate whether a specific fault is in a "critical state". The scenarios of expected ground motion, associated with the alerted areas are then defined by means of full waveforms modeling, based on the possibility to compute synthetic seismograms by the modal summation technique. In this way a set of deterministic scenarios of ground motion, which refers to the time interval when a strong event is likely to occur within the alerted area, can be defined either at national and local scale. The considered integrated approach opens new routes in understanding the dynamics of fault zones as well as in modelling the expected ground motion. The SISMA system, in fact, provides tools for establishing warning

criteria based on deterministic and rigorous forward geophysical models and hence allows for a well controlled real-time testing and validation of the proposed methodology over the Italian territory. The proposed approach complements the traditional probabilistic approach to seismic hazard estimates, since it supplies routinely updated information that can be useful in assigning priorities for timely mitigation actions and hence it is particularly relevant for Civil Defence purposes.

Teaching

Contribution of SAND group, University of Trieste, and IIEPT researchers to the Diploma course of ESP:

Giuliano Panza: Introduction to the Physics of the Earth System (8 lectures).

Antonella Peresan: Environmental Data Analysis I&II (24 lectures), Tutor of 1 Diploma Thesis.

Fabio Romanelli: Wave Physics (24 Lectures), Seismology (12 Lectures), Seismic and Tsunami Hazard (2 Lectures), Tutor of 2 Diploma Thesis.

Franco Vaccari: Computational Earthquake Hazard (6, Lectures & Tutorials), Tutor of 1 Diploma Thesis.

Alexandre Soloviev: Non-linear Dynamics of the Lithosphere (3 lectures), Pattern Recognition Methods and Their Applications to Geophysical Problems (2 lectures), Modeling of Block-and-Fault Dynamics and Seismicity (1 lecture).

Vladimir Kossobokov: Earthquake Prediction (6 lectures).

PhD studies:

Kervin Arturo CHUNGA MORAN in Italy. Follow-up ICTP/TRIL fellowship co-funded by Department of Chemical and Environmental Sciences, University of Insubria, Como, Italy, and SAND Group, Trieste, to finalize the PhD studies about Geologic Hazards Assessment and Deterministic Seismic Zoning in the Ecuadorian Coastal Region near Guayaquil.

FANG Lihua, ZHANG Sufang and ZHANG Xuemei in Italy. In the framework of the MIUR Internationalization PhD Programme (2004-2006): Advanced methodologies in the field of geophysics and geodynamics, coordinated by Giuliano F. Panza, three Chinese students received the international PhD, recognized both in Italy and China. The graduation ceremony will take place in Beijing (March 29 – 30, 2010) during the First Sino Italian Conference on “Advanced Methodologies and Technologies in Geophysics, Geodynamics and Seismic Hazard” an event in the framework of the 40th Anniversary of Diplomatic Relations between Italy and People’s Republic of China. The knowledge and software facilities made available by SAND group members greatly contributed to the success of the activity.

Staff and Long-Term Visitors (3 months or more)

Consultants

G.F. Panza, Italy

Other

M. El-Gabry, Egypt, Junior Associate
H. Hamzehloo, Iran, Regular Associate
A. Harbi, Algeria, Regular Associate
M. Kouteva Guentcheva, Bulgaria, Junior Associate
B. Moreno Toiran, Cuba, Regular Associate
R. Raykova, Bulgaria, Junior Associate
Wang Guo Xin, China, Regular Associate

Visiting Scientists

D. Bisignano, Italy
K. Chunga Moran, Ecuador (TRIL)
S. Dimitrova, Bulgaria (CEI)
Fang Lihua, China
F. Gonzalez Matos O'Leary, Cuba (TRIL)
A. Gusev, Russia
A. Guseva, Russia
B. Grecu, Romania (CEI)
R. Habib, Iran (IIEES)
A. Peresan, Italy
F. Romanelli, Italy
Zhang Sufang, China
Zhang Xuemei, China

In addition, there were 29 short-term (less than 3 months) visitors.

Funding

Internal

SAND Research Group, ICTP, Euro 27,000

Advanced School on Non-linear Dynamics and Earthquake Prediction (28 September - 10 October 2009), €50,000

Joint ICTP/IAEA Advanced Workshop on Earthquake Engineering for Nuclear Facilities (30 November - 4 December 2009) €25,000

External

New - Three year agreement between ICTP and the Civil Defence of the Friuli Venezia Giulia Region (DGR 1459 dd. 24.6.2009): Development of innovative approaches for the modeling of the Earth structure and the seismic sources aimed at the definition of time-dependent seismic input by means of intermediate-term middle-range earthquake prediction in the Friuli Venezia Giulia Region: €127,500 (€42,500/year).

Three years agreement between ICTP and the Civil Defence of the Friuli Venezia Giulia Region (DGR 2226 dd. 14.9.2005): Development of innovative approaches for the modeling of the Earth structure and the seismic sources aimed at the definition of time-dependent seismic input by means of intermediate-term middle-range earthquake prediction in the Friuli Venezia Giulia Region: Euro, 120,000 (Received €30,000 last payment).

Central European Initiative – CEI: €11,200

ENEA, Rome: €2,266

APPLIED PHYSICS
AERONOMY AND RADIOPROPAGATION LABORATORY
(ARPL)

AERONOMY SECTION

Introduction

Aeronomy related activities of the laboratory cover ionospheric modeling studies devoted mostly to 3D and time specification of the electron density in the ionosphere using experimental data ingestion. In addition, a new research topic has been initiated using radio occultation techniques to determine the electron density distribution in the ionosphere.

These studies are mainly oriented to the ionospheric effects in satellite navigation and positioning using GPS, the augmentation systems developed or being developed in the USA, Europe, Japan, China and India and other areas of the world and the future European GALILEO system.

The ICTP has signed in 2009 a MoU with Boston College of the United States of America to promote, through ARPL, activities related to satellite navigation science and technology in Africa. A series of collaborations have started with research groups in African universities towards the implementation of joint research activities in this field.

Research Activities

Ionospheric model studies

The European Space Agency (ESA) has requested ARPL to adapt the Laboratory ionospheric NeQuick 2 model, based on the version originally developed by the ARPL and the University of Graz (Austria), to the International Telecommunications Union requirements to be introduced in ITU Radiocommunications recommendations. A series of model tests and verifications and software and technical documentation will be done under contract with ESA.

The technique developed at the ARPL to reconstruct global and regional three-dimensional and time varying electron density distribution in the ionosphere through experimental data ingestion in ionospheric models is being extended further. The technique is being applied with success also to low latitude Africa under the effect of the ionospheric equatorial anomaly. As an example, slant total electron content (sTEC) data from one station (Libreville, Gabon) have been ingested in the NeQuick 2 model and the sTEC calculated with the regional model so generated are compared with the experimental data obtained at a location (Franceville, Gabon) 485 km away from the first station. The results shows that for the one day 1268 data points analyzed the RMS of the differences between experimental and modeled data is rather small (6.5 TEC units). This study is being extended also in collaboration with researchers from the University of Zambia, Lusaka, and Bahir Dar University, Bahir Dar, Ethiopia.

Equatorial Plasma Bubbles (Ionospheric depletions) detection

The technique to detect electron density depletions or plasma bubbles observed at low latitudes in the ionosphere that has been developed in collaboration with the Universidad Complutense of Madrid (Spain) and reported in the previous year continues to be used to study the occurrence of this phenomenon over Africa with a newly developed software. The technique is applied to time series of total electron content calculated from GPS signals. Electron density depletions are associated to satellite signal scintillations that affects satellite navigation.

Radio occultation studies

In the framework of the project ROSA (Radio Occultation Sounder of the Atmosphere) developed by an Italian consortium and financed by the Italian Space Agency, the Laboratory has initiated a research work in the field of the use of radio occultation of GPS signals received by a low orbiting satellite to determine the electron density distribution in the ionosphere. The ROSA experiment has been put in orbit with the OCEANSAT-2 Indian satellite launched in October 2009.

An independent method has been developed using the “onion peeling” concept to derive the electron density profile from the height of the low orbiting satellite down to the lower layers of the ionosphere. Figure 1 show the principle of the “onion peeling” technique.

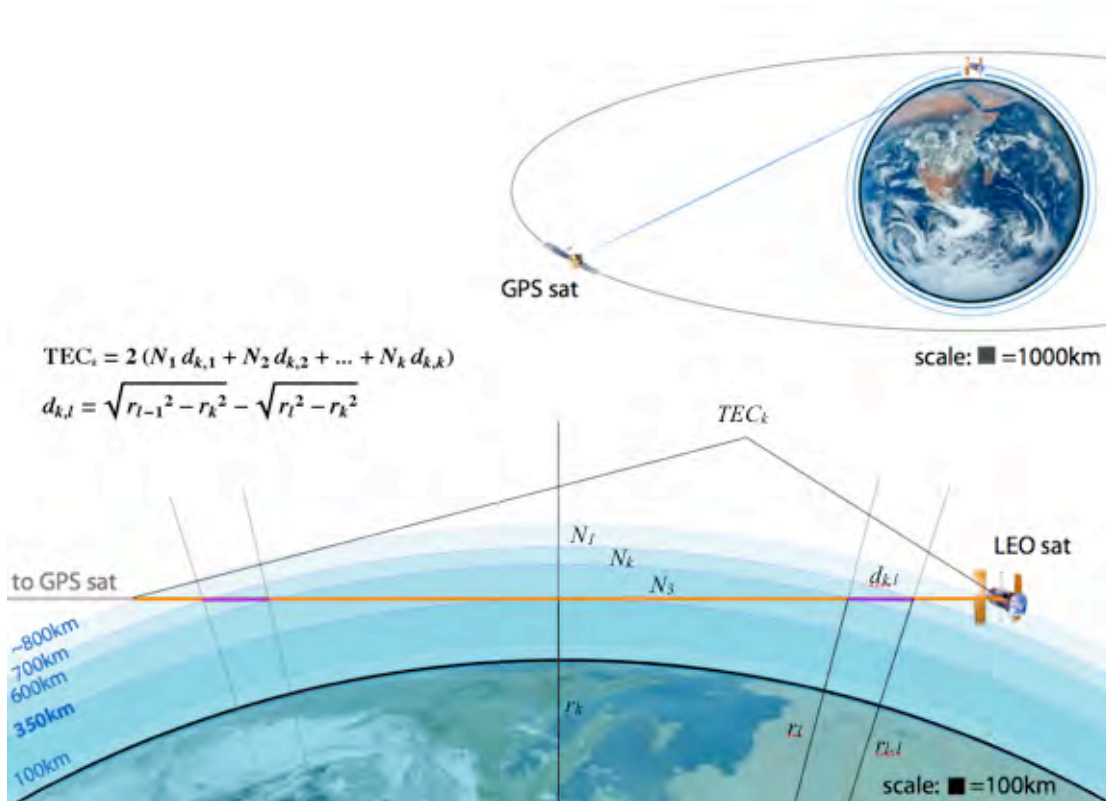


Fig. 1: The principle of the “onion peeling” technique to obtain electron density profiles in the ionosphere with radio occultation data.

In order to validate the “Onion Peeling” algorithm implemented in the software developed in the framework of ROSA project, a number of simulations and experimental data analysis have been performed. In particular, for the day 31 Dec. 2007 all the Radio Occultation (RO) data from the full COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate, a joint U.S.-Taiwan space mission) + GPS constellation have been used. A detailed validation of the electron density profiles obtained after the application of the “Onion Peeling” algorithm, has been carried out using a simulated ionosphere with the NeQuick 2 model. The true satellite orbits (GPS + COSMIC) have been considered and the TEC values for each satellite COSMIC-to-GPS link have been computed integrating the 3D electron density given by the NeQuick 2.

The first electron density profile obtained from the ROSA experiment flying in the OCEANSAT-2 satellite with the “onion peeling” algorithm developed by the ARPL is shown in Figure 2 in blue. To check the validity of the technique the profile obtained has been compared with a “co-located” COSMIC profile. The results are very good.

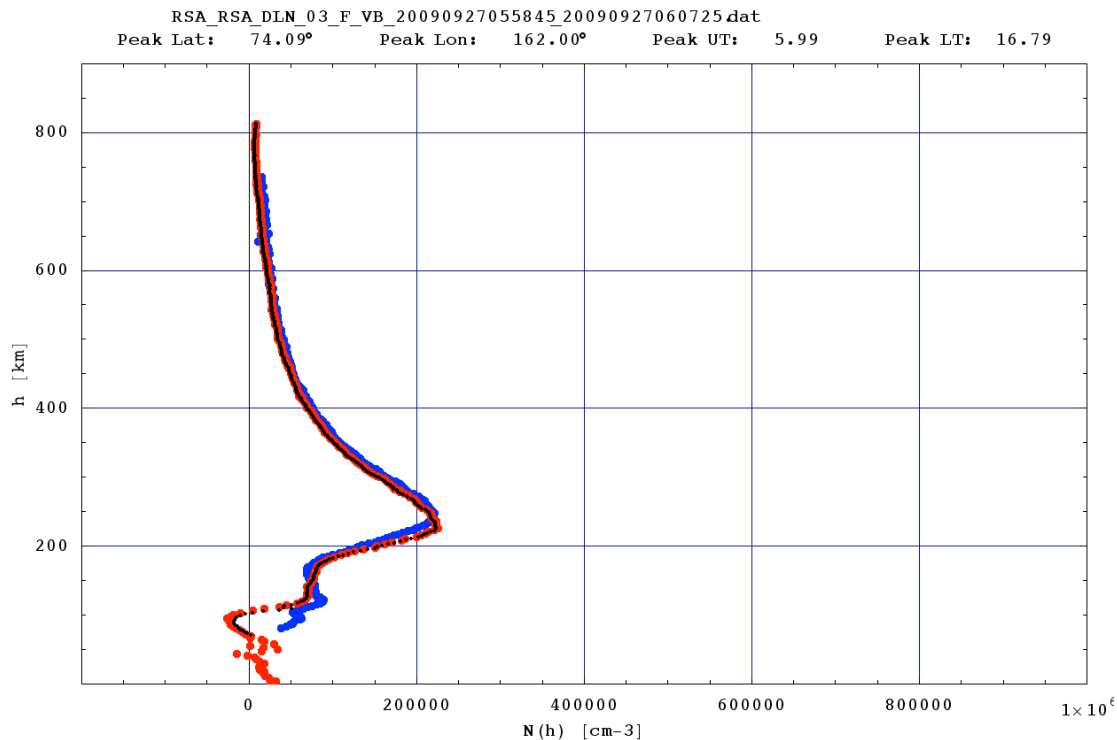


Fig. 2: The first electron density profile obtained with the ROSA experiment on board of OCEANSAT-2 and collocated COSMIC profile.

Training Activities

Satellite Navigation Science and Technology for Africa, 23 March – 9 April 2009, Trieste. (S.M. Radicella co-director, local organizer and lecturer, B. Nava lecturer). The purposes of the workshop, - organized and co-financed by Boston College, USA, under the partner established with this university - was to increase the global navigation satellite science and applications expertise in Africa and to further develop science collaborations with the universities in the continent by promoting the establishment of research groups interested in the field. For this reason professors or senior lecturers were invited to attend together with junior scientists nominated by them.

Nigerian National Meeting on GNSS Science and Applications, Abuja, Nigeria, 16-19 November 2009. (S. M. Radicella co-director and lecturer, B. Nava lecturer). This meeting was co-organized by the ARPL as a follow-up of the Workshop organized in Trieste to promote the establishment of a national effort towards the creation of a network of research groups in satellite navigation related activities in Nigeria.

Participation in International Programmes

Participation in International Meetings

United Nations/Azerbaijan/United States of America/European Space Agency Workshop on the Applications of Global Navigation Satellite System (GNSS), 11-15 May 2009, Baku, Azerbaijan (S.M. Radicella)

IHY-AFRICA/SCINDA 2009 Workshop, Livingstone, Zambia, 7–12 June 2009. (S.M. Radicella)

Summer School “The Exploration of Mars”, 13-17 July 2009, San Lorenzo de El Escorial, Spain. (S.M. Radicella)

Nigerian National Meeting on GNSS Science and Applications, Abuja, Nigeria, 16-19 November 2009. (S.M. Radicella and B. Nava)

RADIOCOMMUNICATION SECTION

Introduction

Activities in information technologies and radiocommunications related topics covered in-house training and capacity building and in-site activities linked essentially to the use of radio systems in information and communication technologies for developing countries. Research and application activities in the area of “wireless sensors” are continuing to acquire the capacity to transfer this new technology to developing countries. Under an agreement signed in February 2004 between the Centre and the International Telecommunication Union – Bureau of Development of Telecommunications (ITU/BDT), a joint ICTP-ITU/BDT “ICT Technology Observatory and Training Unit for Developing Countries” (ICT TO & TU) continued its operation in 2008.

A New Programme of Activities

The Laboratory is involved in the new programme carried out by the ICTP, financed with Italian funds-in-trust with UNESCO that includes the area of ICT Research Infrastructure in Africa. The Laboratory has started work on Preparation of Training Material on Wireless Networking, Preparation of “Wireless Training Kits”, Planning of Training Activities on Wireless Networking and Wireless Sensor Networks, Research on Long Distance Wireless Links and Wireless Sensor Networks including GPS assisted positioning and satellite navigation science and technology in Africa to support such research. These activities involve the Radiocommunication Section of the Laboratory with the collaboration of the Aeronomy Section for the last of these project areas.

Wireless Training Kits

The ARPL section has been concentrating efforts in the development of a Wireless Training Kit. Its goal is to provide all necessary elements to one or more instructors to organize a one week, hands-on training activity in a developing country. Very little local support is assumed, in terms of facilities and infrastructure. The main targets are academic institutions seeking to enrich their scientific/engineering curricula with a short course on “wireless networking laboratory”. After attending such an activity, participants should be able to understand the basics of WiFi networking, including topics such as how to choose the right antenna, how to properly install WiFi equipment, and should understand how all of this fits into their existing network. By the end of the course, attendees will participate in practical exercises and demonstrations with different kinds of WiFi equipment.

The kit is composed of two parts: a set of low-cost advanced technology hardware devices (wireless equipment, antennas, spectrum analyzer, etc...) and a set of training materials for 15 lectures and related exercises.

The kit has been tested as training material in a Workshop carried out in Abomey-Calavi, Benin. Figure 3 show participants of this workshop using elements of the kit.



Fig. 3: Participants at the Workshop in Benin using elements of the training kit.

Wireless systems for environmental monitoring

The collaboration with the Consorzio Venezia Nuova to develop and test wireless systems using Wi-Fi technologies for environmental monitoring is continuing. With financial support from the Consorzio the Laboratory deployed a low cost wireless mesh network that provides Internet connectivity for water sensors in the Venice lagoon. During March-April 2009 a network of WiFi and WiMAX systems have been deployed in the Venice lagoon to test the possibilities of installing similar networks in developing countries for water management monitoring.

A wireless sensor network to monitor water quality has been designed and deployed by the ARPL in 2009 in Malawi. In the country out of a population of 11.8 million, only 62% (95% urban and 58% rural) have access to safe drinking water. Although low priority has been given to water and sanitation programmes, water quality has been a major cause of mortality especially for children under five year. The first implementation of the system has been at the Blantyre Water Board, responsible for delivery of water supply and services in the city of Blantyre. Two wireless sensors to monitor water quality: one in the catchment area and one following the treatment process were put in place (Figure 4) The distance between the pools is about 100 meters, while the catchment area is some 300 meters away. The results of the analysis will be used both at the Water Board and at the Malawi Polytechnic, so that a web server publishing the results will be installed in a second phase. The Water Board has an ADSL connection that will be used to connect the system to Internet. This work has been fully supported by the Royal Institute of Technology (KTH) of Sweden.



Fig. 4: A wireless sensor measuring water quality in Blantyre, Malawi.

Training Activities

ICTP-ITU School on Wireless ICT Low Cost Solutions in Developing Countries: Best Practices, 16 February — 6 March 2009 (S.M. Radicella co-director, C. Fonda and M. Zennaro hands-on laboratory planning and direction and lecturers)

ICTP First Workshop on Open Source and Internet Technology for Scientific Environment: with case studies from Environmental Monitoring. 7-25 September 2009, (M. Zennaro Local Organizer)

Teaching Activities

ICT4D Master at the Universidad Rey Juan Carlos of Madrid, 12-20 January (M. Zennaro lecturer on Wireless Sensor Networks)

AfNOG 2009 Workshop on Network Technology, Cairo, Egypt, 10-15 May 2009 (C. Fonda lecturer)

ISOC-NSRC workshop on wireless networking at Campus Numérique de la Francophonie à Abomey-Calavi, Benin, 9-13 November (C. Fonda and M. Zennaro lecturers)

Participation in International Meetings

ITU Regional Human Capacity Development Forum for Europe and the CIS, Budva, Montenegro, 30 March - 2 April 2009, (M. Zennaro)

WSN2009 conference in San Francisco, USA. 29 July - 9 August 2009, (M. Zennaro, participation fully supported by KTH, Sweden)

ICT4D Symposium in London. 11-12 September 2009, (M. Zennaro, participation fully supported by the organizers)

The Second International Workshop on Next Generation of Wireless and Mobile Networks, Vienna, Austria, 22-25 September 2009, (M. Zennaro)

Funding

Aeronomy activities, ICTP Regular Funds, €13,000

Aeronomy activities, Other institutions, €50,000

ICT TO & TU activities, ITU/BDT, €20,000

ICT TO & TU activities, ICTP Regular Funds, €69,000

Italian funds-in-trust with UNESCO, €157,000

Staff and Long-Term Visitors (3 months or more)

Staff Associates

S.M. Radicella, Italy/Argentina (Head of the ARPL)

Consultants

B. Nava, Italy

R. Flickenger, USA

C. Fonda, Italy

M. Zennaro, Italy

Visiting Scientists

O.A. Oladipo, Nigeria (STEP programme)

K. Alazo Cuartas, Cuba (STEP programme)

APPLIED PHYSICS BIOSCIENCES

BIOASTRONOMY/ASTROBIOLOGY

Introduction

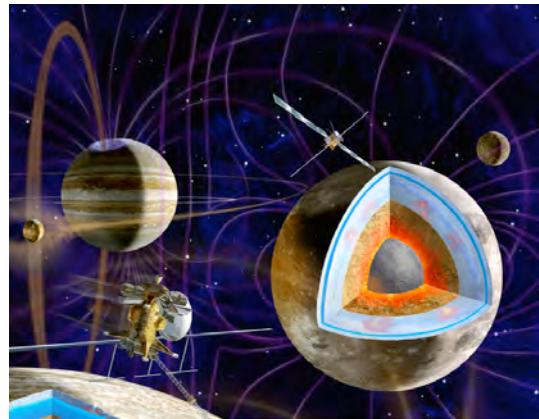
Bioastronomy is concerned with the study of the origin, evolution, distribution and destiny of life in the universe. ('Exobiology' is a synonym often in use, but more recently 'astrobiology' is preferred, cf., <http://www.ictp.it/~chelaf/ss94>) This field was established at ICTP in 1991 with the combined efforts of Abdus Salam, Cyril Ponnampereuma and the present author. Research, seminars and conferences in bioastronomy have attracted a large number of scientists to the Centre.

Research Activities

The distribution of life in the universe is the aspect of bioastronomy that can encourage successful interdisciplinary dialogue with other scientists from the Applied Physics, as well as other scientific sections of the Abdus Salam ICTP. (The other three aspects of bioastronomy are enumerated above.) The cosmic distribution of life still lacks solid theoretical, or observational bases.

Nevertheless, the question of distribution can be probed in terms of a wide range of planetary exploration missions especially dedicated to study whether, or not, we are alone in the universe, as for instance the Europa-Jupiter System Mission now in its planning stages, (cf., Fig 1).

Fig. 1: The proposed baseline of the Europa Jupiter System Mission, EJSM (NASA, ESA, ROSCOSMOS, JAXA) consists of two primary flight elements operating in the Jovian system: the NASA-led Jupiter Europa Orbiter (JEO), and the ESA-led Jupiter Ganymede Orbiter (JGO). JEO and JGO will execute a choreographed exploration of the Jupiter System before settling into orbit around Europa and Ganymede, respectively.



Experimental

The main space agencies have undertaken a sustained effort to search for biosignatures. The discoveries of the successful Galileo mission took place during its fourteen-year activity (1989-2003). Its Near-Infrared Mapping Spectrometer led to the discovery of a series of unexpected lines on the icy surface of the Jovian satellite Europa, due to patches of chemical element impurities. Can some of these new lines be due to the presence of life in the submerged ocean? Could they be interpreted as biosignatures? The relevance of theoretical work at ICTP is to suggest feasible experiments that are possible, not only with present technology, but also within the agency budgets. Originally we had suggested the insertion of a submersible underneath the ice crust (cf., Fig.2):



Fig. 2: The earlier hydrobot-cryobot proposal for directly probing Europa's ocean, Horvath et al, (1997), http://www.ictp.it/~chelaf/searching_for_ice.html

Even though we were attracted to this technology in our earlier paper, we no longer consider it to be realistic, due to the limited budgets to which all the space agencies are constrained. Fortunately, the corresponding study of a surficial biosignature offers a viable alternative that has already been successfully accepted for publication in specialized literature during the year 2009 (cf., Publications, Chela-Flores, 2010a), and remains a

possible option for future missions that are currently in their planning stages, and to which since the 1990s the Abdus Salam ICTP continues participating in the question of identifying the relevant instrumentation (cf., next section).

Theoretical, Experimental and Technological

In the search for biosignatures on Europa on the sulphur patches discovered by the Galileo mission the most appropriate technology—the penetrator—is currently being further developed by the UK Penetrator Consortium for preliminary trials on our own Moon. These instruments consist of small projectiles that can be delivered at high velocity to reach just beneath the surface of planets, or their satellites for probing samples of surficial chemical elements. This type of instrumentation (the penetrators) has a long history of feasible technological development by several space agencies. The research at the ICTP has focused on the type of instruments that the penetrators should be provided with from the point of view of the search for life signatures (cf., Publications, Gowen *et al.*, 2010 submitted).

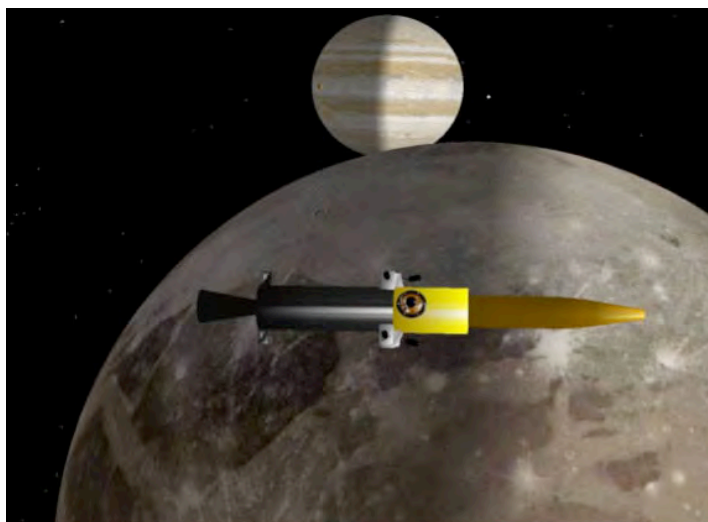


Fig. 3: The penetrator as it should appear approaching Europa (with Jupiter in the background). This technology is currently being further developed by the UK Penetrator Consortium for preliminary trials on our own Moon but for an eventual use on Europa. (cf., Participation in International Meetings, Gowen et al., 2009a).

Participation in International Programmes

Declaration of Interest in science instrumentation in response to the Announcement of Opportunity for Europa Jupiter System Mission (EJSM/Laplace) Cosmic Vision Candidate: Surface Element Penetrators, May 2009 Robert Gowen, Alan Smith, Richard Ambrosi, Olga Prieto Ballesteros, Simeon Barber, Dave Barnes, Chris Braithwaite, John Bridges, Patrick Brown, Phillip Church, Glyn Collinson, Andrew Coates, Gareth Collins, Ian Crawford, Veronica Dehant, Michele Dougherty, Julian Chela-Flores, Dominic Fortes, George Fraser, Yang Gao, Manuel Grande, Andrew Griffiths, Peter Grindrod, Leonid Gurvits, Axel Hagermann, Toby Hopf, Hauke Hussmann, Ralf Jaumann, Adrian Jones, Geraint Jones, Katherine Joy, Ozgur Karatekin, Günter Kargl, Antonella Macagnano, Anisha Mukherjee, Peter Muller, Ernesto Palomba, Tom Pike, Bill

Proud, Derek Pullen, Francois Raulin, Lutz Richter, Simon Sheridan, Mark Sims, Frank Sohl, Joshua Snape, Jon Sykes, Vincent Tong, Tim Stevenson, Lionel Wilson, Ian Wright, John Zarnecki:

http://www.mssl.ucl.ac.uk/planetary//missions/Cosmic_Vision_EJSM_Penetrators_DOI.pdf

Participation in International Meetings

Chela-Flores, J., Bhattacharjee, A. B., Dudeja, S., Kumar, N. and Seckbach, J. 2009. Can the biogenicity of Europa's surficial sulfur be tested simultaneously with penetrators and ion traps? Geophysical Research Abstracts, Vol. 11, EGU2009-0, 2009, EGU General Assembly 2009. The Austria Centre, Vienna, 22 April.

<http://www.ictp.it/~chelaf/EGU2009JCTetal.pdf>

Seckbach, J. and Chela-Flores, J. 2009. Astrobiology: From extremophiles in the Solar System to extraterrestrial civilizations, Astronomy and Civilization, Budapest – August.

<http://www.ictp.it/~chelaf/Budapest.pdf>

Gowen, Robert, Alan Smith, Richard Ambrosi, Olga Prieto Ballesteros, Simeon Barber, Dave Barnes, Chris Braithwaite, John Bridges, Patrick Brown, Phillip Church, Glyn Collinson, Andrew Coates, Gareth Collins, Ian Crawford, Veronique Dehant, Michele Dougherty, Julian Chela-Flores, Dominic Fortes, George Fraser, Yang Gao, Manuel Grande, Andrew Griffiths, Peter Grindrod, Leonid Gurvits, Axel Hagermann, Tim van Hoolst, Hauke Hussmann, Ralf Jaumann, Adrian Jones, Geraint Jones, Katherine Joy, Ozgur Karatekin, Günter Kargl, Antonella Macagnano, Anisha Mukherjee, Peter Muller, Ernesto Palomba, Tom Pike, Bill Proud, Derek Pullen, Francois Raulin, Lutz Richter, Keith Ryden, Simon Sheridan, Mark Sims, Frank Sohl, Joshua Snape, Paul Stevens, Jon Sykes, Vincent Tong, Tim Stevenson, Werner Karl, Lionel Wilson, Ian Wright, John Zarnecki 2009a. Looking for Astrobiological Signatures with Penetrators on Europa, in Physical and Engineering Sciences Exploratory Workshops, W08-115, co-funded by Life, Earth and Environmental Sciences: Biosignatures On Exoplanets; The Identity Of Life , 22-26 June, Mulhouse, France .

<http://www.ictp.it/~chelaf/ESFsummary.pdf>

Gowen, Robert, Alan Smith, Richard Ambrosi, Olga Prieto Ballesteros, Simeon Barber, Dave Barnes, Andrew Bowyer, Chris Braithwaite, John Bridges, Patrick Brown, Phillip Church, Glyn Collinson, Andrew Coates, Gareth Collins, Ian Crawford, Veronique Dehant, Michele Dougherty, Jeremy Fielding, Julian Chela-Flores, Dominic Fortes, George Fraser, Yang Gao, Manuel Grande, Andrew Griffiths, Peter Grindrod, Leonid Gurvits, Axel Hagermann, Tim van Hoolst, Hauke Hussmann, Ralf Jaumann, Adrian Jones, Geraint Jones, Katherine Joy, Ozgur Karatekin, Günter Kargl, Antonella Macagnano, Anisha Mukherjee, Peter Muller, Ernesto Palomba, Andy Phipps, Tom Pike, Bill Proud, Derek Pullen, Francois Raulin, Lutz Richter, Keith Ryden, Simon Sheridan, Mark Sims, Frank Sohl, Joshua Snape, Paul Stevens, Jon Sykes, Vincent Tong, Tim Stevenson, Nigel Wells, Werner Karl, Lionel Wilson, Ian Wright, John Zarnecki 2009b. An update on micro-penetrators for in-situ sub-surface investigations of Europa, Europa Jupiter System Mission (EJSM) Instrument Workshop, JPL and the Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland, July 15-17.

<http://www.ictp.it/~chelaf/NASAabstract09.pdf>

Gowen, Robert, Alan Smith, Richard Ambrosi, Olga Prieto Ballesteros, Simeon Barber, Dave Barnes, Andrew Bowyer, Chris Braithwaite, John Bridges, Patrick Brown, Phillip Church, Glyn Collinson, Andrew Coates, Gareth Collins, Ian Crawford, Veronique Dehant, Michele Dougherty,

Jeremy Fielding, Julian Chela-Flores, Dominic Fortes, George Fraser, Yang Gao, Manuel Grande, Andrew Griffiths, Peter Grindrod, Leonid Gurvits, Axel Hagermann, Tim van Hoolst, Toby Hopf, Hauke Hussmann, Ralf Jaumann, Adrian Jones, Geraint Jones, Katherine Joy, Ozgur Karatekin, Günter Kargl, Antonella Macagnano, Anisha Mukherjee, Peter Muller¹, Ernesto Palomba, Andy Phipps, Tom Pike, Bill Proud, Derek Pullen, Francois Raulin, Lutz Richter, Keith Ryden, Simon Sheridan, Mark Sims, Frank Sohl, Joshua Snape, Paul Stevens, Jon Sykes, Vincent Tong, Tim Stevenson, Nigel Wells, Lionel Wilson, Ian Wright, John Zarnecki 2009c. In-situ Science on the surfaces of Ganymede and Europa with Penetrators, European Planetary Science Congress Abstracts, Vol. 4, EPSC2009, 2009 European Planetary Science Congress, Potsdam, Kongresshotel am Templiner See: 13 – 18 September.

http://www.ictp.it/~chelaf/Gowen_abstract.pdf

Training Activities

Supervision of Associate Members of ICTP

Senior Associate: V.C. Tewari, Wadia Institute of Himalayan Geology, Dehra Dun, India.

Service Activities within ICTP

Seminars of the Applied Physics Scientific Section

Reliability of Gate Oxides: Applications to Space Exploration, Felix R. M. Palumbo, Physics Department, CONICET - CNEA, Buenos Aires, Argentina, 26 February 2009

Darwin: Traces on Ice, Nevio Pugliese and co-workers of the Antarctic Museum, Dipartimento di Scienze Geologiche, Ambientali e Marine, Università degli Studi di Trieste, 26 March 2009

Paleoradiology: Imaging mummies and fossils, Rethy Chhem, Director of the Division of Human Health, International Atomic Energy Agency, Vienna, 11 May 2009

Proposal of an optically stimulated luminescence reader at the Abdus Salam ICTP, F. O. Ogundare, Department of Physics, University of Ibadan, Ibadan, Nigeria, 28 September 2009

Ionospheric Physics and Space Weather Research in Cuba, Alexander Calzadilla-Méndez, Instituto de Geofísica y Astronomía, Departamento de Geofísica Espacial, Ciudad de la Habana, Cuba, 7 October 2009

Modelling Human Bone Mineral Density, Rita Cassia-Moura, Biophysics Division, Physiological Sciences Department, Biological Sciences Institute, Pernambuco University, Recife, Brazil, 29 October 2009

Hardware Implementation of Particle Filters, Imbaby I. Mahmoud, Atomic Energy Authority, NRC, Engineering Department, Cairo, Egypt, 4 November 2009

Stable Isotope Technique in the Evaluation of Soil Physical Quality, Mutiu A. Busari, Department of Soil Science and Land Management, University of Agriculture, Abeokuta, Nigeria, 11 November 2009

Other seminars (including Physics of the Living State: Medical Physics)

Nanotechnology for applications in therapeutics, Sangeeta Kale, Nanoscience Group, Post-graduate and Research Centre Department of Electronic-Science, Fergusson College, Pune, India, 3 June 2009

On the Safety of Persons Accompanying Nuclear Medicine Patients, Marlenin Díaz Barreto, National Control Center for Medical Devices, Havana, Cuba, 26 August 2009

Analyzing and Improving Digital Medical Image Quality, Cuban experiences in Magnetic Resonance and Nuclear Medicine, Marlen Perez Diaz, Central University "Las Villas", Electrical Engineering Faculty, Santa Clara, Cuba, 16 September 2009

Patient radiation doses during selected CT examinations at a large hospital in SW Nigeria, Rachel Ibhade Obed, Physics Department, University of Ibadan, Ibadan, Nigeria, 23 September 2009

Coordination, Seminars on Physics of the Living State (Bioastronomy)

Metabolic adaptation: from a prebiotic lipid world to optimal organization, Daniel Segrè, Bioinformatics Program, Boston University, United States of America, 16 June 2009

Science Communication (Bioastronomy)

1. La notte dei ricercatori: an informal dialogue with the citizens of Trieste, 25 September 2009.
<http://www.ictp.it/~chelaf/ss237.html>

2. Darwin-Anniversary Activities
(<http://www.ictp.it/~chelaf/ss223>)

For the two anniversaries in the year 2009 (the 200th anniversary of the birth of Charles Darwin in 1809 and the 150th anniversary of the publication of "The Origin of Species" in 1859), The Abdus Salam International Centre for Theoretical Physics (ICTP) in collaboration with other institutes in Trieste and the UNESCO Office in Venice, organized an exhibition to commemorate these two events. We participated in the following activities:

(a) Coordinator and speaker during the visits to the ICTP Darwin Exhibition (November-December 2009)

Liceo Scientifico Galileo Galilei (Trieste), 25 November 2009.

Liceo Veronese di Chioggia, 1 December 2009.

Liceo Linguistico di Portogruaro, 2 December 2009.

Scuola Elementare U. Saba and Scuola Elementare Tarabocchia (Trieste), 3 December 2009.

Scuola Media Codermatz (Trieste), 4 December 2009.

Scuola Elementare Giotti (Trieste), 9 December 2009.

Scuola Elementare Biagio Marin (Trieste), 14 December 2009.

(b) Conferences related to the UNESCO Darwin celebrations (Venice and Trieste)

Chela-Flores, J. (2009a). L'origine della vita nell'universo. In: Darwin e la Scienza Moderna, UNESCO Office, Palazzo Zorzi, Venice, 29 April.

<http://www.ictp.it/~chelaf/JCFVenezia1.pdf>

Chela-Flores, J. (2009b). L'origine della vita nell'universo. In: Darwin, evoluzione e scienza. (Miniconferenza, 24 November 2009.)

<http://www.ictp.it/~chelaf/ss246>

Service Activities outside ICTP

Organization of scientific events

II Iberoamerican School of Astrobiology, Organizer Prof. Guillermo Lemarchand. Montevideo, Uruguay, September 13-17, 2009. Member of the Scientific Organizing Committee.

II International Workshop on Chemical Evolution and Origin of Life. Department of Chemistry, Indian Institute of Technology, Roorkee, India. Organizer: Professor Kamaluddin, March 5-7, 2010. Member of the International Advisory Committee.

III Workshop della Società Italiana di Astrobiologia, Castello di Duino, Trieste, May 26-28, 2010. Member of the Scientific Organizing Committee.

Member of editorial boards, reviewer

Member of the editorial board of the book series on "Cellular Origin and Life in Extreme Habitats and Astrobiology" (Springer).

Reviewer for *Advances in Space Research* and *Planetary and Space Science*.

External Examiner

"System Study and Design of a Multi-probe Mission for Planetary in-situ Analysis", Mr. Peter Weiss. PhD examination, The Hong Kong Polytechnic University, 22 February 2010.

Staff and Long-Term Visitors (3 months or more)

Staff Associate

Julian Chela-Flores, Venezuela

<http://www.ictp.it/~chelaf/index.html>

BIOPHYSICS

Introduction

Biophysics is at present the subject of genuine interest for an appreciable number of ICTP scientists that belong to the Associateship Scheme. This wave of renewed interest is partly due to advanced physical techniques that have allowed the systematic study of all the main macromolecules of life, namely, proteins (Fig. 1), nucleic acids such as DNA (Fig. 2), and the macromolecules of the cell membrane, especially phospholipids that make up its corresponding bilipid layer (Fig. 3).



Fig. 1

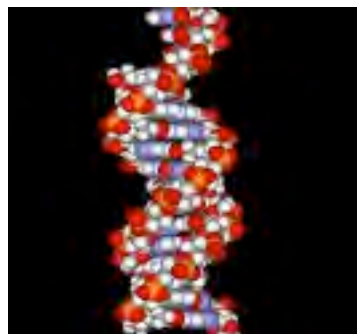


Fig. 2

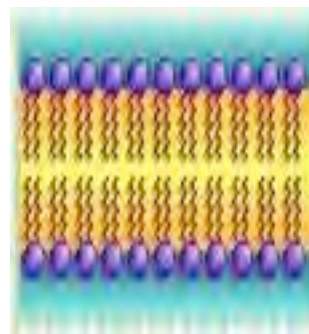


Fig. 3

Training Activities

Supervision of Associate Members of ICTP

Junior Associates:

On-Uma Kheowan, Department of Chemistry, Faculty of Science, Mahidol University, Bangkok Thailand

Armen Phogosyan, The International Scientific Educational Centre of the National Academy of Science of the Republic of Armenia, Yerevan, Armenia

Regular Associates:

Abdol Khalegh Bordbar, Department of Chemistry, Isfahan University, Isfahan, Iran

Rita Cassia-Moura, Physiological Sciences Department, Biological Sciences Institute, Pernambuco University, Recife, Brazil

Yong Li Chuan, School of Physics, Nankai University, Tianjin, China

Senior Associate:

Afolabi Akintunde Akindahunsi, Biochemistry Department, Federal University of Technology, Akure, Nigeria

Service Activity

Coordination of Seminars on Physics of the Living State (Biophysics)

Analysis of ligand binding processes based on thermodynamic quantities, Abdolkhalegh Bordbar, Department of Chemistry, University of Isfahan, Isfahan, Iran, 2 September 2009

Modelling Human Bone Mineral Density, Rita Cassia-Moura, Physiological Sciences Department, Biological Sciences Institute, Pernambuco University, Recife, Brazil, 29 October 2009

Biophysics in cardiac electrophysiology: mapping and modeling, Chuan Yong Li, School of Physics, Nankai University, Tianjin, People's Republic of China, 19 November 2009

Funding

A project financed by Regione Friuli Venezia Giulia: "Con Darwin in un percorso ipertestuale dall'economia alle scienze naturali". Coordinator Giacomo Barroso. Collaborating scientists: Nevio Pugliese, Claudio Tuniz, Gianguido Salvi and Julian Chela-Flores. Collaborating Institutes: Museo Nazionale Antartide - Sezione Trieste, Dipartimento di Scienze Geologiche, Ambientali e Marine dell'Università di Trieste, and ICTP.

Other

Review of all the candidates in the various Associateship Schemes of ICTP (Junior, Regular and Senior) in the area of biophysics.

Staff and Long-Term Visitors (3 months or more)

Staff Associate

Julian Chela-Flores, Venezuela

<http://www.ictp.it/~chelaf/index.html>

NEUROPHYSICS

Introduction

Neuroscientists focus on the brain (cf., Fig. 1), psychologists on the mind. In this area physicists have approached computational aspects of neuron interactions. The hope has been of building

computational models of biologically plausible artificial neural networks that can mimic certain aspects of the brain. The recent advances in determining the structure of molecules has given molecular biology a central role in the progress of molecular neuroscience. This is exemplified by the structure of the neurotransmitter-gated ion-channel transmembrane region (cf., Fig. 2).

Neurophysics has been developed at ICTP through a series of colleges and symposia in which many participants from the Third World and industrialized nations have been brought up to date in their areas of expertise. It was also possible to consider this subject in the broader context of neuronal structure and function, as well as addressing important issues of perception, learning, memory and their computational aspects by the assumption of simplified models (Fig. 3).

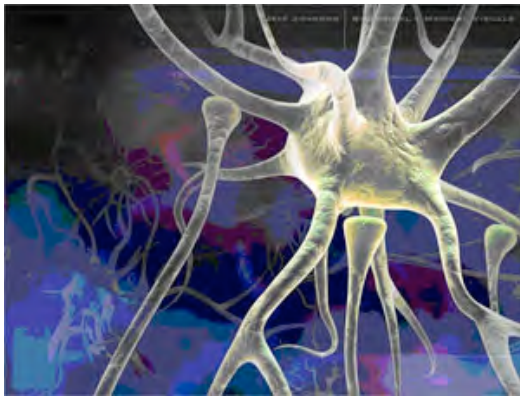


Fig. 1

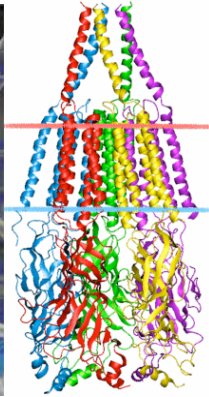


Fig. 2

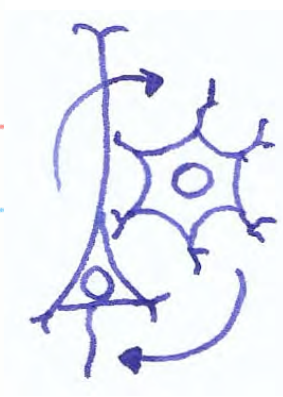


Fig. 3

Training Activities

Supervision of Associate Members of ICTP

Junior Associate: Rafael Rodriguez Rojas, International Centre for Neurological Restoration, Havana, Cuba

Coordination, Seminars on Physics of the Living State (Neurophysics)

Brain in movement: Modelling the biophysics of the human basal ganglia and the cerebral cortex, Rafael Rodriguez Rojas, International Centre for Neurological Restoration, Havana, Cuba, 10 June 2009

Detection of Unusual Objects and Temporal Patterns in EEG Video Recordings, Kostadin Korouthev, Escuela Politecnica Superior, Universidad Autonoma de Madrid, Spain, 29 July 2009

Other

Review of all the candidates in the various Association Schemes of ICTP (Junior, Regular and Senior) in the area of neurophysics.

Staff and Long-Term Visitors (3 months or more)

Staff Associate

Julian Chela-Flores, Venezuela

<http://www.ictp.it/~chelaf/index.html>

APPLIED PHYSICS

FLUID DYNAMICS

Introduction

The ICTP Fluid Dynamics Laboratory is a world-class research laboratory whose activities range from quantum to classical fluid flows and whose centerpiece is an apparatus capable of producing the highest levels of controlled buoyancy-driven turbulence in the world. It operates near the absolute zero of temperature and provides high-resolution data at the far frontier of fluid dynamics.

Research Activities

From its position atop a rotating platform, ICTP's turbulent convection experiment provides data applicable to large scale natural phenomena like atmospheric and solar convection in a range of control parameters not possible elsewhere. Recent experiments have focused on the role of Coriolis forces on highly turbulent convection, at Taylor (Ta) and Rayleigh (Ra) numbers up to 5 orders of magnitude larger (both greater than 10^{15}) than other studies using conventional fluids. These results have been obtained in a diameter-to-height aspect ratio of $\frac{1}{2}$, to obtain high Ta, Ra, without pushing the operating point too close to the critical point of the gas where compressibility effects would become important. The results obtained (*Journal of Fluid Mechanics*, in press) show that the addition of Coriolis forces at such high Ra have a qualitatively different effect than at smaller Ra. Novel techniques involving the propagation of high frequency thermal waves have made it possible to provide the first direct mapping of a thermally "superconducting" core at high turbulent intensities, which has been one of the key assumptions in phenomenological theories of turbulent convection. These types of experiments are possible precisely because of the favorable material properties at cryogenic temperatures.

The lab is also equipped to undertake experiments in quantum turbulence, which is a fast-emerging field that may well provide the clues necessary for significant advances in our understanding of ordinary turbulence. Laser-based detection methods for fluid flows are possible future directions in technology development for low temperature studies of highly turbulent dynamics.



Future directions of the lab include some optofluidics experiments both in the context of biophysics training in conjunction with TASC-CNR (Trieste) and with the Laser Center in Cape Coast, Ghana and in quantum fluids where it may be possible to manipulate single quantized vortices through optical "tweezing" techniques with the addition of suitable seeding particles.

*The cryogenic cell installation at the Fluid Dynamics Laboratory
(Courtesy: M. Essoun).*

Additional work in fluid dynamics concerns large-scale numerical simulations of thermal convection at high Prandtl numbers (of the order of 1000) at Rayleigh numbers of the order 10^8 ; this work is being done in collaboration with Professor Roberto Verzicco (University of Roma). In collaboration with Professor P.K. Yeung of Georgia Institute of Technology and Dr. Donzis of the University of Maryland, computations of isotropic and homogeneous turbulence have been performed, with and

without a passive admixture, in a periodic box of 4096 grid points along an edge. Both sets of simulations are at the edge of capability of present computers. In collaboration with Dan Lathrop and his colleagues at the University of Maryland, we have made an extensive study of the reconnections of quantized vortex lines and of superfluid turbulence. Two PhD students from the joint PhD Programme in Fluid Mechanics, Cecilia Rorai and Enrico Fonda, are presently pursuing research at the University of Maryland, working with both Profs. Dan Lathrop and Michael Fisher. Enrico is doing mostly experimental work in superfluid visualization—utilizing basic training received in the Fluid Dynamics laboratory— and Rorai is working on numerical simulations of the nonlinear Schrödinger equation in order to better understand the reconnection mechanisms for quantized vortices in turbulent superfluid flows.

Training Activities

In addition to basic research activities, the laboratory has been made available for training purposes, from advanced courses for PhD students at the University of Trieste (a course in Experimental Methods in Fluid Mechanics) to basic skills development on request for those persons who wish to have the possibility to join international research teams. The laboratory has planned training activities in optofluidics/optical manipulation jointly with the laser center in Cape Coast Ghana and with TASC-CNR in Trieste.

The laboratory is also made available to students in ICTP's Diploma Programme who wish to do an experimentally-based thesis.

Two classes in the joint University of Trieste/ICTP PhD Programme in Environmental Fluid Mechanics are connected with the laboratory's activities:

- Statistical Analysis
- Experimental Methods in Fluid Mechanics

The laboratory had two STEP students during this period:

- Marcelline Essoun (Benin)
- Margarita Kuqali (Albania)

One TRIL fellow, Mahesh Eddula (India) also trained in the laboratory.

Ms. Kuqali has now obtained her PhD

The laboratory also plays host to students from ICTP's Diploma Programme in Condensed Matter and Earth System Physics.

Four students from the joint PhD Programme in Environmental Fluid Mechanics were supervised in 2009:

Gabriela Silano (obtained PhD)
Enrico Fonda
Cecilia Rorai
Valentina Stocca

Participation in International Programmes

The laboratory is involved in a proposal to the EU for establishing several cryogenic turbulence user facilities within Europe of which it would be one dedicated to geophysical problems. Longer range goals are to establish at CERN a large scale cryogenic user facility to which training and prototyping would be carried out at ICTP.

Staff and Long-Term Visitors (3 months or more)

Coordinator
J. Niemela, USA

STEP Students
M. Essoun, Benin
M. Kuqali, Albania

APPLIED PHYSICS

OPTICS AND LASERS

Introduction

The ICTP laser laboratory is a collaborative experimental facility serving the needs of both ICTP and ELETTRA. It serves as a training facility for STEP students and TRIL fellows and provides research opportunities for Associates in addition to its function as a support laboratory for the new FERMI Free Electron Laser at ELETTRA.

Research Activities

The laboratory is strongly involved in the development of the ultrafast laser systems for the Fermi@Elettra project. FERMI will be a seeded Free electron Laser (FEL) facility, including several state-of-the-art laser systems. These laser systems are based on commercial oscillator/amplifier units, which have been further developed and upgraded in the ICTP/ELETTRA laser laboratory.

The development of low-cost ultrafast lasers has applications to fundamental studies of DNA cross-linking and the laser lab is collaborating with ICGEB of Trieste in this area.

The lab is also involved in the study of laser “tweezers” for the manipulation of microscopic biological objects. This work is done in collaboration with the TASC Laboratory of the INFN-CNR. Some aspects of this work will be done jointly with the neighboring ICTP Fluid Dynamics Laboratory at Elettra.

Training Activities

In 2009 the laboratory had:

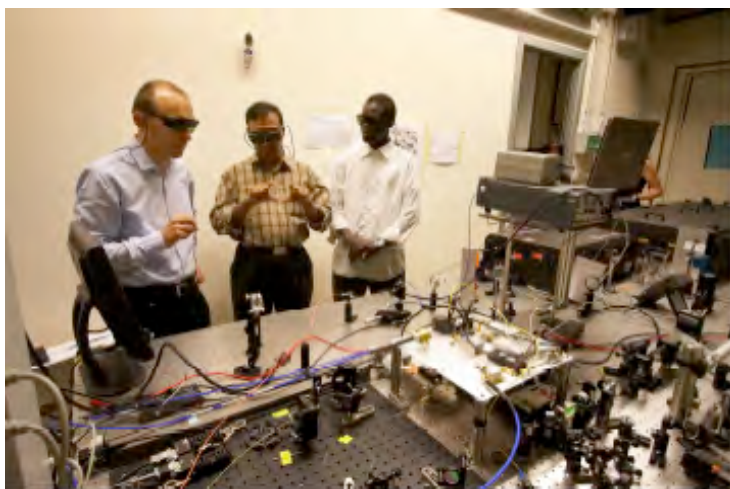
4 visits by STEP students

1 visit by an Associate Member

1 visits by TRIL fellows.

1 Mentoring visit through the OSA/ICTP Mentorship Programme

Participation in International Programmes



The laser laboratory hosts students coming from the Institute of Physics of the National Academy of Sciences of Belarus under the secondary network scheme of the Central European Initiative. In addition, there are mentoring visits from Prof. Orlovich and Grabcikov of the Nonlinear Optics Laboratory of Belarus.

Preparation of a fibre laser setup in the laser lab with an ICTP associate and a STEP student.

Staff and Long-Term Visitors

Professional Staff

Director (ELETTRA): M. Danailov, Bulgaria

Coordinator (ICTP): J. Niemela, USA

ICTP-SPIE-INFN Quantum Cascade Laser Project

Coordinators: J. Niemela, ICTP and Andrea Vacchi, INFN Rome

ICTP and SPIE, the international optics and photonics society, have started a new research initiative on quantum cascade lasers (QCL) which have numerous applications in the remote sensing of environmental gases and pollutants, as well as medical diagnostics.

The QCL research is being carried out in collaboration with INFN (Istituto Nazionale di Fisica Nucleare) and led by Dr. Andrea Vacchi, member of the INFN National Board, Silvia Dalla Torre, director of the Trieste section of INFN and J. Niemela at ICTP.

ICTP/SPIE/INFN QCL laboratory, INFN, Trieste. Postdoctoral Fellow Lyubomir Stoychev, Bulgaria (left) and STEP student Milohum Mikesokpo Dzagli, University of Togo, Lome.



APPLIED PHYSICS

MULTIDISCIPLINARY LABORATORY (MLab)

Introduction

The ICTP MLab promotes interdisciplinary experimental activities based on advanced instruments and methods developed in basic physics research. The aim of this programme is to stimulate synergic cooperation with other research laboratories in the Trieste area as well as at national and international level.

MLab activities include scientific instrumentation development, novel detectors and electronic circuits design and prototyping, x-ray imaging and accelerator-based analytical techniques. The goal is also to involve visiting scientists and PhD students from developing countries in hands-on activities. The knowledge and experience gained through experimental training enhances their professional autonomy and at the same time strengthens their ability to conduct interdisciplinary research in cooperation with heterogeneous research teams.

Research Activities

The main research activities at MLab are organized through four research lines:

- 1) ICTP-INFN Microprocessor Laboratory
- 2) Dense Plasma Focus Laboratory
- 3) X-Ray Imaging and analysis
- 4) Accelerator-based analytical techniques

These are not secluded projects but part of an integrated programme aimed at generating synergies for the realization of different research and training activities.

Several ICTP associates members in the area of microelectronics and nuclear/accelerator physics are connected to MLab research activities:

1. Kostyantyn Lukin, Ukraine
2. Imbaby Ismail Mahmoud Gad Allah, Egypt
3. Felix Roberto Mario Palumbo, Argentina
4. Ariadna Mendoza Cuevas, Cuba
5. Abu Bakar Md. Ismail, Bangladesh
6. Md. Mamun Bin Ibne Reaz, Malaysia
7. Ajit Kumar Panda, India
8. Adel Mellit, Algeria
9. Robert Tchitnga, Cameroon
10. Benfdila Arezki, Algeria
11. Ogundare Folorunso Ogunmola, Nigeria

1. ICTP-INFN Microprocessor Laboratory

a) COMPASS Experiment at CERN

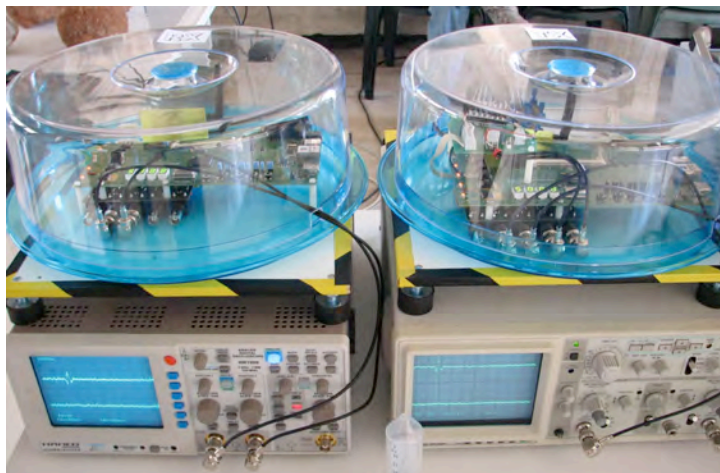
COMPASS is a high-energy physics experiment at the Super Proton Synchrotron (SPS) at CERN in Geneva, Switzerland. The purpose of this experiment is the study of hadron structure and hadron spectroscopy with high intensity muon and hadron beams. COMPASS has generated

hundreds of Tera Bytes of data during 2009. An important fraction of these data were generated by the RICH-1 detector. The initial readout system of this instrument was developed at the ICTP-INFN Microprocessor Laboratory. The ICTP group, as part of the COMPASS Collaboration, participates to the annual shifts at CERN, attends various COMPASS collaboration meetings, and co-authors several publications.

b) Reconfigurable Virtual Instrumentation (RVI) Project

A research initiative is being carried out, in collaboration with the microelectronic US company Actel Corp., in the area of novel architectures for the implementation of RVI systems using programmable logic devices. The goal is to provide low-cost reusable hardware/software platforms for the implementation of multiple electronic and scientific instrumentation systems. Twenty-three modular platforms have been produced and used in the “Advanced Training Course on FPGA Design and VHDL for Hardware Simulation and Synthesis” held at ICTP during November 2009. These platforms have also been used in research activities for algorithm prototyping and specific scientific instrumentation for experimental research in neuroscience and novel particle detectors in high energy physics.

This material has been given on loan to various external collaborators from Colombia, Cuba, Argentina, Mexico, Ukraine, Malaysia, India, USA, and Peru, as part of collaborative projects on innovative parallel architectures and instrumentation. A growing number of teachers and researchers request these platforms not only for their academic and research needs, but also to be involved in the RVI open collaboration project for the production of freely available intellectual property in the area of programmable logic devices.



The ICTP-RVI platform being used for prototyping in advanced instrumentation development for experimental neuroscience research.

A Nigerian visiting scientist is supported by the special UNESCO Funds for Africa to carry out research on novel architectures for RVI based on FPGA. He will contribute to the creation of a network of African professionals related to microelectronics design techniques and open source projects for international cooperation in areas of research, academic and industrial interest in Africa.

c) ICTP-INFN-INAF XDXL (X Drift eXtra Large) Project

Silicon Drift Detectors (SDD) are low-noise devices, optimum detectors for low energy x-ray measurements, but the detectors commercially available have a small active area. The Trieste INFN group is internationally recognised for its work in large area multi-anode drift detectors like those built for the ALICE experiment at CERN LHC accelerator. The ALICE SDD has been designed for position measurements of the impact point of ionizing particles close to the interaction vertices of the LHC beams, and it needs to be tailored to meet the low noise requirements of spectroscopy. Among the goals of XDXL are:

- The realization of detectors for low energy spectroscopy and timing measurements in astrophysics space experiments

- The coupling of SDDs to LaBr₃ Scintillators to extend the energy range for applications such as Compton gamma ray cameras, both for space experiments and medical imaging devices (e.g. SPECT detectors)
- Development of a satellite born x-ray detector for the prolonged study of few black holes to uncover the dynamics of their interactions with the surrounding media in collaboration with the group of Prof. Sandip Kumar Chakrabarti at the Indian Centre for Space Physics in Kolkata

During 2009 the work in XDXL was focused to the multi-channel characterization of the ALICE SDD. A 32 channel ASIC chip has been designed in collaboration with the Pavia University. The objective is to develop a system that can automatically sample the output of all the 32 channels when the signal due to the interaction of a photon is detected in just one of the connected anodes. Several tests have been carried out to map the behaviour of the SDD to see how the energy resolution changes as the impact point is moved away from the anodes. All the information gathered in 2009 will be used to design a new prototype of SDD to be produced in 2010 by FBK-IRST in Trento.

2. Dense Plasma Focus (DPF) Laboratory

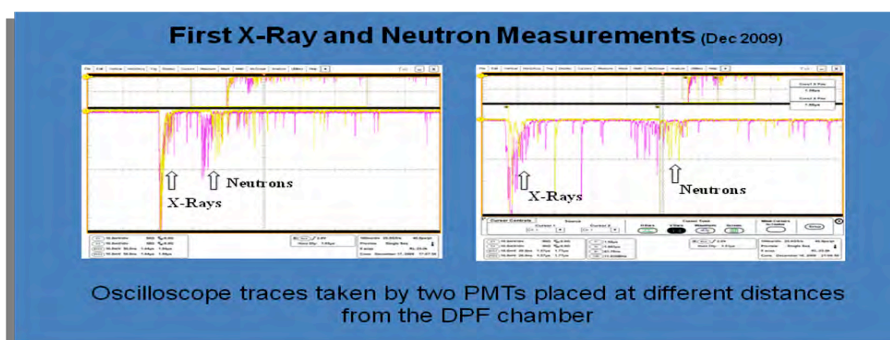
The objective of the MLab DPF Laboratory is to establish a research centre for reference on plasma focus science and applications at ICTP with a visible contribution to main stream research, excellence education, and innovative applications. DPF applications include characterization of nanotechnology materials; dynamical defectoscopy of moving or rotating objects, materials testing, explosives and other illicit materials detection, and production of isotopes for medical diagnosis and cancer therapy. 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, technological applications and basic research.

This activity benefits from the expertise of Prof. Vladimir Gribkov, Institute for Theoretical and Experimental Physics, Moscow, Russia, and of Dr. Ryszard Miklaszewski, Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland.

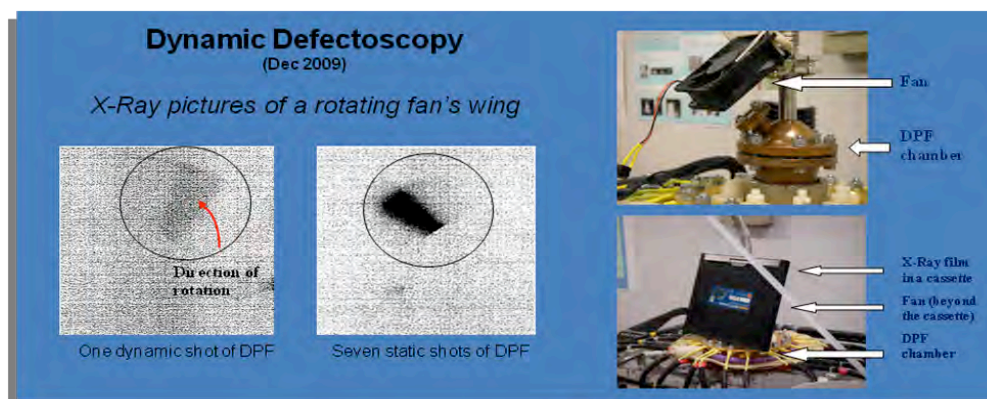
The official authorization to carry out experimental research activities with x-rays and neutrons at the MLab was obtained from local authorities, and the first official verification of the experimental setup was successfully completed in summer 2009

During 2009, the MLab DPF device was equipped with detectors to measure absolute neutron and x-ray yields donated by the Institute of Plasma Physics and Laser Microfusion (IPPLM), Warsaw, Poland and the Moscow Physical Society (MPS). Several measurements to characterize the electrical parameters of the device have shown that the main electrical system operates in proper regime.

We measured the temporal characteristics of neutrons and hard x-rays measuring using two photomultiplier tubes placed at different distances. X-ray photons and neutron pulses show time separation due to different velocities as shown in the figure below. The absolute hard x-ray and neutron yields was also measured. The hard x-ray yield was about 2 mRöntgen/pulse, while the overall neutron yield was $2-3 \times 10^6$ neutrons/pulse.



Some experiments in the field of dynamic defectoscopy were also carried out. By using just a single pulse of DPF's x-rays, it is possible to take "static" x-ray radiographies of machines and mechanisms during their operation. Two pictures of a fan were taken in its static position and in its dynamic (rotating) state as shown in the figure below.



Other PDF-related activities during 2009:

- Second Research Coordination Meeting of the IAEA Coordinated Research Project (CRP) on the Integrated Approach to Dense Magnetized Plasmas Applications in Nuclear Fusion Technology held in Warsaw, Poland.
- A specific agreement between ICTP; Institute of Plasma Physics and Laser Microfusion (IPPLM), Warsaw, Poland; the Moscow Physical Society (MPS) and A.A. Baikov Institute of Metallurgy and Material Science (IMET), Moscow, RF has been signed for scientific cooperation in the investigations of DPF physics and applications.

3. X-ray Imaging and Analysis

a) X-Ray Portable System for Non-Destructive Analysis of Archeological and Artistic Materials

The MLab has received a €600,000 grant from the local government of Regione Friuli Venezia Giulia for its three-year project "Development of an X-Ray Portable System for Non-Destructive Analysis of Archeological and Artistic Materials". ICTP received €200,000 corresponding to the first annual phase of the project. The project is being carried out jointly with the ELETTRA Synchrotron Light Laboratory in Trieste. To successfully achieve the goals of this project, both research institutions, ICTP and ELETTRA, will complementarily exploit their scientific and technological expertise through a synergic cooperation.

The purpose of the project is to develop a compact portable device based on x-rays for the in-situ not-destructive characterization of a wide range of materials of interest to cultural heritage.

a1) Micro-computed X-ray Tomography (μ -CT)

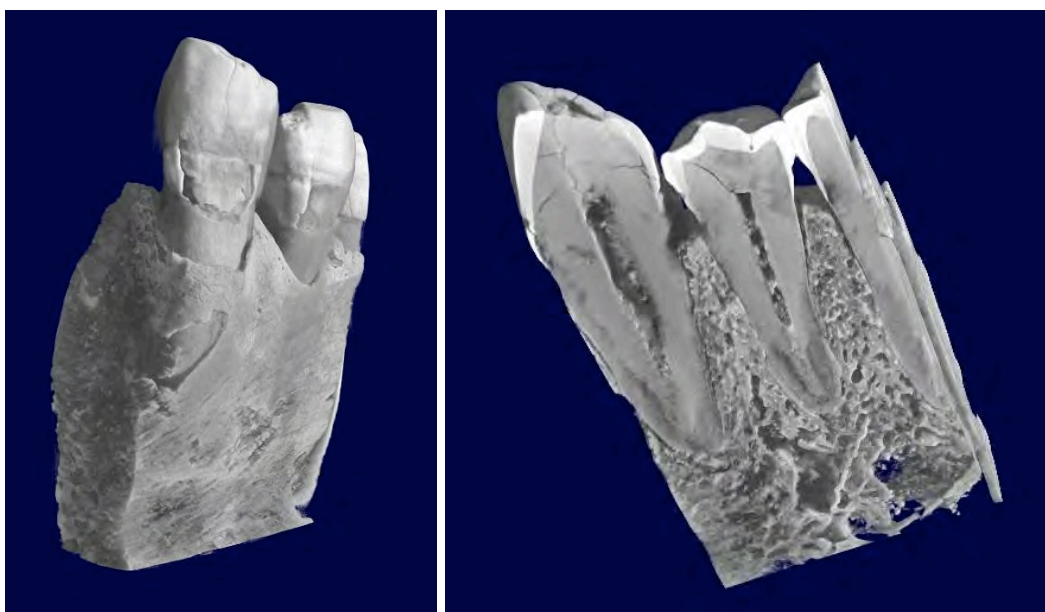
A μ -CT system has been designed to characterize paleontological and archaeological materials. μ -CT is an x-ray imaging technique to produce three-dimensional images of solid objects. Studies of the external morphological features of archaeological and paleontological remains are not sufficient to extract all the information for a paleontological study. Nowadays observations of internal structures become increasingly important, but these observations should be non-destructive. Because μ -CT is a non-destructive characterization technique, it represents a powerful investigation tool in many different applications, especially in the area of cultural heritage conservation and management.

The main components of the μ -CT system, x-ray source, x-ray detector and turntable, have been acquired during 2009. Tests started at the ELETTRA's Tomolab facility giving encouraging results. The μ -CT and will be soon assembled at the MLab. The MLab μ -CT system is designed

to image relatively large objects (20x20x20 cm³) with a very high definition (from 5 to 50 micrometers), using also phase contrast techniques. Phase contrast radiography is effective to characterise details of materials having a small absorption for hard X-rays, exploiting variation in the optical path length.

a2) Analysis of the prehistoric Loke jaw

The detector of the MLab Micro-computed X-ray Tomography system have been used to analyzed one of the most important palaeoanthropological remain kept in the Trieste Natural History Museum. It is part of a human jaw discovered at the beginning of last century in a cave, not far from Trieste, near Loke village (northern Histria, Slovenia). It was found cemented on the wall of the cave. The jaw is considered one of the most ancient anthropological fossils from northeastern Italy but, with the exception of a short note published soon after the discovery, there are not available characterization studies and absolute dating of the object. For this reason the Lonche jaw was a perfect sample to show how the new μ -CT can be important in the study and valorization of cultural heritage.



3D-rendering (on the left) and virtual longitudinal cut (on the right) of the Loke jaw.

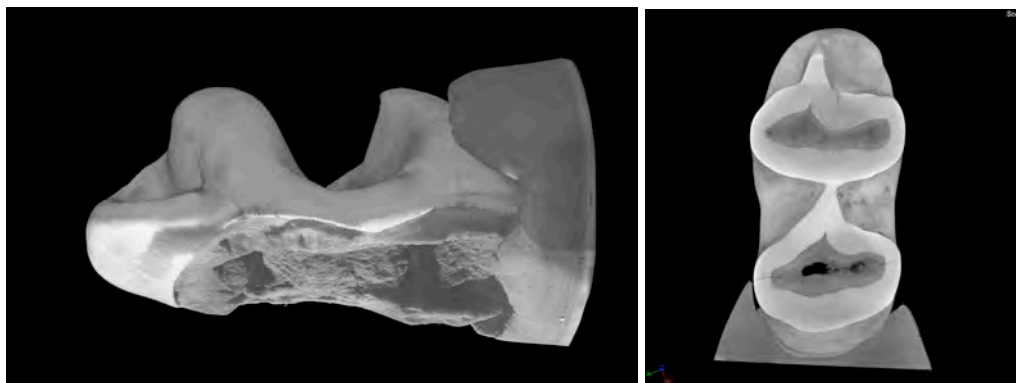
b) Record of stress in Australian extinct megafauna with synchrotron radiation microtomography

This project is in collaboration with ELETTRA, Chieti University and Australian National University. The aim of the project is to use Micro-computed X-ray Tomography to study tooth enamel diseases from Australian megafauna, which could contribute to the debate about its extinction in the late Pleistocene. Possible enamel hypoplasia (reduction of the growth of tooth related to stress) can be correlated with animal age, its diet and environmental conditions.

Extinction of the Australian megafauna (body mass >44 kg) in the late Pleistocene has generated much debate. Current radiometric and luminescence dating results suggest that the extinctions were complete by 40-50,000 years ago, an interstadial period when dramatic changes of climate were absent and shortly after the first arrival of Homo Sapiens in Australia. Different scholars favour either a human-mediated or a climate-habitat change cause for the extinctions, but there is very little data on how the large animals died.

Generic stress can leave a lasting record in the teeth only if it occurs during the period of amelogenesis (formation of enamel on teeth). Tooth enamel forms from cells, called ameloblasts, which in most animals have a limited life. A generic stress that can produce a reduction in the metabolism of the ameloblasts can have an impact on these cells. If the 'suffering' of the cells

persists for a long period (at least 5 days) then it translates in a reduction of the growth of tooth enamel. This reduction is called 'linear enamel hypoplasia'. Consequently, every generalized stress that can cause cellular suffering—hence suffering of the ameloblasts—that lasts at least 5 days translates in the formation of a hypoplastic line in the enamel. Enamel hypoplastic lines remain fixed until adulthood, as the ameloblastic activity ceases and enamel does not change after the end of growth.



3D-rendering (on the left) and virtual transversal cut (on the right) of a giant Pleistocene kangaroo tooth (width: about 15 mm).

A collaborative agreement has been signed between ICTP, Sincrotrone Trieste and the University of Chieti to develop a joint research programme based on the application of advanced technologies in human evolution studies, particularly in the area paleopathology and bone paleobiology.

4. Accelerator-based Analytical Techniques

Accelerator Mass Spectroscopy (AMS) allows novel applications of long lived radionuclide such as ^{14}C , ^{10}Be , ^{26}Al , ^{36}Cl , used as chronometers in paleoclimate studies and cultural heritage or as tracers in biomolecular medicine. Research programmes in these areas are being considered with relevant groups. In particular, the following joint projects are being scoped: analysis of long lived tracers with IAEA Marine Environmental Laboratories and ENEA; use of the radiocarbon bomb pulse for dating human cells, with ICGEB and University of Naples.

ICTP has collaborative programmes with the AMS Facilities of Caserta. Access to this facility by scientists from developing countries is supported via TRIL and STEP mechanisms.

J. Tandoh, visiting scientist from Ghana, supported by the special UNESCO Funds for Africa is carrying out research on Accelerator Mass Spectrometry (AMS) and related methods in culture heritage studies and paleoanthropology. In particular, he will undertake training and practical research work in radiocarbon dating of archaeological samples using AMS, analyzing charcoal samples from some Iron Age sites in Ghana (upper Volta region). Practical and theoretical knowledge gained through this project will help in the training and development of new students interested in this field as Ghana awaits the installation of its first Accelerator at Ghana Atomic Energy Commission.

Other Initiatives

Optically Stimulated Luminescence (OSL) dating facility at the ICTP-MLab

The ICTP-MLab is considering a proposal to set up an Optically Stimulated Luminescence dating facility for applications in many areas including geology, archaeology, meteorology, and cultural heritage. During 2010 it will be evaluated this proposal possibly in cooperation with geologists of the University of Trieste, where there are some groups strongly interested to develop OSL capabilities.

Such experimental facility will not only be used for research and training of visiting scientists but it will be a valuable complementary technique in connection with other multidisciplinary activities at the MLab.

Darwin and Evolution

Two exhibits on Darwin and Evolution have been organized to commemorate the 200th anniversary of Charles Darwin's birth: (b1) in Venice with UNESCO Office, UNESCO Regional Bureau for Science and Culture in Europe (BRESCE), April 2009; and (b2) at ICTP, November-December 2009.

Training Activities

Advanced Training Course on FPGA Design and VHDL for Hardware Simulation and Synthesis, October-November 2009. Directors: N. Abdallah (Actel Corp.), A. Marchioro (CERN), A. Cicuttin (ICTP); ICTP Local Organizers: M.L. Crespo

First Workshop on Open Source and Internet Technology for Scientific Environment: with case studies from Environmental Monitoring, 7-25 September 2009. Directors: A. Induruwa, C. Kavka, U. Raich; ICTP Local Organizers: M.L. Crespo and M. Zennaro

PHYSWARE: A Collaborative Workshop on Low-cost Equipment and Appropriate Technologies that Promote Undergraduate Level, Hands-on Physics Education throughout the Developing World, February 2009. Directors: P. Jolly, P. Laws, E. Sassi, D. Zollman; ICTP Local Organizer: J. Niemela

Joint ICTP/IAEA Advanced School on in-situ X-ray Fluorescence and Gamma Ray Spectrometry (October 2009). Organizer(s): IAEA: A. Markowicz, P. Martin, U. Sansone. ICTP Local Organizer: C. Tuniz

Joint ICTP/IAEA Workshop on Atomic and Molecular Data for Fusion (April 2009) Organizer(s): IAEA: R.E.H. Clark. ICTP Local Organizers: C. Tuniz and J. Niemela

Joint ICTP/IAEA Training Workshop on Technology and Performance of Desalination Systems (May 2009) Organizer(s): IAEA: I. Khamis. ICTP Local Organizer: C. Tuniz

Joint ICTP/IAEA Advanced School on Dosimetry in Diagnostic Radiology and its Clinical Implementation (May 2009) Organizer(s): IAEA: A. Meghzifene, D. MClean. ICTP Local Organizers: L. Bertocchi, C. Tuniz

Joint ICTP/IAEA School on Nuclear Knowledge Management (September-October 2009) Organizer(s): IAEA: Y. Yanev and A. Kosilov. ICTP Local Organizer: C. Tuniz

Workshop on NPP Simulators for Education (October 2009) Organizer(s): J. Cleveland (IAEA); ICTP Local Organizer: C. Tuniz

Joint ICTP/IAEA School on Physics and Technology of Fast Reactors Systems (November 2009) Organizer(s): IAEA: C. Ganguly, G. Mank and A. Stanculescu. ICTP Local Organizer: C. Tuniz

Joint ICTP/IAEA Workshop on Irradiation-induced Embrittlement of Pressure Vessel Steels (November 2009) Organizer(s): IAEA: Ki Sig Kang. ICTP Local Organizer: C. Tuniz

Joint ICTP/IAEA Workshop on Advanced Simulation and Modelling for Ion Beam Analysis (February 2009). Directors: N.P. Barradas (Instituto Tecnológico e Nuclear, Portugal), N. Dytlewski (IAEA, Vienna), C. Jeynes (University of Surrey Ion Beam Centre, United Kingdom), M. Mayer (Max-Planck-Institut für Plasmaphysik, Germany). ICTP Local Organizer: C. Tuniz

Preparation of the ICTP Latin-American Basic Course on FPGA Design for Scientific Instrumentation to be held in Argentina, March 2010. Directors: A. Cicuttin (ICTP), N. Abdallah (Actel Corp.), H. Larrondo (UNMdP, Argentina), L. Tabares (CEADEN, Cuba), ICTP Local Organizer: M.L. Crespo, LO: J. Finochietto, C. Gonzalez (UCAECE, Argentina).

Preparation of the Joint ICTP-IAEA Workshop on Dense Magnetized Plasma and Plasma Diagnostics to be held at ICTP in November 2010. Directors: V. Gribkov, G. Mank, A. Markowicz, R. Miklaszewski, C. Tuniz. Local Organizer: M.L. Crespo.

On-going PhD Theses

Six PhD students supported by the STEP programme are working in the areas of medical physics, radiotherapy, nuclear and plasma physics, and related subjects at the MLab in cooperation with University Trieste, IAEA, INFN and ARPA:

1. Maridelin Ramos Aruca (Cuba)
2. Mohammed Khalil Saeed Salih (Sudan)
3. Elena Robu (Romania)
4. Omer Abdul Aziz Ali (Sudan)
5. Busari Mutiu Abolanle (Nigeria)
6. Faycal Kharfi (Algeria)

Participation in International Programmes

Research Agreement with IAEA

A five-year research agreement has been signed between ICTP and IAEA for the creation of testbed at ICTP MLab based on repetitive Dense Plasma Focus device for applications in radiation material sciences as well as in nuclear medicine and for training of young researchers. This device will be used for training young scientists from developing countries on modern diagnostics for fusion plasma experiments.

ICTP/IAEA programmes

The IAEA is supporting the Ghana Atomic Energy Commission for the acquisition of a tandemron accelerator for AMS and IBA research. This facility will promote teaching and learning of nuclear physics and materials engineering research in Ghana. The main focus will be in national priority areas such as human resources food and agriculture, health, environmental studies and preservation of Ghanaian art works. ICTP is providing scientific advice to develop a national programme in collaboration with other tertiary and research institutions.

Services

Hardware Loan Programme Project

ICTP MLab development and educational hardware platforms based on FPGA were given on loan to external collaborators through a simple written agreement for research and education purposes. Among the beneficiaries of this programme there are teacher, researchers, and students from Colombia, Cuba, Argentina, Mexico, Ukraine, Malaysia, India, USA, and Peru. While borrowers can use this material on long term basis, the MLab supervises its utilization to ensure proper use and profitability, retaining its right to reallocate these resources to another person or group. This experimental "Hardware Loan Programme" has been initiated in cooperation with ACTEL Corp., a semiconductor high-tech company which has sponsored several ICTP advanced training activities on microelectronics. The beneficiaries of this programme are expected to form a small collaborative international community for the production of software and other FPGA related intellectual property which will enhance the availability of public domain technical resources especially for research and education in developing countries.

Staff and Long-Term Visitors

Professional Staff

C. Tuniz, Italy

Consultants

M.L. Crespo, Argentina / Italy

Staff Associates

V. Gribkov, Russian Federation

Technical Staff

A. Cicuttin, Italy

Visiting Scientists

Dipak Debnath, India

Debashis Bhowmick, India

Ritabrata Sarkar, India

Olufemi Oluwole Adeluyi, Nigeria

Joseph Bremang Tandoh, Ghana

Federico Bernardini, Italy

Daria Zandomenighi, Italy

Funding

- a) The MLab has received a €600,000 grant from the local government of Regione Friuli Venezia Giulia for its project “Development of an X-ray Portable System for Non-destructive Analysis of Archaeological and Artistic Materials”. In 2009, ICTP received in advance €140,000 of the €200,000 corresponding to the first annual phase of the project.
- b) New Projects under Italian Funds-in-Trust with UNESCO
 - Project 1: Practical Training and Research in Basic and Applied Sciences including Education, Energy, Environment and Health Education for Africa
Subproject: Multidisciplinary Laboratory (MLab)
Assigned budget for the period 2009-2011: €44,250

 - Project 2: Research Infrastructure for Africa
Subproject: Accelerators for sustainable development
Assigned budget for the period 2009-2011: €17,700
- d) A proposal for the €1,500.000 project BEFORE (“Building a European Future for the Heritage of the Human Past”) has been submitted to the European FP7 programme in collaboration with University of Rome “La Sapienza”, ELETTRA, Nectar Imaging s.r.l., Italy; University of Cambridge, UK; National Museum of Natural History - Musée de l’Homme, France; Royal Belgian Institute of Natural Sciences, Belgium; National Museum, Czech Rep.; National Museum of Natural History, Austria.

*TRAINING AND EDUCATION
PROGRAMMES*

TRAINING AND EDUCATION PROGRAMMES—PHD LEVEL

DIPLOMA PROGRAMME

Talented young science students in developing countries are sometimes limited in achieving their full potential by the absence of advanced postgraduate-level training that is up to international standards. It was in 1991 that Prof. Abdus Salam instituted an intense 12-month Diploma Programme in the (then) main research fields of ICTP, namely condensed matter physics, high energy physics, and mathematics. Starting from September 2006, the Diploma Programme also includes the branch of earth system physics. A new diploma programme in basic physics started in September 2007 (details are given below).

The ICTP Diploma Programme is a gateway for young people who might otherwise never have had a chance, to reach international-level standards in physics and mathematics, and to more fully realize their intellectual potential. Former students from the very earliest batches, who have returned home (having completed the usual academic training of a PhD and a couple of postdocs), are now applying for ICTP Junior Associateships, and for participation in ICTP Activities. They are training students of their own, some of whom may apply to the ICTP Diploma Programme, thus closing Salam's virtuous circle.

The Diploma Programme differs from other ICTP training/research activities such as Schools/Colleges: the Diploma period is one year; the level is pre-PhD; the participants are younger; and the number is small. From about 100 applicants to each of the four Diploma programmes, only 10 students are admitted in each. All 40 are given full support, covering airfare and living costs. The focus is especially on those developing countries for which high-quality advanced scientific training is less accessible. In the 2008-09 batch, the 41 students who joined came from 22 countries: Azerbaijan, Bangladesh, Cameroon, Colombia, Ethiopia, Ghana, Indonesia, Iran, Jordan, Kenya, Mongolia, Nepal, Nigeria, People's Republic of Congo, Peru, Senegal, Sudan, Syria, Turkey, Uganda, Vietnam, Zambia.

The one-year academic programme itself is quite intense, and consists of three terms covering basic courses, advanced topics, and dissertation research under a supervisor. During the first and second terms, covering 9 months of the Diploma Programme, students attend around 10 hours a week of lectures, with problem sets and final exams in each of the 8-10 courses (see table on next pages for 2008-09 courses). Standards are maintained: students are asked to leave if they fail in two or more courses; if their final average grade is below a C; or if their dissertation is unsatisfactory. The vast majority (89.4%) of the 565 students over the past 18 years, have successfully surmounted these hurdles, whatever their initial background.

After the Diploma, most students go on to PhD work in Europe or North America, or return to jobs as college teachers, or register for a PhD in their home countries. In the 2008-09 batch of 40 total students that received their Diplomas, the PhD placements include: Universities of Texas, Southern California, Rochester, Maryland, University of Strasbourg and Leibniz Universität Hannover for CMP Diploma; Pennsylvania State University, Oklahoma State University, University of Minnesota, Queens University Kingston Ontario and SISSA, for HEP Diploma; Universities of Alabama, Auburn, Utah and Katholieke Universiteit Leuven, for MTH Diploma; Universities of Memphis, Missouri, Waterloo Toronto, Reading UK, Freie Universität Berlin, and School of Mines Denver Colorado for ESP diploma. The others took up PhD registrations, or teaching positions in their home countries.

A new diploma programme in basic physics started in September 2007, designed to provide young physicists and mathematicians coming from sub-Saharan Africa with the intent to pursue further studies at the graduate level. During the academic year 2008-09, 8 students joined this programme, and came from 8 countries: Cameroon, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Senegal and Sudan. Of the 8 who got their basic physics diploma, 5 were admitted to the regular diploma programmes (1 in HEP, 1 in CMP, and 3 in ESP). Two were admitted to a MSc.

Programme at the University of Trieste (Laurea Magistralis) and one to a MSc. Programme at Western Michigan University.

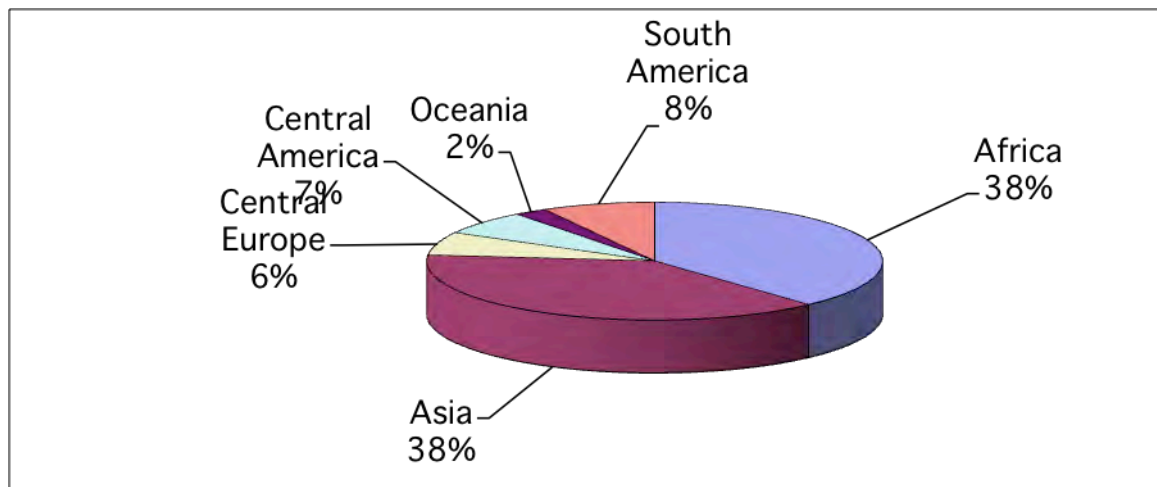


Fig. 1: Geographical distribution of Diploma students 1991-2009. The total number of students is 599.

The 2008-2009 ICTP Diploma Programme in Brief

1 September 2008 through 31 August 2009

First term: September-December 2008

Second term: January-May 2009

Course of Study: **Condensed Matter Physics** — Co-ordinator: S. Scandolo (ICTP)

First term:

Mathematical Techniques (16.5)
Advanced Quantum Mechanics (45)
Numerical Methods (45)

F. Franchini (ICTP)
G. Santoro (SISSA), R. Gebauer (ICTP)
J. Christie, L. Dall'Asta, E. Coppola,
M. Lee (ICTP)

Statistical Mechanics (36)
Symmetries, Electron Bands & Phonons (36)

M. Sellitto (ICTP)
S. Scandolo (ICTP)

Second term:

Many-Body Physics (27)
Advanced Statistical Mechanics (18)
Magnetism (18)
Superconductivity (18)
Biological Physics (18)
Selected Topics in CMP (18)

A. Nersesyan (ICTP)
A. Silva (ICTP)
M. Kiselev (ICTP)
O. Yevtushenko (Munich)
M. Vendruscolo (Cambridge)
A. Chatterjee, F. Franchini (ICTP)

Course of Study: **High Energy Physics** — Co-ordinator: K. S. Narain (ICTP)

First term:

Introduction to Particle Physics (34.5)
Lie Groups & Lie Algebras (30)
Quantum Electrodynamics: Introduction
to Quantum Field Theory (37.5)
Relativistic Quantum Mechanics (30)

A. Smirnov (ICTP)
B. Acharya (ICTP)
S. Randjbar-Daemi (ICTP)
E. Gava (SISSA)

Second term:

General Relativity (37.5)
Quantum Field Theory (39)
The Standard Model (30)
SUSY Field Theory (22.5)

P. Creminelli (ICTP)
K.S. Narain (ICTP)
G. Senjanovic (ICTP)
E. Gava (Italy)

Course of Study: **Mathematics** — *Co-ordinator*: Lê Dung Tráng (ICTP)

First term:

| | |
|---|--------------------------------------|
| Linear Algebra (15) | R. Ramakrishnan |
| Foundations of Mathematical Analysis (15) | C. Chidume |
| Calculus on \mathbb{R}_n (15) | M.G. Mora (SISSA) |
| Abstract Algebra (30) | R. Ramakrishnan, L. Götttsche (ICTP) |
| Point-set Topology (30) | B. Zimmermann (Trieste University) |
| Real Analysis (30) | G. Dal Maso (SISSA) |
| Complex Analysis (30) | D. Pancholi (ICTP) |

Second term:

| | |
|-----------------------------|---|
| Functional Analysis (22.5) | C.E. Chidume (ICTP) |
| Differential Geometry (30) | J. Li (ICTP) |
| Differential Equations (30) | S. Zagatti, S. Le Coz, I. Ianni (SISSA) |
| Functional Analysis II (30) | N. Djitte (Senegal) |
| Algebraic Topology (15) | D. Repovš (Ljubljana) |
| Algebraic Geometry (30) | L. Götttsche (ICTP) |

Course of Study: **Earth System Physics** — *Co-ordinator*: K. Aoudia (ICTP)

First term:

| | |
|--|--|
| Introduction to Physics of the Earth System (36) | G.F. Panza (Trieste Un. /ICTP), C. Piani (ICTP) |
| Mathematical Methods in Geophysics (18) | F. Kucharski (ICTP) |
| Wave Physics (36) | F. Romanelli (Trieste University) |
| Environmental Data Analysis (18) | A. Peresan (Trieste University) |
| Numerical Methods (27) | E. Coppola, M. Lee, J. Christie, L. Dall'Asta (ICTP) |

Second term:

| | |
|--|--|
| Physics of the Atmosphere (18) | D. Giaiotti, F. Stel (ARPA FVG) |
| Physics of the Oceans (24) | M. Gacic, P. Poulain, A. Crise (OGS) |
| Mechanics of the Earth and Tectonophysics (19.5) | A. Aoudia (ICTP) |
| Seismology (18) | F. Romanelli (Trieste University) |
| Dynamics of the Atmosphere (18) | F. Kucharski, C. Piani (ICTP) |
| Specific Topics (37.5) | V. Kossobokov, A. Soloviev (MITPAN Moscow), F. Vaccari (Trieste University), F. Stel, D. Giaiotti (ARPA FVG) |

Course of Study: **Basic Physics** — *Co-ordinator*: S. Randjbar-Daemi (ICTP)

First term:

| | |
|----------------------------------|------------------------|
| Mathematical Methods (52.5) | K.S. Narain (ICTP) |
| Classical Mechanics (30) | M. Fabbrichesi (SISSA) |
| Quantum Mechanics (60) | G. Thompson (ICTP) |
| Advanced Electromagnetism (31.5) | X. Bi (ICTP) |

Second term:

| | |
|-------------------------------------|---|
| Statistical Mechanics (43.5) | M. Marsili (ICTP) |
| Advanced Quantum Mechanics (45) | M. Santoro (SISSA) |
| Solid State Physics (34.5) | S. Scandolo (ICTP) |
| Relativistic Quantum Mechanics (30) | S. Randjbar-Daemi, M. Torabian (ICTP) |
| Physics of the Earth System (22.5) | F. Kucharski, A. Tompkins, A. Aoudia (ICTP) |

TRAINING AND EDUCATION PROGRAMMES—PhD LEVEL
ICTP-IAEA SANDWICH TRAINING
EDUCATIONAL PROGRAMME (STEP)

The ICTP Sandwich Training Educational Programme (STEP) aims at offering fellowship opportunities to PhD candidates from developing countries. The scientific fields covered by the programme are those falling in the scientific and technical competence of ICTP and its collaborating institutions. In 2009 the programme was funded by ICTP, the IAEA Department of Technical Cooperation, CEI (Central European Initiative), the Japanese Government through the UNESCO-ICTP Mori Fellowship Scheme, and the Italian Funds in Trust with UNESCO.

The programme is addressed to PhD students in developing countries who are offered fellowships of 3-6 month stay each year, for 3 successive years at the ICTP or at collaborating Institutions (ELETTRA Synchrotron Light Laboratory, Laser Laboratory, ICGEB, ICS-UNIDO, Universities of Trieste, Udine, Bologna, ARPA, IAEA Laboratories in Seibersdorf, Jozef Stefan International Postgraduate School in Ljubljana, Hospitals of Udine and Trieste, INFN, TASC, and others). Fellows can thus work on their PhD thesis on a sandwich basis with their supervisor at their home Institute and a co-supervisor at the hosting Institute. Their PhD is awarded at their home Institute.

In order to strengthen the STEP Programme, in 2009 the Optical Society of America (OSA) supported the visit of a STEP fellow's home supervisor. This kind of visits should be encouraged as they improve the working conditions of fellows and offer the opportunity to strengthen scientific links between ICTP and the home supervisors.

2009 Fellows Financially Supported by IAEA:

Mutiu Abolanle BUSARI (M), Nigeria

Periods of visit: 4 November 2008 - 31 January 2009, and 1 November 2009 - 31 January 2010

Topic or title of PhD thesis: Transport of Pollutants Through the Vadose Zone of Fertilized Fields as Measured Using Stable Isotopes

Rim CHERIF (F), Tunisia

Period of visit: 2 June - 11 July 2009

Topic or title of PhD thesis: Study of Non-Linear Effects in Photonic Crystal Fibres

Georgiev Alexander GAYDARDZHIEV (F), Bulgaria

Period of visit: 6 December 2009 - 5 March 2010

Topic or title of PhD thesis: Generation and Amplification of Ultra-Broadband Coherent Optical Radiation in the UV and near IR Spectral Regions

Anton Alyksandravich KANANOVICH (M), Belarus

Period of visit: 13 July - 12 October 2009

Topic or title of PhD thesis: Generation Dynamics of Crystalline Continuous Wave Raman Lasers

Wilbroad E. MUHOGORA (M), Tanzania

Period of visit: 1 July - 30 December 2009

Topic or title of PhD thesis: Performance Analysis and Optimization of a Low Cost Prototype Photostimulable Phosphor Screen for Computed Radiography

Olubunmi Oluyemi Akinbobola OBASEKI (F), Nigeria
Period of visit: 1 September - 30 November 2009
Topic or title of PhD thesis: Phytoextraction of Heavy Metals from Contaminated Soil

Myagmarjav ODSUREN (F), Mongolia
Period of visit: 3 October - 29 December 2009
Topic or title of PhD thesis: The Study of Fast Neutron Induced Charged Particle Emission Reaction Cross Sections

Ilie Simion SANDU (M), Moldova
Period of visit: 12 October - 12 December 2009
Topic or title of PhD thesis: Source Mechanisms of Vrancea Earthquakes

Ahmed Kamal SHALABY (M), Egypt
Period of visit: 3 August - 29 October 2009
Topic or title of PhD thesis: Coupling of Regional Chemistry-Aerosol and Regional Climate Model: Application of Aerosol and its Effects on Mediterranean

Bidini Alade TALEATU (M), Nigeria
Period of visit: 25 November 2009 - 24 March 2010
Topic or title of PhD thesis: Preparation and Characterization of Doped Zinc Oxide Thin Film for Solar Cell Applications

Bolat URALBEKOV (M), Kazakhstan
Period of visit: 22 September - 21 December 2009
Topic or title of PhD thesis: Assessment of Radiation Exposure in the Uranium Mining and Milling Area in the Central Asian Republics of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan

Jiafeng ZHAO (M), China
Period of visit: 27 December 2008 - 27 March 2009
Topic or title of PhD thesis: ARPES Measurement and Epitaxy Growth of Strong Correlated Films

2009 Fellows Financially Supported by CEI:

Inna A. SERENKOVA (F), Belarus
Periods of visit: 11 September - 9 December 2009
Topic or title of PhD thesis: Search for and Identification of Extra Spatial Dimensions with ATLAS at LHC

Dmytro Nikolayevich TATYANKO (M), Ukraine
Period of visit: 17 November 2008 - 15 February 2009 and 3 October 2009 - 2 February 2010
Topic or title of PhD thesis: Absolute Meters for Precise Measurement of Optical Power and Short Distances

2009 Fellows Financially Supported by ICTP:

Katy ALAZO CUARTAS (F), Cuba
Periods of visit: 7 November 2008 - 28 February 2009 and 14 April - 23 August 2009
Topic or title of PhD thesis: Modelling of the Ionospheric GPS-TEC in Central America and the Caribbean Region

Lucero ALVAREZ MINO (F), Colombia
Period of visit: 7 January - 7 March 2009 and 21 June - 11 August 2009
Topic or title of PhD thesis: Study of Tunnelling Magnetic Junctions Based on Nanostructured Oxides

Galbadrakh DAGVADORJ (M), Mongolia
Period of visit: 10 August - 10 November 2009
Topic or title of PhD thesis: Multicomponent Ultracold Atoms in Optical Lattice

Nadeesha Manohari WICKRAMAGE (F), Sri Lanka
Period of visit: 10 January - 10 May 2009
Topic: Experimental Physics with CMS Detector

2009 Fellows Financially Supported by the Japanese Government through the UNESCO-ICTP Mori Fellowship Scheme:

Nana Ama Kum BROWNE (F), Ghana
Period of visit: 10 August - 9 December 2009
Topic or title of PhD thesis: Developing and Evaluation Ensembles for Seasonal Predictions in West Africa

Marcelline ESSOUN (F), Benin
Period of visit: 18 August - 16 December 2009
Topic or title of PhD thesis: Stability and Analysis of the Evolution of Vorticity in a Free Shear Layer of a Supersonic Flow

Oluwayomi Peach FAROMIKA (F), Nigeria
Period of visit: 17 April - 14 August 2009
Topic or title of PhD thesis: Mathematical Modelling and Computational Simulation of the Bloch NMR Flow Equations for Blood Analysis

Landry MOUKETO (M), Congo
Period of visit: 25 April - 25 August 2009
Title of PhD thesis: Interface Magnetism and Quantum-Confinement Effects in Nanostructures Including Transition Metals (TM) and Rare-Earth (RE) or Noble Metals

Eric Uwadiogwu OFOEDU (M), Nigeria
Period of visit: 1 April - 26 September 2009
Topic or title of PhD thesis: Existence Theorem and Iterative Approximation of Solutions of Equations Involving Generalization of Nonlinear Nonexpansive Maps

Olushola Abel OLADIPO (M), Nigeria
Period of visit: 3 February - 2 June 2009
Topic or title of PhD thesis: Variability of the Equatorial Ionospheric Electron Density at Fixed Heights Below the F₂ Peak

A. Folasade Mayowa OLAJUYIGBE (F), Nigeria
Period of visit: 19 August - 30 October 2009
Topic or title of PhD thesis: Crystallographic and Biophysical Investigations of Thermostable Alkaline protease from *Bacillus Macerans* IKBM-11 Isolated from Ikogosi Warm Spring S.W. Nigeria

Abdou Ciss WADE (M), Senegal
Period of visit: 5 May - 4 November 2009
Topic or title of PhD thesis Carbon Nanotubes as Support for Bimetallic PtRu Nanoclusters: Enhancement of Methanol Oxidation Reaction for Fuel cell Technology

Tunde RAJI (M), South Africa
Period of visit: 3 March - 1 July 2009
Topic or title of PhD thesis: Computational Studies of Defects Dynamics and their Influence on Macroscopic Mechanical Properties of Ion Implanted Materials

2009 Fellows Financially Supported by the Italian Funds in Trust with UNESCO:

Mohammed Ahmed ABBAS (M), Egypt
Period of visit: 25 February - 20 August 2009
Topic or title of PhD thesis: Lepton Mixing and Flavour Symmetry

Jean Pierre BELL (M), Cameroon
Period of visit: 3 April - 30 September 2009
Topic or title of PhD thesis: The Influence of Land-Surface Processes of Rainfalls Generated by a Regional Model in the Congo Basin - Case of RegCM

Dick Heartmann DOUMA (M), Congo
Period of visit: 6 September 2009 - 3 March 2010
Topic or title of PhD thesis: Electron Transfer in Sensitized Semiconductor Surfaces from the Time-Dependant Density Functional Theory: Applications to Dye-sensitized Solar Cells

Mikesokpo Milohum DZAGLI (M), Togo
Period of visit: 7 October - 29 December 2009
Topic or title of PhD thesis: Technique of Fabrication, Optical and Electrical Characterization of Semiconductor Lasers Based on GaSb for Mid Infrared

Franck Djidémè HOUENOU (M), Benin
Period of visit: 30 April - 30 October 2009
Topic or title of PhD thesis: Hofer Metric's Behaviour Under Mean Curvature Flow

Evariste Heutchi NGATCHOU (M), Cameroon
Period of visit: 24 November 2009 - 30 June 2010
Topic or title of PhD thesis: GS Geodesy Along Cameroon Volcanic Line

Leontine NKAGUE NKAMBA (F), Cameroon
Period of visit: 1 July - 29 December 2009
Topic or title of PhD thesis: Mathematical Modelling and Numerical Simulation for the Control of Meningitis

Phillip Wilfsen Otieno NYAWERE (M), Kenya
Period of visit: 20 June - 19 December 2009
Topic or title of PhD thesis: First Principle Molecular Dynamics Calculation of the Superionic Properties of BaF₂ and La:BaF₂

Larby RAHILI (M), Morocco
Period of visit: 20 June - 19 October 2009
Topic or title of PhD thesis: Phenomenology of Extended Higgs Sector at LHC and ILC

Elisa Josiane RINDRAHARISAONA (F), Madagascar
Period of visit: 11 July 2009- 12 January 2010
Topic or title of PhD thesis: Tectonic Evolution, Provenance Analysis of the Madagascar Rift System and Currently Kinematic for Somalia-Nubia Using a Data Collected in Madagascar

Olaniyi Kamil YUSUFF (M), Nigeria

Period of visit: 1 June - 30 November 2009

Topic or title of PhD thesis: Simulation of Haemoglobin Foldings and Aim Oriented Processes: Human and Avian Haemoglobins as Case Studies

Tadesse Terefe ZELEKE (M), Ethiopia

Period of visit: 7 October 2009 - 4 April 2010

Topic or title of PhD thesis: Customization and Adaptation of ICTP Regcm3 for Current and Future Climate Change Impact Studies Over Eastern Africa

2009 Fellows Financially Supported by the Astronomical Observatory of Trieste (OAT):

Heng YU (M), China

Periods of visit: 6 February - 15 July 2009

Topic or title of PhD thesis: Cosmological Parameters Investigated Via Observations in the X-Ray Band of High Redshift Clusters of Galaxies: Comparison with Numerical Simulations, Predictions for Future X-Ray Missions and Implications for Dark Energy

TRAINING AND EDUCATION PROGRAMMES—PhD LEVEL

JOINT PROGRAMMES IN HIGHER EDUCATION

ICTP-University of Trieste Laurea Magistralis in Fisica, and Laurea Magistralis in Astrofisica e Fisica Spaziale¹

Both courses are covered in two academic years. The Italian “Laurea Magistralis” degree corresponds to an advanced masters’ degree. The programme is open to anyone having the equivalent of a bachelor degree in physics. A limited number of fellowships are awarded to the best students from developing countries. Upon successful completion of the entire study plan, students are awarded a degree from the University of Trieste. In 2009, fellowships were awarded to three students. Seven students (from Iran, Pakistan, Ghana, Senegal and Ethiopia) were enrolled in the programme in 2009. It is remarkable that all the courses and examinations are held in English and the goodwill to collaborate of both the Italian professors and students is gratefully acknowledged.

PhD Programme in Environmental Fluid Mechanics

This is a joint programme sponsored by ICTP, the University of Trieste, and three Italian scientific institutions in Trieste: Istituto di Scienze Marine del Consiglio Nazionale delle Ricerche (ISMAR-CNR), Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), and Osservatorio Meteorologico Regionale - Friuli Venezia Giulia (OSMER-FVG). Now in its fourth year, the programme is patterned after a typical American PhD programme. In 2009, ICTP sponsored one student from Iran.

¹ The degree called “Laurea Magistralis” corresponds to the last two years of the New European Educational System as fixed by the Bologna-Sorbonne agreement among the European Ministers of Education in the mid nineties. It can be compared to an advanced master’s degree.

TRAINING AND EDUCATION PROGRAMMES—CAREER SUPPORT

ASSOCIATESHIP SCHEME

The Associate as well as the Federation Arrangement Schemes represent two main channels through which the vocation of ICTP for the promotion and development of scientific knowledge in developing countries has been turned into reality. In particular, the Associateship Scheme enables individual scientists to maintain long term formal contacts with the stimulating and active scientific environment of the Centre. It has to be stressed that all evaluation committees of ICTP activities, both those of its mother institutes, IAEA and UNESCO, as well as those of external bodies, like SIDA, have expressed their high appreciation for the excellence and efficiency of these programmes and for the results which have been achieved through them.

The Standard Scheme

The Associateship Scheme currently includes Junior, Regular, Senior, and Group Associates.

Junior Associates

Young Third World scientists coming from geographically isolated areas may be nominated Junior Associates. Starting from 1999, the Junior Associateship award has a six-year duration throughout which the Junior Associate is entitled to visit ICTP three times, from six weeks to 90 days each time, with three fares paid. A fare will be granted for visits having a minimum duration of 42 days. The age limit for a Junior Associate nomination is 35.

Regular Associates

These are Third World scientists entitled to spend up to 270 days (with a maximum duration of 90 days for any single visit) at the Centre, in a period of six years, with three fares paid. A fare will be granted for visits having a minimum duration of 42 days. For each visit the Centre provides a daily living allowance. Age limits for Regular Associates are between 36 and 45, at the time of nomination.

Senior Associates

Third World scientists who have acquired international scientific status may be nominated Senior Associates. They are entitled to the sum of € 7,250 to be spent during the six-year period of their appointment. These funds are made available for visits in the form of a daily living allowance and/or travel expenses. The age limit for a Senior Associate nomination is 62.

Group Associates

Starting in 1999, ICTP decided to reinstate the possibility of applying for Group Associations. Each group will avail of a number of Associateship privileges depending on the number of components of the group, such as to allow each member of the group at least one visit at ICTP during the period allocated.

Partnership visits

The implementation of this programme depends on the establishment of an agreement between ICTP and another scientific institute, located in an advanced country.

Once a partner institute is established, Regular and Senior Associates may utilize their privilege to visit such institute instead of ICTP. The agreement also foresees that partner institutes take care of part of the expenses involved, while ICTP grants the standard daily living allowance and/or travel support, where applicable. Currently there are 14 partner institutes (list follows).

List of ICTP Partner Institutes

Australia

National Institute for Theoretical Physics, University of Adelaide

Belgium

Department of Physics, University of Antwerp

Department of Soil Management and Soil Care, University of Ghent

Finland

High Energy Physics Division, Department of Physics, University of Helsinki

France

Institut Universitaire des Systemes Thermiques Industriels, Marseille

Germany

Institut für Techno- und Wirtschaftsmathematik, Kaiserslautern

Microstructure Laboratory and Technical Physics, University of Würzburg

Italy

Department of Mathematics, University of Pavia

Department of Nuclear and Theoretical Physics, University of Pavia

Department of Physics "A. Volta", University of Pavia

Department of Physics, University of Pisa

CNIT - Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Pisa

ECT - European Centre for Theoretical Studies in Nuclear Physics and related Areas, Trento

United States of America

Institute for Fusion Studies, University of Austin, Texas

Identification and Selection of Candidates

ICTP collects all Associateship applications which are usually (but not exclusively) submitted by scientists who have had some interaction with ICTP (typically participants in courses and workshops) and, at the end of the year, such applications are divided according to the fields of interest of the applicants and sent to the appropriate scientific committees of ICTP, which are invited to prepare a priority list.

The Office previously identified the number of appointments expiring, and took this as well as the budget allocated for the Programme into account, to define the approximate number of new appointments for the subsequent year, so that the committees have a clear indication of how many new appointments would be issued in their field.

Each Committee is requested to indicate - with an extra 50% margin - a foreseen number of new appointments in their field, so that in the end, when the general overview of the proposals is at the disposal of the Office, we can rearrange things in such a way as to respect the geographical distribution of the Associates. Just to give an indication of the work connected with this preliminary and essential action we stress that for about 100 new positions opening each year, we analyze approximately 1,000 applications.

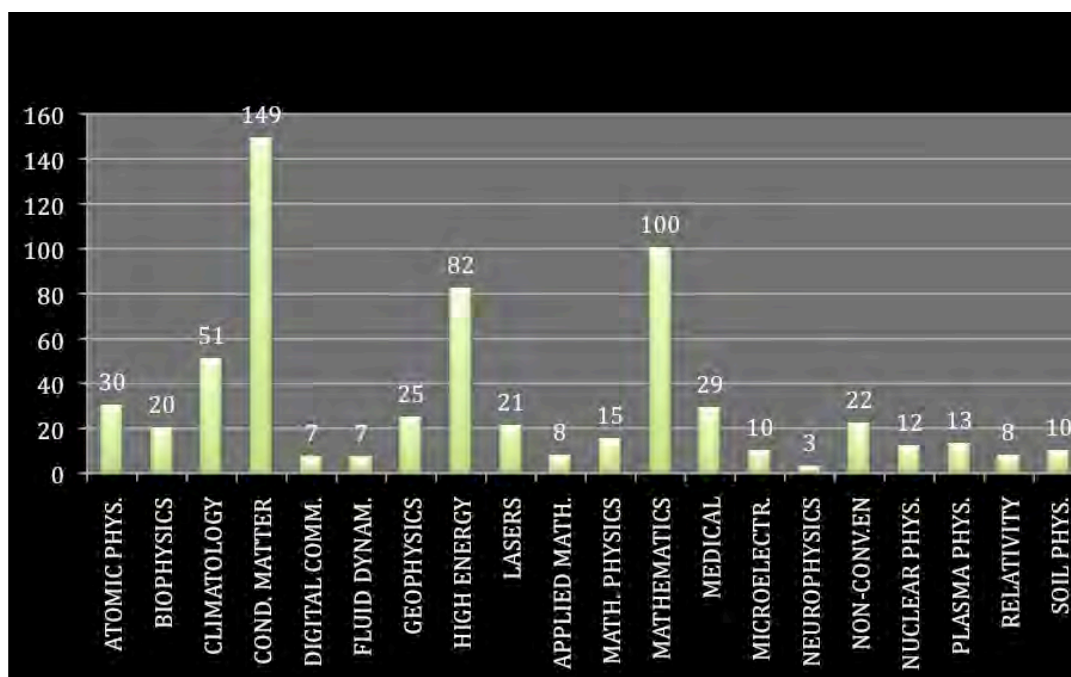
For their evaluation, Committees are invited to take into account the scientific level of the candidates as emerging from their academic titles and positions and particularly from their scientific production appearing on international journals.

Finally, we require the Committee to give priority to young active scientists and to women.

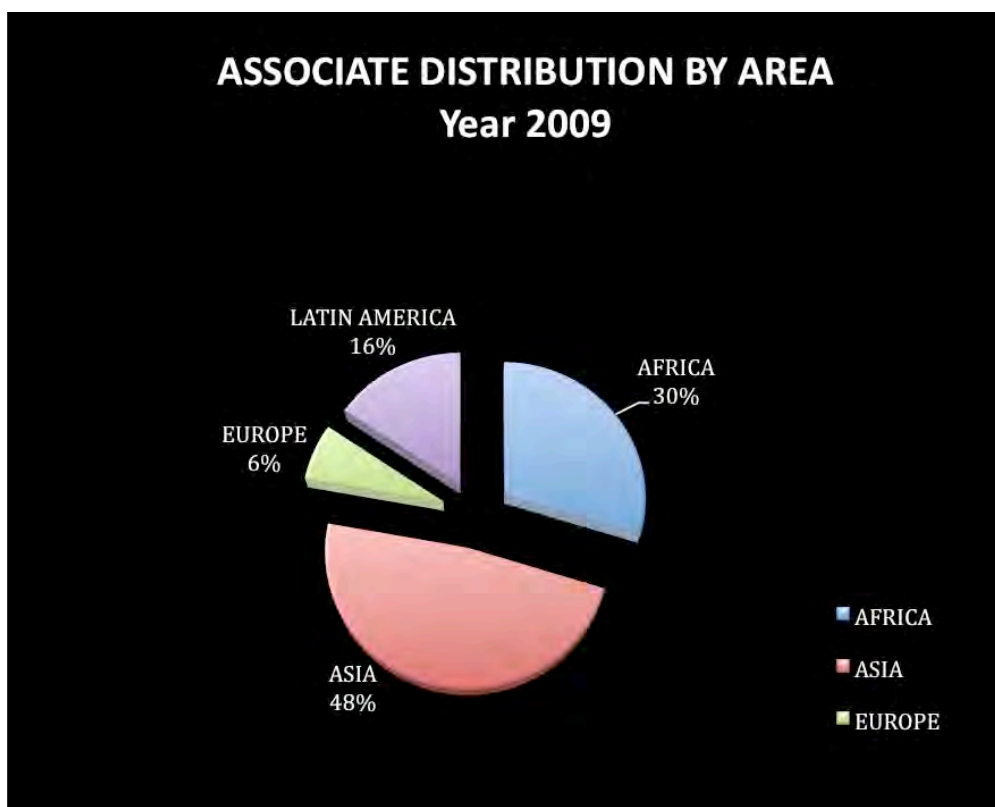
Modification in Selection Procedure

We have requested an on-line Associate application form to speed up the whole process from the input of applications to the selection of candidates and feedback on behalf of the relevant scientific committees.

The following chart shows the 2009 distribution of Associate Members by field of research.



The following chart shows the 2009 distribution of Associate Members by geographical area.



Summary of the 2009 Associateship Programme

a. Number of Associates by Category

| | |
|---------|-----|
| Junior | 190 |
| Regular | 287 |
| Senior | 134 |
| Group | 11 |

Total 622

b. Visits and Costs:

In 2009, 206 Associateship visits were paid to ICTP by 200 scientists, as follows:

| Associates' Visits and Costs | | | | | | |
|------------------------------|--------|------------|--------------------------|--------------------|-----------------------|---------------------|
| CATEGORY | VISITS | TOTAL DAYS | TOTAL EXPENDITURE (EURO) | AVERAGE COST VISIT | AVERAGE COST PER DIEM | AVERAGE COST TRAVEL |
| Junior | 57 | 3,248 | 168,613.00 | 2,958.00 | 2,279.00 | 679.00 |
| Regular | 105 | 5,078 | 286,221.00 | 2,726.00 | 2,176.00 | 550.00 |
| Senior | 40 | 892 | 68,936.00 | 1,723.00 | 1,115.00 | 608.00 |
| Group | 4 | 300 | 18,254.00 | 4,564.00 | 3,375.00 | 1,189.00 |

Average with respect to a hypothetical full utilization of these groups in 2009:

| Associates' Average Utilization | | | |
|---------------------------------|------------------|--------------------|-------------------|
| CATEGORY | IN TERMS OF DAYS | IN TERMS OF TRAVEL | IN TERMS OF FUNDS |
| Junior | 38% | 52% | |
| Regular | 39% | 49% | |
| Senior | | | 43% |
| Group | 61% | 73% | |

This year in August, we were facing budgetary problems and were granted an extra Euro 37,000 to cover the forecasted shortfall.

However at the end of 2009 we were left with an unspent balance of approx. Euro 40,000 owing to last minute visit cancellations.

General Concise Forecast for 2010 (at 21/1/2010)

a. Number of Associates

These figures are partial, as they do not take into account the 2010 awards since the selection of new Associate members is currently in process.

| | |
|---------|-----|
| Junior | 151 |
| Regular | 236 |
| Senior | 100 |
| Group | 11 |

Total 498

b. Expected Visits

| | |
|---------|-----|
| Junior | 96 |
| Regular | 148 |
| Senior | 66 |
| Group | 3 |
| Total | 313 |

The above figures are in line with the 2009 ones which amounted to 322 visit requests in the same period.

TRAINING AND EDUCATION PROGRAMMES—CAREER SUPPORT FEDERATION ARRANGEMENTS SCHEME

The main difference between the Associateship Scheme and the Federation Arrangements Scheme derives from the fact that while the former is addressed to an individual scientist the latter involves an institution.

The Standard Scheme

Federation Arrangements are contracts of scientific collaboration signed by ICTP and a scientific institution in a Third World country, whereby the latter may send its junior representatives to ICTP, for periods ranging from 60 to 150 person-days per year on a cost sharing basis. No invitation is sent automatically. All cases are screened by the relevant activities' organising committees or research groups. There are presently five standard types of arrangements, adopted according to geographical areas, which foresee different numbers of person-days.

The Scheme represents an interesting complementary programme to that of the Associates, in the sense that it differs under three important respects:

- If appropriately used, more scientists can be exposed to the scientifically stimulating atmosphere of ICTP because it is not addressed to an individual but to an institute;
- It should represent the basis of a long-term and fruitful co-operation between an institute and ICTP;
- It should stimulate the local community to make efforts to invest energy and resources to keep the important link with ICTP alive. In fact, the Scheme always foresees a financial commitment of the Federated Institute and if such commitments are not respected the agreement is cancelled.

Change of Policy

To increase the efficiency of the programme and to allow the Federated Institutes to make medium-term plans, starting in 1999 the duration of the agreements was increased from one to three years. At the same time, taking into account the financial problems that the Associate and Federation Arrangements Schemes had to face in connection with the many new initiatives, the number of person-days per year allocated to each institution was slightly reduced.

Criteria for the Selection of the Institutes

Experience with this programme and efforts made to avoid misuses have allowed us to identify some general criteria which we believe should be followed in establishing new Federation Arrangements:

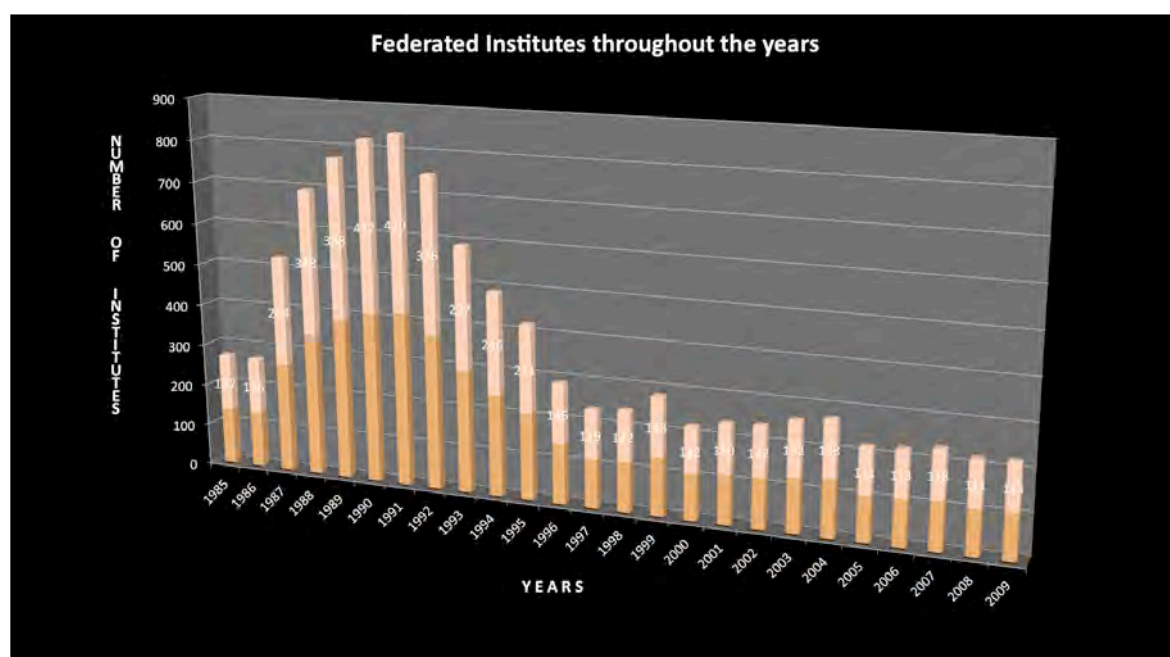
- We will consider only institutions of high scientific level and in which there is a rather consistent scientific population;
- We will pay specific attention to institutes in which there are brilliant young people scientifically active. In fact one of the drawbacks of the previous utilizations was that in many cases the institutes were proposing quite old scientists as visitors. If the Scheme has to contribute to the growing of new, high level competences, we have to—just as we do for the Associates—keep, as our primary objective, that of performing actions which can have a long-term impact on the local situation. The obvious way to do so is to support active young researchers;

- Finally, even though this will not be an absolutely strict rule, we will try to establish agreements with institutes with which we already have serious collaborations, such as those in which there are (and/or were) prominent Associates or those which are included in other ICTP programmes, such as the ICAC Centres. To prevent this policy from leading to the exclusion of institutes of recent formation which are, however, promising, we will also make serious efforts to spread the information about the programme to receive more applications which will then be scrutinized to ensure the adequate scientific level already established for the programme.

Modification in Visit Procedure

We have requested an on-line visit application form to speed up the selection process and feedback on behalf of the relevant activity organizers.

The following chart shows the number of Federated Institutes throughout the years.



Summary of the 2009 Federation Arrangement Programme

In 2009 ICTP had a total of 112 Federation Arrangements, 104 of which were standard. The total number of visits under the programme was 76.

The total number of days available for the three-year period is 13,980 (i.e. an average total utilisation per year of 4,660 days). In 2009, 1831 days were utilised. Accordingly, in terms of days, the total utilisation was 39%.

The total expenditure (daily living allowance, and travel contribution when applicable) was €96,185. A full utilization of one third of the total available would have implied an expenditure of €235,200. Accordingly, in terms of funds, the total utilization was 40%.

General Concise Forecast for 2010

Total Number of Federated Institutes: 114

Visits from Federated Institutes already committed: 12

TRAINING AND EDUCATION PROGRAMMES—CAREER SUPPORT

TRAINING AND RESEARCH IN ITALIAN LABORATORIES (TRIL)

Introduction

The programme of Training and Research in Italian Laboratories (TRIL) offers scientists from developing countries (Third World and Eastern Europe-Balkans) an advanced experimental counterpart to ICTP's theoretical research and lecture-based training programmes. The fields covered reflect the lines of interest to the Centre: for example, physics of condensed matter; physics and energy; physics and technology; earth and environmental sciences; physics of the living state and a few miscellaneous interdisciplinary subjects.

A more far-sighted view is to promote, through direct contacts and side-by-side research, collaborations between the Italian scientific community and individuals, groups and institutions in developing countries. TRIL can be viewed as a genuine 'Italian' project in advanced scientific training co-ordinated by ICTP. This project helps to implement an important aspect of the mission of ICTP to form and strengthen a permanent scientific elite in developing countries who are aware of local needs and resources and cognisant of those frontiers of science and technology that are most likely to influence national progress.

Until now 400 Italian laboratories have contributed to TRIL, and 1215 scientists from developing countries (through December 2009 for a total of 1836 grants and 17,566 person-months) have been offered opportunities to participate in side-by-side high-level, mostly experimental, research enjoying access to Italian teams and advanced equipment and experiencing an international atmosphere.

Universities are the most numerous host institutions because of their historical ability to deal with a wide spectrum of scientific problems. On the other hand, laboratories of public and private research institutions such as CNR (Italian National Research Council), ENEA (Italian National Agency for New Technologies, Energy and the Environment), INFN (Italian National Institute of Nuclear Physics), ISPRA (Institute for Environmental Protection and Research), ST (Sincrotrone Trieste), OGS (National Institute for Oceanography and Experimental Geophysics) and others often have special equipment better geared to a specific research purpose. The presence of foreign visitors can also provide a practical solution to temporary personnel shortages at these laboratories. In many cases, the visit of an individual scientist has led to a more extended collaboration.

As a measure of the success, one can cite the high standard of the published reports, the often significant contribution offered by our fellows to laboratory research activities, and the fact that a TRIL fellowship frequently has been instrumental for promotions (to the rank of full professor, vice chancellor, high ministerial official, minister, etc.). More importantly, the visit of an individual scientist often represents the starting point for more extended collaboration that sometimes involves the institutions.

One should mention the fruitful collaboration programmes established among institutions in Italy and those in Argentina, Cuba, India, Nigeria, and other countries. This aspect of the programme, i.e. the 'follow-up' stage, represents one of the main objectives of TRIL and needs continued attention and support.

Demand from the Fellows' side is high—9,152 applications through December 2009. This confirms that TRIL is a valuable component of ICTP's action to strengthen a scientific-technological elite in the developing world.

From the Italian side, a positive aspect is represented by the increasing interest and participation of Italian scientific institutions, universities and national agencies, which continue to offer the possibility of high-level scientific collaboration and often contribute financially to the costs of the

grants. New agreements have been signed and existing ones strengthened. For 2009, the annual financial contribution from external sources was of the same order of the budget provided by ICTP. We trust that such schemes of collaboration will represent a regular component of the TRIL programme.

Activities in 2009

Funds available were used for fellowships (new fellowships and extensions). Altogether the number of TRIL fellows in 2009 was 107 (24 women) with a total of 603 person-months awarded in the following topics:

- medical physics;
- earth and environmental sciences (some of the fellowships were covered in the framework of the agreements with OGS, ENEA);
- materials science, optical physics and condensed matter physics (some of the fellowships were supported through the Agreement with ST and funds provided by the laboratories)
- renewable energies. The relevant financial support is mainly coming ENEA.

The TRIL Programme was also involved in initiatives in higher education in collaboration with the University of Trieste—see p. 99.

A number of fellowships (17) were awarded under the project “Training and Research in Italian Laboratories (TRIL) for AFRICA” financed by the Italian Funds-in-trust with UNESCO for high-level training and participation in research. The fellows selected under this project are from Madagascar, Ethiopia, Nigeria, Sudan, Ghana, Ivory Coast, South Africa and Senegal. The topics of the training are renewable energy, Earth and environmental sciences and medical physics. The same project allowed to finance four fellowships to selected students from Senegal, Ghana and Iran for the joint Programme with the University of Trieste for the Laurea Magistralis in Physics.

The Italian Funds-in-trust with UNESCO allowed also to start the project “Study of Air Quality by means of DOAS (Differential Optical Absorption Spectroscopy) in Accra-Tema, Ghana”. The Project is done in collaboration with the Institute of Atmospheric Sciences and Climate (ISAC, Bologna) of the Italian National Research Council (CNR), and with the Laser and Fibre Optics Centre of the University of Cape Coast, Ghana, and will allow to establish the first ground-based station devoted to environmental and climatological observations by means of DOAS in Ghana.

A new announcement of fellowships was published, in the frame of the collaboration agreement with the Sincrotrone Trieste - ELETTRA Laboratory. Altogether 8 fellows visited the ST Laboratory in 2009.

A Collaboration Agreement was signed between the ICTP and the Iraqi Ministry of Higher Education and Scientific Researches (MOHESR) to support the research in the fields of Lasers, Optical Communications, Renewable energies, Earth and Environmental Sciences, Medical Physics and Technological Research, by allowing Iraqi Faculties and Postgraduate Students to visit Italian Laboratories. Two fellowships were granted in 2009 under this agreement.

What's next?

The need to maintain the contacts between the Italian laboratory and the scientists who have successfully worked there has been repeatedly stressed. Such follow-up action should become one of the main lines of action of TRIL and in this connection the creation of the TRIL-Associate scheme was advocated. Also the Laurea Magistralis Scheme (jointly with the University of Trieste) should become a regular component of the TRIL activities.

At present, owing to fund limitations, only 14 TRIL Associates have been appointed in: Condensed Matter (Nigeria, Uruguay, Cuba, India, Ethiopia), Optical Physics (Ghana, China,

Slovak Republic), Environment and Earth Sciences (India, Argentina, Cuba, Bulgaria), Instrumentation (Morocco, Nigeria) with complete satisfaction of both the sides involved. Several other “return visits” have been supported occasionally but it is clear that this new scheme must receive adequate attention and financial support in the near future.

TRAINING AND EDUCATION PROGRAMMES—CAREER SUPPORT

ICTP-ELETTRA USERS PROGRAMME

The programme offers access to the synchrotron radiation facility ELETTRA in Trieste in the years 2007-2011 to scientists from and working in developing countries. The programme offers a limited number of grants to cover travel and living expenses of individuals and small groups who participate in the beamtime at ELETTRA. The number of scientists who can receive support depends on the number of allocated shifts and available funds.

A minimum annual total of 1,500 hours is available within this programme for beamtime applications at any of the existing ELETTRA beamlines.

The proposed experiments are selected for beamtime assignment on the basis of their scientific merit.

A total of 2,392 hours were allocated in 2009, which indicates the overwhelming success of the programme.

In 2009, ICTP supported 36 visits of participants coming from:

| | |
|--------------|----|
| Argentina | 1 |
| Brazil | 5 |
| China | 3 |
| Cuba | 2 |
| India | 13 |
| Mexico | 2 |
| Pakistan | 3 |
| Singapore | 2 |
| South Africa | 1 |
| Sri Lanka | 1 |
| Thailand | 2 |
| Ukraine | 1 |

Special attention is devoted to the number of countries benefitting from the programme in order to achieve a balanced geographical distribution of the assignments.

Measurements were run on the following beamlines:

Advanced Line for Overlayer, Interface and Surface Analysis (ALOISA): the beamline is a multipurpose beamline, which offers a wide range of complementary experimental techniques like photoemission spectroscopy, photoelectron diffraction, X-ray diffraction etc.

Advanced Photoelectric-effect Experiments (APE): is a facility for advanced experiments on solid surfaces and nanostructured matter.

Beamline for Advanced DiChroism (BACH): performs light polarisation dependent experiments in the 35-1600 eV photon energy range.

Bending magnet for Emission Absorption and Reflectivity (BEAR): the BEAR apparatus, beamline and experimental station, is designed for the study of a wide class of samples with emphasis on joint structural and electronic (magnetic included) properties of reduced dimensionality systems including free surfaces, interfaces, multilayers and adsorbates.

Circular Polarized Beamline (CIPO): deals with magnetic circular dichroism in absorption spectroscopy; X-ray photoemission spectroscopy; photoemission spectroscopy from UV to soft X-ray; spin-resolved photoemission; angle-resolved photoemission with high energy resolution.

Gas Phase Photoemission (GAPH): is specifically devoted to research on gaseous systems.

Laboratory for Interdisciplinary Lithography (LILIT): the beamline is devoted to the fabrication, by means of X-ray lithography, of structures at micro and nano resolution level, taking advantage of the high brilliance and wide X-ray domain spectrum of ELETTRA.

Materials Characterisation by X-ray diffraction Beamline (MCX): allows to perform a wide range of non-single crystal diffraction experiments.

Nanospectroscopy (NASP): the Nanospectroscopy beamline consists of two branches designed for two imaging photo-electron microscopes.

Source for Imaging and Spectroscopic Studies in the Infrared (SISSI): the beamline extracts the IR and visible components of synchrotron emission for applications of spectroscopy, microspectroscopy and imaging.

SYnchrotron Radiation for MEDical Physics (SYRMEP): the beamline has been designed for research in medical diagnostic radiology.

X-ray Absorption Fine Structure (XAFS): EXAFS spectroscopy provides microscopic structural information of a sample through the analysis of its X-ray absorption spectrum.

X-Ray Diffraction 1 (XRD1): designed primarily for macromolecular crystallography.

TRAINING AND EDUCATION PROGRAMMES—CAREER SUPPORT

SESAME PROJECT

The SESAME (Synchrotron Light for Experimental Science and Applications in the Middle East) project aims to build a synchrotron light source in Jordan, at Al Bal'qa University, and to operate it, as an international laboratory, for all interested scientists from the region. SESAME is developed under the aegis of UNESCO and is overseen by a Council, with representatives of the participating countries (Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestine Authority and Turkey). Sir Chris Llewellyn Smith, former Director General of CERN, is the chairman of the SESAME Council.

ICTP has a role in the training programmes of SESAME. In order to give Middle Eastern scientists an opportunity to contribute to the design and the use of the future facility in the most productive way, it is essential that they acquire familiarity with the existing facilities. ICTP offers its assistance in the programmes aiming at giving young scientists from the region an opportunity to spend six months or more in a facility in Europe. ELETTRA and other facilities in Europe have agreed to welcome trainees from the SESAME countries and ICTP is assisting them in securing funds from the programmes of the IAEA Division of Technical Cooperation or from the hosting facilities themselves. The IAEA-STEP also offers opportunities for training of PhD students from SESAME countries in the field of use of the synchrotron beamlines. In view of the culturally very rich region where SESAME is being set up, SESAME gives priority to fostering a users community in the cultural environment and will organise a meeting on cultural heritage.

ICTP and SESAME have signed a Memorandum of Understanding during the meeting of the 14th Sesame Council held in Istanbul on 20 July 2009. ICTP was represented by Claudio Tuniz, ICTP's Assistant Director.

Tuniz attended the 15th meeting of the Sesame Council, held in Jordan from 24 to 25 November 2009. He is also member of the SESAME Advisory training Committee that was held in Petra on 23 November 2009.

The Memorandum of Understanding between ICTP and SESAME is aimed at scientific capacity building in the Middle East, the Mediterranean region and surrounding areas, through scientific research and training, and the promotion of sustainable development and peace. Collaborative activities will include developing and organizing research and training programmes and scientific events taking advantage of the existing schools and training programmes at ICTP. In particular, it was proposed to organise in Trieste, a workshop on the application of synchrotron radiation in structural molecular biology, in cooperation with Sincrotrone Trieste and Egyptian Academy of Sciences (2011), a workshop on Synchrotron Radiation for Cultural Heritage, in cooperation with UNESCO and IAEA (2011). The ICTP Office of External Activities will support a Sesame-Japan workshop in Antalya (Turkey) in 2010.

TRAINING AND EDUCATION IN DEVELOPING COUNTRIES

OFFICE OF EXTERNAL ACTIVITIES (OEA)

The Office of External Activities (OEA) was established in 1986 with the objective of helping the research and training activities of physicists and mathematicians living and working in developing countries. OEA provides assistance to scientists in their home countries. Such support complements the training and research that is provided to scientists from developing countries at the Centre. The OEA programmes can provide funds for student grants, fellowships for young researchers, visits of research collaborators, equipment, literature, etc.

OEA actions are aimed at providing a backup to individuals, groups or institutes in developing countries to accelerate their promotion to an international level (South-North collaboration) and to stimulate networking of scientists in the developing regions to reach a critical mass of researchers (South-South collaboration).

Assistance is carried out within the following schemes:

- Affiliated Centres
- Projects
- Networks
- Visiting Scholars/Consultants
- Scientific Meetings

Affiliated Centre (ICAC) Programme

An Affiliated Centre is an institute or university department of physics or mathematics that carries out a specific long-term research project on a definite subject with well defined purposes. Affiliated Centres have a regional character and are strongly supported by the local authorities and the hosting institute.

In 2009 OEA supported 6 Affiliated Centres: 4 in Africa, 1 in Latin America and 1 in Eastern Europe.

Projects

Given the lack of trained personnel in physics and mathematics at universities in some developing countries and the fact that many students from these countries who pursue their graduate studies in industrialized countries do not return to their countries of origin, OEA supports specific PhD courses, primarily in Africa. OEA also supports several research projects that do not currently fit the category of Affiliated Centres. There are 13 active projects, of which 6 are in Africa, 5 in Asia, 1 in Latin America and 1 in Southeastern Europe.

Network Programme

A Network is a system of research groups in an entire region, or among different regions, that pursue a common scientific project over an extended period.

The OEA supports networks because they are an efficient approach to overcoming the problem of isolation and counteracting the brain drain. ICTP emphasizes South-South collaboration and the sharing of expertise and facilities. At present the Centre supports 11 networks in various fields of physics and mathematics. There are 5 Networks in Africa including North Africa; 2 in Asia and 4 in Latin America and the Caribbean.

Scientific Meetings

OEA encourages the organization of international and regional scientific meetings in developing countries by offering financial assistance to the organizers of conferences, workshops, and schools.

75 scientific meetings received support in 2009:

| | |
|----------------------|--|
| 17 in Africa: | 1 Algeria, 1 Burkina Faso, 2 Cameroon, 2 Egypt, 1 Ethiopia, 2 Ghana, 1 Libya, 2 Morocco, 1 Nigeria, 2 Senegal, 1 Tanzania, 1 Tunisia |
| 30 in Asia: | 1 Cambodia, 1 China, 5 India, 2 Indonesia, 3 Iran, 2 Malaysia, 2 Nepal, 2 Oman, 3 Pakistan, 1 Singapore, 1 Thailand, 1 Turkey, 2 Uzbekistan, 4 Vietnam |
| 21 in Latin America | 10 Argentina, 5 Brazil, 2 Chile, 1 Colombia, 1 Guatemala, 1 Mexico, 1 Uruguay |
| 7 in other countries | 1 Bulgaria, 2 Italy, 1 Macedonia, 1 Romania, 2 Ukraine |

Visiting Scholars/Consultants

This programme promotes collaboration between scientists working in institutions in developing countries and leading scientists throughout the world. The Visiting Scholar/Consultant is required to make at least two research visits over three years, each lasting at least a month. The Visiting Scholar/Consultant carries out joint research with his counterpart and lectures students in his field of expertise. This is another effective way to counteract the isolation of scientists and to allow them to maintain contacts and collaboration with leading experts from other countries.

There are currently 25 active Visiting Scholars, of which 8 awarded in 2009 to visit institutes in the following countries: Argentina, Benin, Cuba, Ghana, Madagascar, Malawi, Morocco and Peru.

Collaborations

OEA collaborates with other institutions in promoting research and training in physics and mathematics in the developing countries. In particular there are collaborations with:

Centro Latino-Americano de Física (CLAF)

Since its inception, ICTP has maintained close links with CLAF. This collaboration was formalized in a Memorandum of Understanding signed with CLAF in 1996 and renewed in 2001 for another 5 years. Under this MoU ICTP provides a substantial support for CLAF activities in Latin America that include research exchange visits and sandwich PhD programmes. This collaboration has been very fruitful.

AWARDS AND PRIZES

AWARDS AND PRIZES

Dirac Medal

ICTP instituted the Dirac Medal in 1985. The Medal is awarded yearly on P.A.M. Dirac's birthday—8 August—to individuals who have made significant contributions to physics. The Medallists also receive a prize of US\$ 5,000. An international committee selects the winners from a list of nominated candidates. The ICTP Dirac Medal is not awarded to Nobel Laureates, Fields Medallists, or Wolf Foundation Prize winners.

The Dirac Medal 2009 was awarded to:

- Roberto Car, Department of Chemistry, Princeton University
- Michele Parrinello, Swiss Federal Institute of Technology (ETH Zurich)

Citation:

“The 2009 Dirac Medal recognizes the joint contributions of Roberto Car and Michele Parrinello in developing the ab-initio simulation method in which they combined, elegantly and imaginatively, the quantum mechanical density functional method for the calculation of the electronic properties of matter with molecular dynamics methods for the Newtonian simulation of atomic motions. The Car-Parrinello method has had an enormous impact, joining together the fields of simulation and of electronic structure theory, and has given rise to a variety of applications well beyond condensed matter physics.”

The official awards ceremony will be held on 21 May 2010.

ICTP Prize

Annual ICTP Prizes were created in 1982 by the ICTP Scientific Council in recognition of outstanding and original contributions within mathematics and physics by young scientists from developing countries.

The 2009 ICTP Prize in honour of Edward Norton Lorenz was awarded to Professor Marcelo Barreiro, Atmospheric Sciences Unit, School of Sciences, *Universidad de la República*, Montevideo, Uruguay.

The Prize recognizes Professor Barreiro's important contributions in the field of tropical Atlantic variability, and the exploration of dynamical mechanisms to explain the paleoclimatic record in the last few million years. The results of his investigations have important implications for seasonal forecasting and the climate change debate.

The official awards ceremony will be held on 8 June 2010.

ICO/ICTP Gallieno Denardo Award

ICO, the International Commission for Optics, and ICTP have established a joint prize, called the ICO/ICTP Award, reserved for young researchers from developing countries who conduct their research in developing countries. The award is given to scientists less than 40 years old who are active in research in optics and have contributed to the promotion of research activities in optics in their own or another developing country.

The recipient receives a certificate, US\$1,000, and the invitation to participate in and deliver a lecture at an ICTP activity relevant to optics.

Since 2008, the award is called “ICO/ICTP Gallieno Denardo Award” to honour the memory of Gallieno Denardo, who was in charge of optics activities at ICTP for more than twenty years.

The ICO/ICTP Gallieno Denardo Award for 2009 was awarded to Saifollah Rasouli, Institute for Advanced Studies in Basic Sciences, Zanjan, Iran, “for his creative implementation of Moiré interferometry to fiber optics, optical metrology and atmospheric optics, including measurements of turbulence parameters, and possible applications to wavefront distortion compensation in adaptive optics systems.”

The prize was awarded to the winner on 10 February 2009, during the Winter College on Optics in Environmental Science.

Ramanujan Prize for Young Mathematicians from Developing Countries

In late 2004, ICTP created the Ramanujan Prize for young mathematicians from developing countries. The Prize is funded by the Niels Henrik Abel Memorial Fund.

The Prize carries a \$15,000 cash award and travel and subsistence allowance to visit ICTP for a meeting where the Prize winner will be required to deliver a lecture. ICTP awards the prize through a selection committee of five eminent mathematicians appointed in conjunction with the International Mathematical Union (IMU).

The 2009 Srinivasa Ramanujan Prize was awarded to Ernesto Lupercio, CINVESTAV, *Instituto Politécnico Nacional*, Mexico.

The prize was in recognition of “his outstanding contributions to algebraic topology, geometry and mathematical physics. He is an expert in the theory of orbifolds (spaces with singularities arising from finite symmetric groups). He has fundamental results on K-theory, gerbes, and Chas-Sullivan type string topology operations.

The prize is also in acknowledgement of the enormous contribution that Professor Lupercio has made to mathematics in Mexico, through his energy, enthusiasm and collaborations with young researchers.”

The official awards ceremony will be held at ICTP on 13 July 2010.

*SCIENTIFIC SUPPORT
SERVICES*

MARIE CURIE LIBRARY

New Website and Online Catalogue

The Library announced the launch of its new website and search interface, following one year of planning, designing and testing.

The goal is to provide users with a web environment that informs better about library services and helps discover/retrieve scientific production at ICTP and essential electronic resources. The home page offers a practical quick access to the new search interface, which brings together resources previously scattered among different archives.

The screenshot shows the Marie Curie Library website homepage. At the top, there is a blue header with the ICTP logo and the text "Marie Curie library The Abdus Salam International Centre for Theoretical Physics". Below the header, there is a navigation menu on the left with links like "Library Home", "Catalogue", "Collections", "e-Resources", "Reference Links", "About the Library", and "Website Index". The main content area features a "Quick catalogue search" box with a search button. Below this, there are sections for "Catalogue" (Find books and journals), "Journal Titles" (Alphabetical list of journal titles), "Services" (eJournals Delivery Service, Book Donation Programme, Junior Associate Book Orders), and "e-Resources" (Web of Science, MathSciNet, ScienceDirect, SpringerLink, PROLA, JSTOR, DOAJ, more). There is also a "Spotlight On" section featuring a portrait of Darwin and the text "Darwin Year in the Library". A "News" section on the right lists recent updates like "New Books on Display" and "Royal Society Digital Journal Archive - Free Access". At the bottom, there is a footer with contact information: "str. costiera 11 - I-34014 Trieste, Italy - phone: +39 040 2240111 fax: +39 040 224163 -- © 2004 - www.ictp.it (since march 1994)" and technical details like "Powered by Plone Valid XHTML Valid CSS Section 508 WCAG".

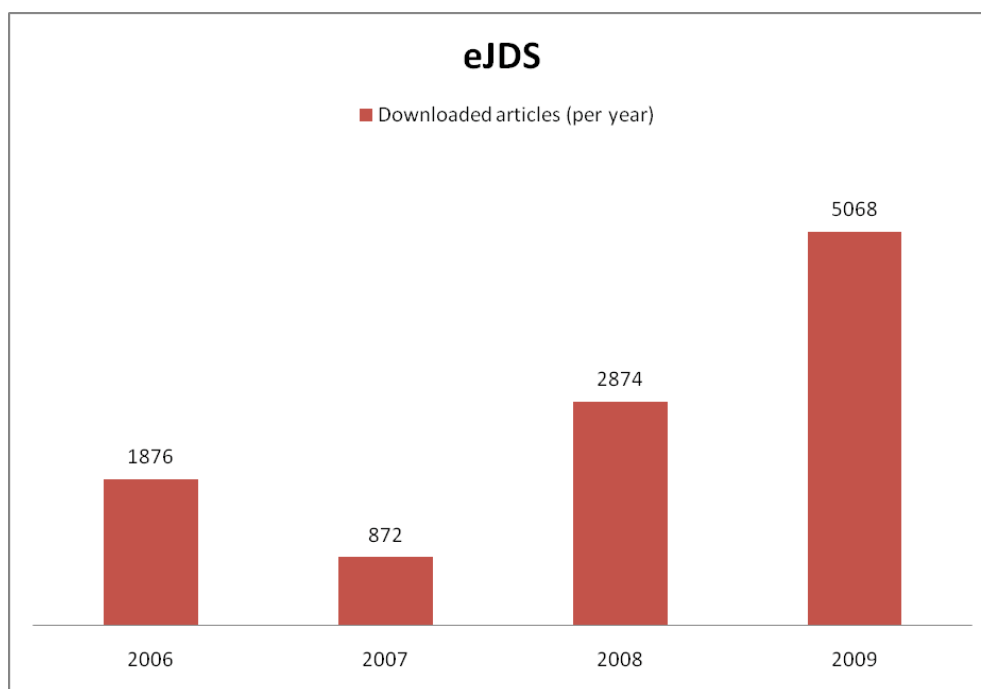
Digital Archives

The Integrated Library System (ILS) traffic volume jumped from 1,108M Mbytes to 11,564M Mbytes in one year. These figures illustrate the amount of content that was added to the digital archives, catalogued and made easily available through the Online Catalogue. The content, for the most part original, includes full-text documentation on scientific activities at ICTP, photos, clippings and streaming videos.

New boost to eJDS

The trend in 2009 confirms that the e-Journals Delivery Service (eJDS) is alive and well. The service was revived in the last two years thanks to new agreements with leading publishers and a promotional campaign among potential users. Usage has almost doubled in the last year, and increased by over 5 times since 2007.

ICTP's eJDS is a cost-free service for the distribution of scientific articles via e-mail to individual scientists in least developed or low-income countries. The service is run by the Marie Curie Library in collaboration with the SDU.



Marie Curie Library in Figures

| | |
|------------------|---------------------|
| Surface area | 3,200 square meters |
| Shelf space | 5,000 linear meters |
| Reading places | 70 |
| Public terminals | 12 |
| Printers | 2 |
| Photocopiers | 2 |

Statistics as at December 2009

Collections

Print collections

| | |
|---------------------------------|--------|
| Books | 67,500 |
| New acquisitions | 1,112 |
| Journals, current subscriptions | 341 |
| Total print titles | 1,280 |
| Theses | 1,500 |

Electronic and multimedia resources

| | |
|--------------------------|--------|
| Current e-journal titles | 4,000 |
| Electronic books | 1,600 |
| Pictures | 2,500 |
| Films and videos | 250 |
| Laser discs | 600 |
| Databases | 5 |
| Preprints | 10,000 |
| Press clippings | 435 |

Usage statistics

| | |
|--------------------------|--------|
| Circulation transactions | 10,236 |
|--------------------------|--------|

| | |
|------------------|--------|
| Registered users | 1,461 |
| Gate counter | 86,332 |

Library services

Inter-library loans and document delivery

| | |
|---------------------------------|-----|
| Items requested | 108 |
| Items issued to other libraries | 323 |

e-Journal Delivery Service

| | |
|-------------------|-------|
| Registered users | 3,584 |
| New registrations | 553 |
| Total downloads | 5,068 |

Junior associate book orders

| | |
|----------------|-----|
| Requestors | 102 |
| Books supplied | 551 |

Donations

| | |
|------------------------|-------|
| Recipient countries | 27 |
| Recipient institutions | 53 |
| Donated items | 1,164 |

SCIENCE DISSEMINATION UNIT

Introduction

The Science Dissemination Unit (SDU) of ICTP was created in late 2004 with the broad aim of disseminating scientific contents to more people than are able to visit the Centre, and to the public in general throughout the world, via any electronic media type. Website: <http://sdu.ictp.it>

SDU also collaborates with special requests, and advice, for issues related to Information and Communication Technologies (ICT) for the Director's Office at ICTP.

Research Activities

Integrated ICT (Information and Communication Technologies) is today necessary for the economic and social development of a country but also for its scientific and technological progress. SDU research activities are directed to develop innovative cost-effective ICT solutions for "Science for Development" and "Distance Learning" with special emphasis to support scientists working in developing countries. This research is done in collaboration with different groups at ICTP and beyond campus, and it has been reported in the international literature (see list below).

Training Activities

In 2009 the SDU organized a workshop on "Scientific Information in the Digital Age: Access and Dissemination" (smr2062), 12-16 October 2009.

*Participants of the
ICTP-SDU workshop.*



The aim of the workshop was not only to introduce the newest technologies in Open Access but also to give participants a hands-on experience on selected techniques. A better understanding on what Open Access is, and examples of what it offers to individual scientists and to scientific institutions in developing countries, was presented. It consisted of theoretical lectures, hands-on sessions and demos.

Following the ICTP mandate, 99% of the selected participants were new to ICTP and the majority came from developing countries. More than 150 applications for the workshop were received from all continents. About 45 of these, plus some old and young ICTP Associates, were selected by the organizers among the staff of the university libraries and computer centres, and physics and mathematics departments, which normally are the ones building Internet access and on-line services in their Universities and serve as focal points for their academic user community. A unique opportunity was given to participants coming from least developing countries such as Egypt, Nigeria, Zambia, South Africa, Brazil, Philippines, Bangladesh, Malaysia, Pakistan, India, Sri Lanka, Tanzania, Zimbabwe, Cuba, Madagascar, Iran, Lao, Thailand.

The whole workshop was recorded using the automated EyA system developed by the ICTP-SDU. Every participant received at the end of the workshop a Diploma of Attendance plus a free USB Pen Drive (8 GB) to copy all the recorded material. See <http://sdu.ictp.it/openaccess09/>

International Collaborations

- IEPM group at the Stanford Linear Accelerator Center (SLAC), USA
- INASP - International Network for the Availability of Scientific Publications, UK.
- eIFL.net - Electronic Information for Libraries Initiative.
- Statistical Physics Sector, Prof. G. Mussardo, SISSA, Italy.
- With many groups on the Internet working on ICT for Development.

Projects

Diploma Course On-line and Distance Learning

The SDU has developed a completely automated and non-intrusive system for the webcasting of physics and mathematics lectures given at the ICTP Diploma Course and during some ICTP conferences and workshops. The system is named EyA-“Enhance your Audience” and has been the winner of the 2007/2008 Innovation Award of the Regione Friuli Venezia Giulia in the non-profit category. Plans for 2009 continued to promote the use of the free openEyA version of the system in developing countries via www.openeya.org



World-wide interest on the ICTP Diploma Lectures on-line in the last months.

To date, there are more than 5,000 hours of recorded lectures from the five different ICTP Diploma Courses at the website



Starting in 2009, SDU also aims to spread out the use of free openEyA around Africa to support academic webcasting and e-learning programmes at universities and research centres. Preliminary tests with openEyA automated recordings are being carried out in collaboration with

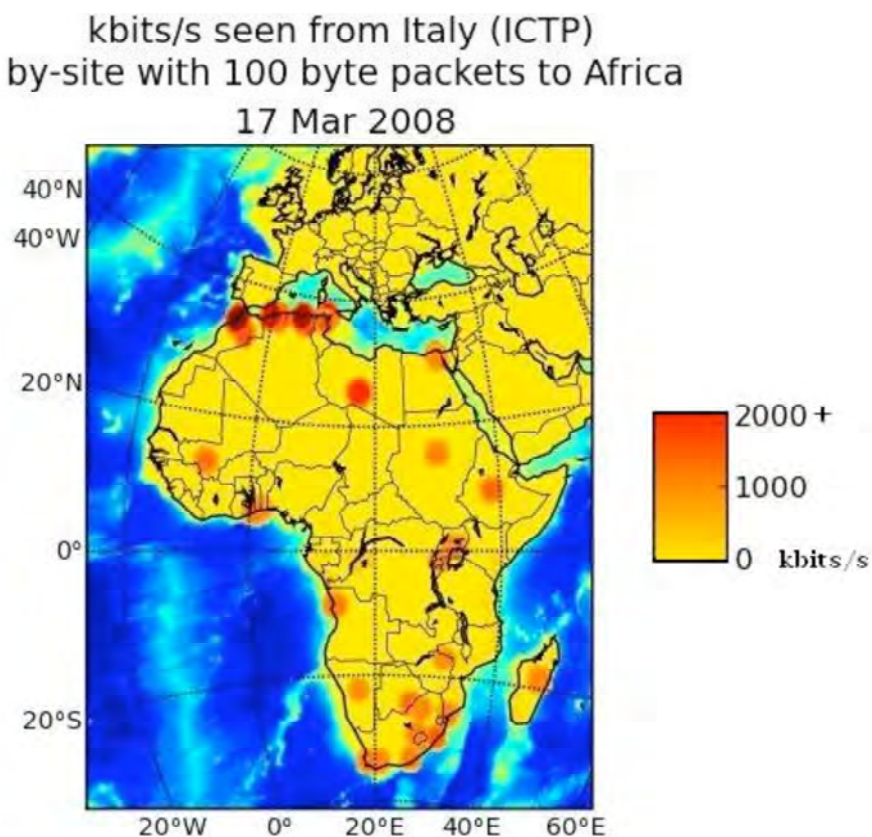
Dr Antoine Bagula's Group at Department of Computer Science, University of Cape Town, South Africa.

African Connectivity as Measured from ICTP: PingER

PingER (Ping End-to-end Reporting) is the name given to the Internet End-to-end Performance Measurement (IEPM) project to monitor end-to-end performance of Internet links, developed by the IEPM group at the Stanford Linear Accelerator Center (SLAC). Throughout 2009, the SDU has monitored sites in the African continent directly from ICTP premises.

Sites in Africa participating in the PingER project (from a frame of the African internet Weather video available on YouTube).

Most recently, the project is being extended to build an embedded PingER monitoring host (ePinger) based on an inexpensive embedded Linux platform. If successful one could consider using these in production reducing the costs, power drain (they draw about 5W of 120V DC power compared to typically over 100W for a desk side computer or 20W for a laptop) and space (6x6") assisting monitoring sites to be able to procure and support such monitoring hosts. ePinger could be very valuable for sites in Africa where cost, power utilization and to a lesser extent space may be crucial.



Embedded PingER device tested in Africa and handled by SDU.

Free Electronic Journals Delivery System (eJDS)

The SDU supervises the functioning of the pioneering free electronic Journals Delivery System (eJDS). The aim of eJDS is to facilitate access to current scientific literature for scientists at institutions in developing countries who cannot afford to download articles from the Internet specially due to insufficient bandwidth. After registering, scientists -residing in the approved

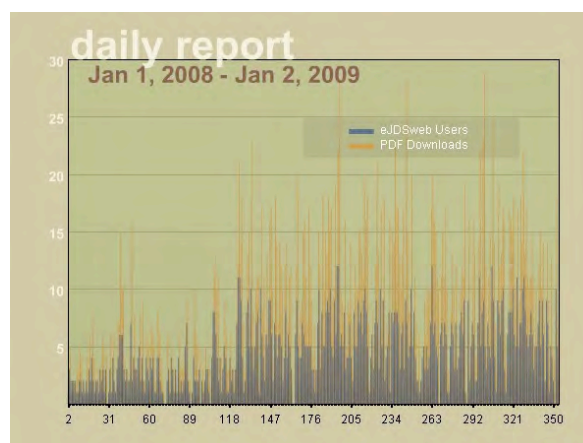
countries, can receive via an web-to-email gateway a number of articles per week. The project is carried out in collaboration with the ICTP Library (for the agreements with the Publishers or Societies and the users' subscriptions) and the Scientific Computing Section (for the eJournals server admin). Website: www.ejds.org

eJDS, based in low-cost open source ICT addresses these main issues of great concern in the scientific community at large:

1. The dissemination of scientific data and information which is necessary for the advancement of research and education in order to provide contents that contribute to the benefit and well-being of society and to promote and participate in international scientific and technological activities.
2. Integration of all new (web) and old (electronic mail) on-line services to facilitate the transfer of knowledge and exchange of scientific information via the use of today's ICT.
3. Electronic publishing for development, including Copyright issues, e-Libraries and the digital contents.

To give an idea of the number of electronic journals downloaded in PDF format via the web-to-email eJDS gateway by scientists within the African continent, it is interesting to note that the scientists in countries with very low Digital Access Index (DAI: from International Telecommunications Union) such as Algeria (DAI: 0.37), Cameroon (DAI: 0.16), Nigeria (DAI: 0.15), Kenya (DAI: 0.19), Ethiopia (DAI: 0.10) and many others countries below the threshold value of 0.4 make the largest use of eJDS for their research work.

Typical number of daily PDF articles downloaded in one year (clear) by eJDS users (dark).



Open Access at ICTP promoted by SDU

The African Physical Review eJournal

The SDU supervises the server of the ICTP African Physical Review -a free, on-line, peer-reviewed, international eJournal that publishes reviews, research articles, and brief communications in all branches of experimental and theoretical physics and related interdisciplinary fields. One of the objectives of this eJournal is to bridge the knowledge gap resulting from the inability of a large number of academic institutions in African countries to subscribe to leading physics periodicals. This is done in collaboration with Prof. K.T. Shah (ICTP) and ICTP's Printing and Publications Office. Website: www.aphysrev.org

"Difusion Cientifica y las Iniciativas de Acceso Abierto" - Free Book in Spanish

The SDU book on "Science Dissemination Using Open Access" was made available in Spanish, thanks to a translation provided by the Universidad de los Andes in Merida, Venezuela. The book explains the concept of open access and guides scientists on the numerous low-cost solutions available. It includes a compendium of open access literature to increase awareness of open publishing's potential. The book also aims to encourage decision makers in academia and research

centres to adopt institutional and regional open access journals and archives to make their own scientific results public and fully searchable on the Internet.

See <http://sdu.ictp.it/openaccess/book.html>



Staff

Consultants:

- E. Canessa, Chile
- C. Fonda, Italy
- M. Zennaro, Italy

Funding

- ICTP (principal contributor, 13K Euro during 2009)
- INASP-International Network for the Availability of Scientific Publications, UK (grant provided in 2008 and also used in 2009)

The SDU staff produced two papers and produced many conferences papers and public presentations (seminars, talks, posters, etc.) on the motivation, technologies and strategies adopted for SDU to disseminate and support science around the world.

INFORMATION AND COMMUNICATION TECHNOLOGY SECTION (ICTS)

The ICTP Information and Communication Technology Section (ICTS) provides informatic services for the ICTP community (scientific and administrative) and for the scientific activities of ICTP.

In addition to the computing support services it provides to ICTP's Trieste campus, the Centre's Information and Communication Technology Section (ICTS) participates in training activities that benefit developing countries. The section helps organize training activities, both in Trieste and abroad, in the areas of High Performance Computing (HPC) and Grid computing to help improve research infrastructure in Africa

During 2009, ICTS coordinated several activities in HPC, including an intensive, three-week workshop on the installation and maintenance of HPC equipment for computational physics. Of the 10 participants, eight were from Africa. Several of these participants applied their skills soon after, installing new HPC equipment for climate modelling donated by ICTP at Addis Ababa University, under the watchful eyes of a team from ICTP. A ceremony to officially commission the equipment was held that month, and was attended by representatives from the University, ICTP, the UN, and the Italian Embassy in Addis Ababa, as well as the Ethiopian Meteorological Agency and the Meteorological Society of Ethiopia.

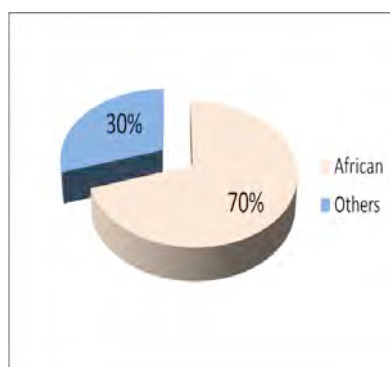
In July, ICTP met with representatives from several African countries at Addis Ababa University to discuss the creation of a master's programme in HPC for three African institutions. Meeting participants developed a joint curriculum, discussed the goals, and agreed on a target starting date of September 2010.

THE AFRICAN PHYSICAL REVIEW

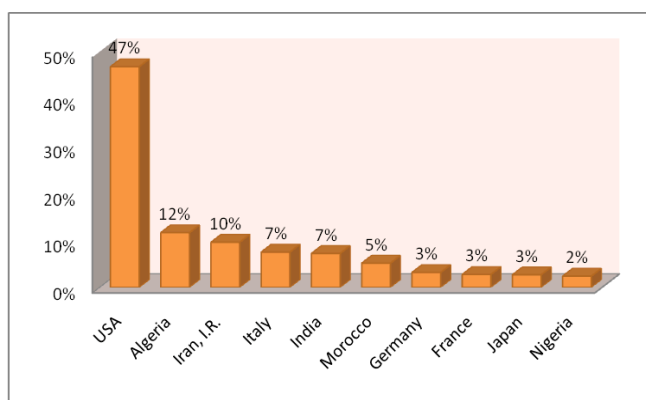
www.aphysrev.org

The African Physical Review (APR) is a free, on-line, peer reviewed, international journal that publishes reviews, research articles, and brief communications in all branches of experimental and theoretical physics with an emphasis on originality and excellence. It was created in 2007 to satisfy the demand of African scientists, many of whom were frequent visitors to the Abdus Salam International Centre for Theoretical Physics and who produce good quality publications, but were unable to find high quality journals in their home countries that met international standards. The quality of scientific material being published is overseen by an international editorial team consisting of eminent scientists, including a Nobel Laureate. One of the goals of the journal is to assist competent African scientists to become more proficient in writing scientific papers.

The African Physical Review, now an official organ of the African Physical Society, is widely listed by libraries and other eJournal listing organization around the world. Over 15,000 visits occurred to its website between September 2007 when its first issue appeared and February 2009, with a major portion of readers located in North America, followed by Asia and Europe. In its first three years of operation, *The African Physical Review* has published over 150 papers authored by more than 400 scientists from over 150 institutions worldwide with 70% African contribution. *The African Physical Review* continued to improve its organizational structure and its system's capabilities. The software system used has been recently upgraded to enact all new features, making the journal fully automatic, attractive and user friendly, keeping in mind various kinds of technical difficulties faced by many African scientists at their local systems. In October 2009, *The African Physical Review* was named as the official journal of the newly formed African Physical Society.



The African Physical Review *Authorship*.



Top 10 Country Readership of The African Physical Review

APPENDICES

SCIENTIFIC CALENDAR 2009

8-10 January

(Co-sponsored)

14th International Workshop on Computational Physics and Materials Science: Total Energy and Force Methods

Co-sponsors: International School for Advanced Studies (SISSA), INFN (Italian National Institute for the Physics of Matter) DEMOCRITOS National Simulation Center, International Center for Materials Research (ICMR), Psi-k Network, *Centre Européen de Calcul Atomique et Moléculaire* (CECAM)

Organizers: R. Gebauer, F. Mauri, D. Vanderbilt

26-30 January

Preparatory School to the Winter College on Optics in Environmental Science

Co-sponsors: Central European Initiative (CEI), European Optical Society (EOS), International Commission for Optics (ICO), Optical Society of America (OSA), Italian Society of Optics and Photonics, (SIOF), The International Society for Optical Engineering (SPIE)

Organizers: A. Consortini, R.P. Singh, S. Svanberg

Local Organizer: J. Niemela

2-13 February

Winter College on Optics in Environmental Science

Co-sponsors: Central European Initiative (CEI), European Optical Society (EOS), International Commission for Optics (ICO), Optical Society of America (OSA), The International Society for Optical Engineering (SPIE)

Organizers: A. Consortini, R.P. Singh, S. Svanberg.

Local Organizer: J. Niemela

16-27 February

PHYSWARE: A Collaborative Workshop on Low-cost Equipment and Appropriate Technologies that Promote Undergraduate Level, Hands-on Physics Education throughout the Developing World

Organizers: P. Jolly, P. Laws, E. Sassi, D. Zollman

Local Organizer: J. Niemela

16 February - 6 March

ICTP-ITU School on Wireless ICT Low Cost Solutions in Developing Countries: Best Practices followed by

2nd Awareness Workshop on Relevance of Low Cost Wireless ICT Solutions for Development

Co-sponsor: Telecommunication Development Bureau of the International Telecommunication Union (ITU/BDT)

Organizers: S.M. Radicella, R. Struzak

23-27 February

(Co-sponsored)

Joint ICTP/IAEA Workshop on Advanced Simulation and Modelling for Ion Beam Analysis

Co-sponsor: International Atomic Energy Agency (IAEA)

Organizers: N.P. Barradas, N. Dytlewski, C. Jeynes, M. Mayer

Local Organizer: C. Tuniz

2-13 March

Workshop on Theoretical Ecology and Global Change

Organizers: G.A. Canziani, G.A. De Leo, A.P. Dobson, M. Pascual

Local Organizer: F. Giorgi

16-20 March
(Co-sponsored)
Workshop on Topics in Quantum Turbulence
Organizers: L. Skrbek, W.F. Vinen
Local Organizers: J.J. Niemela, K.R. Sreenivasan

16-20 March
Joint ICTP/IAEA School on Novel Synchrotron Radiation Applications
Organizer: F. Mulhauser
Local Organizer: N. Binggeli

23-31 March
Spring School on Superstring Theory and Related Topics
Collaborations: Asia Pacific Center for Theoretical Physics (APCTP), Italian Institute for Nuclear Physics (INFN), International School for Advanced Studies (SISSA)
Organizers: J. de Boer, E. Gava, S. Kachru, K.S. Narain, S. Randjbar-Daemi

23 March - 9 April
Satellite Navigation Science and Technology for Africa
Organizers: P. Doherty, S.M. Radicella

20-24 April
Joint ICTP/IAEA Advanced Workshop on Development of Radiation Resistant Materials
Organizers: V. Inozemtsev, A. Zeman
Local Organizer: S. Scandolo

20-30 April
School on Astrophysical Turbulence and Dynamoes
Organizers: A. Shukurov, S. Sridhar, K. Subramanian
Local Organizer: K.R. Sreenivasan

20-30 April
Joint ICTP/IAEA Workshop on Atomic and Molecular Data for Fusion
Co-sponsor: International Atomic Energy Agency (IAEA)
Organizer: R.E.H. Clark
Local Organizers: J. Niemela, C. Tuniz

27 April - 8 May
Water Resources in Developing Countries: Planning and Management in a Climate Change Scenario
Co-sponsor: Kuwait Foundation for the Advancement of Sciences (KFAS)
Organizers: E. Coppola, S. Rauscher, S. Sorooshian

4-8 May
Conference on Research Frontiers in Ultra-Cold Atoms
Co-sponsor: MIT-Harvard Center for Ultracold Atoms (CUA)
Organizers: W. Ketterle, C.A.R. Sa de Melo, H. Stoof, S. Yip
Local Organizer: M. Kiselev

11-15 May
Joint ICTP/IAEA Training Workshop on Technology and Performance of Desalination Systems
Organizer: I. Khamis
Local Organizer: C. Tuniz

11-15 May
Joint ICTP/IAEA Advanced School on Dosimetry in Diagnostic Radiology and its Clinical Implementation
Co-sponsor: Radcal, RTI Electronics, PTW Freiburg GmbH, Unfors
Organizers: M. de Denaro, D. McLean, R. Padovani
Local Organizers: L. Bertocchi, C. Tuniz

11-29 May

Advanced School and Conference on Knot Theory and its Applications to Physics and Biology

Organizers: S. Jablan, L.H. Kauffman, S. Lambropoulou, J. Przytycki

Local organizer: Li Jiayu

18-23 May

Conference on Superconductor-Insulator Transitions

Organizers: M. Feigelman, M. Muller, Z. Ovadyahu, M. Sanquer

Local Organizer: V. Kravtsov

25-29 May

International Workshop: Quantum Chromodynamics from Colliders to Super-High Energy Cosmic Rays

Organizers: Y. Dokshitzer, M. Strikman, D. Treleani

1-5 June

Introduction to Optofluidics

Organizers: D. Cojoc, J. Niemela, S. Raghu

1 June - 5 June

(Co-sponsored)

Conference: From DNA-Inspired Physics to Physics-Inspired Biology

Co-sponsor: Wellcome Trust

Organizers: A.A. Kornyshev, W.K. Olson, V.A. Parsegian

Local Organizer: R. Gebauer

1-5 June

2nd Conference on Drug Development for the Third World: from Computational Molecular Biology to Experimental Approaches

Co-sponsors: International Centre for Science and High Technology (ICS-UNIDO), International Atomic Energy Agency (IAEA), International Centre for Genetic Engineering and Biotechnology (ICGEB), INFN DEMOCRITOS National Simulation Center.

In cooperation with ICS-UNIDO and INFN (Italian National Institute for the Physics of Matter) DEMOCRITOS National Simulation Center.

Organizers: W.G.J. Hol, E. Lattman, S. Miertus

Local Organizer: P. Carloni

3-19 June

Special Training Programme on Installing and Using High Performance Clusters

Organizer: C. Onime

8-12 June

Workshop: Eternal Inflation

Co-sponsor: Italian National Institute of Nuclear Physics (INFN)

Organizers: R. Bousso, A. Nicolis, A. Vilenkin

Local Organizers: P. Creminelli, M. Musso

8-12 June

School and Conference: From Biological Networks to Cellular Function: Evolution, Dynamics and Spatial Organization

Co-sponsor: GENetic NETworks: Emergence and Complexity (GENNETEC)

Organizers: M. Aguiar, W. Banzhaf, G. Bianconi, R. Dilao, S. Franz, F. Képès, M. Lässig, O. Martin, D.

Segré, M. Weigt

Local Organizer: M. Marsili

15-20 June

Co-sponsored School/Workshop on Integrable Systems and Scientific Computing

Co-sponsor: European Science Foundation (ESF) MISGAM (Methods of Integrable Systems, Geometry, Applied Mathematics) Programme, International School for Advanced Studies (SISSA)

Organizers: B. Dubrovin, T. Grava, C. Klein, A. Kuijlaars
Local Organizer: C.E. Chidume

15-26 June

Summer School on Particle Physics in the LHC Era

Organizers: B. Acharya, G. Dvali, G. Isidori, G. Senjanovic, A.Yu. Smirnov

22 June - 10 July

Summer School and Advanced Workshop on Trends and Developments in Linear Algebra

Organizers: R. Bhatia, J. Holbrook, S. Serra Capizzano

Local Organizer: R.T. Ramakrishnan

29 June - 2 July

Joint ICTP-INFN-SISSA Conference: Topical Issues in LHC Physics

Organizers: B. Acharya, M. Cobal, G. Kane, A. Romanino, A. Vacchi

6-24 July

Summer College on Nonequilibrium Physics from Classical to Quantum Low Dimensional Systems

Organizers: L. Cugliandolo, L. Glazman, G. Mussardo

Local Organizers: M. Kiselev, A. Silva

13-17 July

Workshop Towards Neutrino Technologies

Organizers: G. Fiorentini, J. Learned, M. Lindner, A.Yu. Smirnov

20-24 July

From Core to Crust: Towards an Integrated Vision of Earth's Interior

Local Organizers: A. Aoudia, J. Niemela, S. Scandolo

27 July - 7 August

2nd International Conference and Advanced School on Turbulent Mixing and Beyond

Organizers: S.I. Abarzhi, M.J. Andrews, S.I. Anisimov, H. Azechi, S. Gauthier, C.J. Keane, R. Rosner, A.L. Velikovich

Local Organizers: J.J. Niemela, K.R. Sreenivasan

27 July - 7 August

Targeted Training Activity: Predictability of Weather and Climate: Theory and Applications to Intraseasonal Variability

Organizers: V. Krishnamurthy, J. Shukla, D. Straus

Local Organizer: Jin Ho Yoo

10-14 August

Workshop on High Resolution Climate Modelling

Co-sponsors: Center for Ocean, Land and Atmosphere (COLA), National Aeronautics and Space Administration (NASA)

Organizers: In-Sik Kang, S. Schubert, J. Shukla

Local Organizer: F. Kucharski

10-28 August

Summer College on Plasma Physics

Organizers: R. Bingham, S.M. Mahajan, P.K. Shukla, L. Stenflo, Z. Yoshida

Local Organizer: J. Niemela

17-28 August

(Co-sponsored)

Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa

Co-sponsors: International Association of Seismology and Physics of the Earth's Interior (IASPEI), International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), National

Science Foundation (NSF), University Navstar Consortium (UNAVCO), United States Agency for International Development (USAID)

Organizers: A. Aoudia, E. Calais, C. Ebinger, M. Miller, T. Wright, G. Yirgu

31 August - 18 September

Advanced School and Workshop on p-adic Analysis and Applications

Organizers: Ha Huy Khoai, V. Berkovich

Local Organizer: L. Goettsche

7-25 September

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

Organizers: A. Induruwa, C. Kavka, U. Raich

Local Organizers: M.L. Crespo, M. Zennaro

21-25 September

Pseudochaos and Stable-Chaos in Statistical Mechanics and Quantum Physics

Organizers: OrgR. Artuso, A. Kolovsky, R. Livi, T. Prosen, A. Vulpiani

Local Organizer: M. Marsili

28 September - 2 October

Joint ICTP/IAEA School of Nuclear Knowledge Management

Co-sponsor: International Atomic Energy Agency (IAEA), IAEA Interregional Project, European Nuclear Education Network Association (ENEN)

Organizers: A. Kosilov, M. Saidy

Local Organizer: C. Tuniz

28 September - 10 October

Advanced School on Non-linear Dynamics and Earthquake Prediction

Organizers: V.I. Keilis-Borok, G.F. Panza, A.A. Soloviev

5-8 October

(Co-sponsored)

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

Organizers: A. Diongue-Niang, A. Kamga, D. Parker

Local Organizer: A. Tompkins

5-9 October

Joint ICTP/IAEA Workshop on Alternative Response Actions to Climate Change and Energy Options

Co-sponsor: International Atomic Energy Agency (IAEA)

Organizers: A.I. Jalal, D. Sharma, F.L. Toth

Local Organizer: A. Tompkins

12-16 October

Workshop on Scientific Information in the Digital Age: Access and Dissemination

Organizers: E. Canessa, C. Fonda, M. Zennaro

12-23 October

Joint ICTP/IAEA Workshop on Nuclear Power Plant Simulators for Education

Organizers: S. Bilbao y Leon, Seong-Deuk Jo

Local Organizer: Claudio Tuniz (ICTP)

19-24 October

(Co-sponsored)

Joint ICTP/FANAS Conference on Trends in Nanotribology

Co-sponsor: FANAS (Friction and Adhesion in Nanomechanical Systems) Programme of the European Science Foundation, University of Milan, SPECS Zurich GmbH

Organizers: O. Gulseren, N. Manini, A. Vanossi

Local Organizer: E. Tosatti

26-27 October

Structure and Dynamics of Hydrogen-Bonded Systems

Co-sponsor: Centre for Molecular Structure and Dynamics of the Science and Technology Facilities Council (STFC)

Organizers: J. Kohanoff, S. Koval, R. Senesi

Local Organizer: E. Tosatti

26-30 October

Joint ICTP/IAEA Advanced School on in-situ X-ray Fluorescence and Gamma Ray Spectrometry

Organizers: A. Markowicz, P. Martin, U. Sansone

Local Organizer: C. Tuniz

26 October - 7 November

School on Geothermics

Co-sponsor: ENEL (Italian National Agency for Electric Power) - Green Power, International Geothermal Association (IGA), University of Trieste, Unione Geotermica Italiana (UGI), Italian National Research Council (CNR)

Organizers: F. Batini, R. Bertani, D. Chandrasekharam, A. Manzella, M. Pipan

Local Organizer: G. Furlan

26 October - 20 November

Advanced Training Course on FPGA Design and VHDL for Hardware Simulation and Synthesis

Organizers: N. Abdallah, A. Cicuttin, A. Marchioro

Local Organizer: M.L. Crespo

2-10 November

Workshop and Conference on Biogeochemical Impacts of Climate and Land-Use Changes on Marine Ecosystems

Organizers: A. Bracco, L.T. Cang and J. Montoya

Local Organizer: E. Coppola

9-20 November

Joint ICTP/IAEA School on Physics and Technology of Fast Reactors Systems

Organizers: D. Abriola, C. Ganguly, G. Mank, A. Stanculescu

Local Organizer: C. Tuniz

23-27 November

Joint ICTP/IAEA Workshop on Effects of Mechanical Properties and Mechanisms Governing the Irradiation-induced Embrittlement of Pressure Vessel Steels

Organizers: K.-S. Kang, L. Kupca

Local Organizer: C. Tuniz

30 November - 4 December

Joint ICTP/IAEA Advanced Workshop on Earthquake Engineering for Nuclear Facilities

Co-sponsor: Kuwait Foundation for the Advancement of Sciences (KFAS)

Organizers: S. Morita, P. Sollogoub, G.F. Panza

30 November - 11 December

(Co-sponsored)

Advanced School in High Performance and GRID Computing—Concepts and Applications

Co-sponsor: Central European Initiative (CEI), INFN (Italian National Institute for the Physics of Matter) DEMOCRITOS National Simulation Center, Joint DEMOCRITOS/SISSA eLab, E4 Computer

Engineering S.p.A., Italian National Institute for Nuclear Physics (INFN), NVIDIA

Organizers: S. Cozzini, A. Kohlmeyer

HELD OUTSIDE TRIESTE

19-30 January

Latin American School on Computational Materials Science (Santiago, Chile)

Co-sponsor: Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), Programa Bicentenario de Ciencia y Tecnología

Collaborations: Universidad Andrés Bello (UNAB), Project Anillo ACT/24/2006 - Universidad de Chile "Computer Simulation Lab in Nanobio Systems", INFM - DEMOCRITOS National Simulation Center

Organizers: S. Cozzini, P. Giannozzi, E. Menendez-Proupin, W. Orellana, S. Scandolo

11-5 May

Joint RID/ICTP/IAEA Workshop on "Neutron probing for compositional and structural characterisation of materials and biological samples" (Delft, The Netherlands)

Organizers: E. Bruck, N. Ramamoorthy, A. van Well, A. Zeman

22-27 June

Latin American Tutorial in High Performance and GRID Computing (Antioquia, Colombia)

Co-sponsor: Universidad de Antioquia, Universidad Pontificia Bolivariana, Universidad de los Andes, Servicio Nacional de Meteorología e Hidrología (CPN/SENAMHI)

Organizers: H. Castro, S. Cozzini, A. Ospina, R.M. San Martin, J.I. Zuluaga

28 June - 5 July

5th Regional Meeting on String Theory (Crete, Greece)

Organizers: F. Ardalan, I. Bakas, E. Kiritsis, K.S. Narain, E. Rabinovici, S. Wadia

29 June - 4 July

Advanced Workshop on Spin and Charge Properties of Low Dimensional Systems (Sibiu, Romania)

Organizers: M.E. Flatté, M. Kiselev, M. Polini, I. Tifrea, G. Vignale

8-22 July

(Co-sponsored)

Workshop on How to Build a Habitable Planet and Conference on Operational Modeling of Oceanographic Coastal Zones (Cape Town, South Africa)

Organizers: Yi Chao, G. Philander, N. Pinardi, C. Roy

26 July - 7 August

(Co-sponsored)

Hands-On Research on Complex Systems School (São Paulo, Brazil)

Co-sponsor: Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Universidad Federal do ABC, U.S. Office of Naval Research, U.S. Army Research Office, Consortium of the Americas for Interdisciplinary Science

Organizers: E. Gueron, V. Kenkre, R. Koeberle, R. Roy, K. Showalter, H. Swinney

Local Organizer at ICTP: K.R. Sreenivasan

23-30 August

Workshop on Trends in Nanoscience: Theory, Experiment, Technology (Sibiu, Romania)

Co-sponsors: European Office of Aerospace Research & Development (EOARD), Autoritatea Nationala pentru Cercetare Stiintifica (ANCS), Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN-HH), Université Libre de Bruxelles (ULB)

Organizers: A. Aldea A. Safrany, S. Scandolo

6-21 October

International School and Conference on Foliations, Dynamical Systems, Singularity Theory and Perverse Sheaves (Samarkand, Uzbekistan)

Co-sponsor: Samarkand State University, National University of Uzbekistan, International Mathematical Union (IMU), Centre International de Mathématiques Pures et Appliquées (CIMPA)

Organizers: F. El Zein, S. Gusein-Zade, R. Langevin, D. Massey, A. Narmanov

Local Organizer: A. Soleev

Local Organizer at ICTP: Le Dung Trang

14-25 December

Regional School on Physics at the Nanoscale: Theoretical and Computational Aspects (Hanoi, Viet Nam)

Organizers: B.L. Altshuler, M.N. Kiselev, V.E. Kravtsov, N.V. Lien, S. Scandolo

Local Organizer: N.H. Quang

HOSTED ACTIVITIES

13-15 January

La musica in testa: tre giorni di scienza, musica e apprendimento

Organizers: SISSA and others

19 January - 6 February (19, 28 January; 6 February)

Progetto scuola: fare scienza con il computer

Organizers: G. Pastore, M. Peressi (Department of Physics of the University of Trieste)

3 February

TWAS Steering Committee Meeting

Organizers: M.H.A. Hassan

12-13 February

Workshop on Best Practices for Advisory and Honorific Roles of Science Academies

Organizers: InterAcademy Panel on International Issues (IAP), Council of Canadian Academies

9 March

Second Timing and Synchronization Workshop

Organizers: INFN (Italian National Institute for Nuclear Physics) - Laboratori Nazionali di Frascati,

Progetto SPARX in collaboration with Sincrotrone Trieste, Progetto Fermi.

Organizer: A. Gallo

10-13 March

Annual Meeting IRUVX (Infra Red Ultra Violet X ray)

Organizers: Sincrotrone Trieste - Consorzio IRUVX (F. Mazzolini)

30-31 March

TWOWS Executive Board Meeting

Organizer: Third World Organization for Women in Science (TWOWS)

30 March - 2 April

Course on RNA Structure and Function

Organizer: G. Tocchini-Valentini - International Centre for Genetic Engineering and Biotechnology (ICGEB)

2-3 April

XXII selezione nazionale del Parlamento Europeo dei Giovani 2009

Organizers: Liceo Ginnasio Statale "F. Petrarca" e Liceo Scientifico "G. Galilei", Trieste; contacts: P. Tarsia and R. Grill (Liceo Galilei).

17-18 April

International Congress on: "Heart Failure and Cardiomyopathies 2009: Controversial Issues"

Organizers: Fondazione Internazionale Menarini

27-30 April

Kick-off meeting for Egypt-USA project

Organizers: ICTP Earth System Physics section (A. Zakey)

9 May

Cerimonia di premiazione scuole partecipanti al concorso "Scienza in fiore, 2008-2009"

Organizer: Ms. A. Bernardi (Science Centre Immaginario Scientifico)

11-16 May

Seminario: a un passo dalla International Physics Olympiad (IPHO)

Organizer: G. Cavaggioni

21-23 May

5th International Workshop on "Radiation Safety at Synchrotron Light Sources"

Organizer: G. Tromba (*ELETTRA*)

19 June

Celebrations for Immaginario Scientifico's 10th Anniversary - IS10

Organizer: Immaginario Scientifico

27 July

Meeting of TWAS Officers

Organizers: The Academy of Sciences for the Developing World (TWAS)

28-29 August

IUPAP (International Union of Pure and Applied Physics) C13 Meeting

Organizer: S. Scandolo

31 August - 4 September

Summer School: When Humanities Meets Ecology: Historic Changes in Mediterranean and Black Sea Marine Biodiversity and Ecosystems since the Roman Period until Nowadays

Organizers: History of Marine Animal Populations (HMAP, R. Gertwagen); Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS, S. Libralato, D. Melaku Canu, C. Solidoro), Istituto Superiore per la Ricerca Ambientale (ISPRA, T. Fortibuoni, O. Giovanardi, S. Raicevich)

3-4 September

Meeting of FUND - European funded project, programme FP7, Science in Society

Organizer: International School for Advanced Studies SISSA - MEDIALAB (M. Prandini, P. Rodari)

7 September

TWOWS Selection Committee Meeting for postgraduate fellowships

Organizer: Third World Organization for Women in Science (TWOWS)

24-25 September

InterAcademy Medical Panel (IAMP) Executive Committee Meeting

Organizer: InterAcademy Medical Panel (IAMP)

5-6 October

First Summer School: "Dopaminergic Neurons and Parkinson's Disease"

Organizers: International School for Advanced Studies (SISSA, S. Gustincich), Consorzio per la Medicina Biomolecolare (CBM)

12-16 October

EIPAM/PEIC Joint EU-Australia Meeting 2009

Organizers: The Open University (N. Mason)

19-21 October

2nd International Meeting of Young Researchers on the Mechanics of Materials and Structures

Organizer: A. De Simone (International School for Advanced Studies SISSA)

24-25 October

Seminar on Innovative Ideas for Geothermal Exploitation

Organizer: International Centre for Science and High Technology (ICS - UNIDO)

29-30 October

TWAS Fellowship Selection Committee Meeting

Organizer: The Academy of Sciences for the Developing World (TWAS)

11-13 November

Scuola Archivistica d'Autunno

Organizer: International Institute for Archival Science of Trieste and Maribor (A. Monteduro)

16-20 November

ICAN4: Formalizing the Network, Engaging the Mediterranean

Organizer: D. Wright (Oregon State University), in cooperation with EEA Meeting H245

16-20 November

European Environment Agency EEA/ European Environment Information and Observation Network EIONET Workshop on Maritime and Coastal Information Systems

Organizer: C. Colliander (EEA), in cooperation with ICAN Meeting H206

23-26 November

Riunione rete nazionale italiana EURODESK e reti di comunicazione comunitaria

Organizer: Presidenza EURODESK Italia, Comune di Trieste

23-27 November

IAEA Regional Workshop on Essential Safety Assessment Knowledge: An Introduction to DSA and to PSA

Organizer: International Atomic Energy Agency (IAEA)

27 November

Giornata di studio su: rischio clinico nella gestione dei farmaci antitumorali in emato oncologia pediatrica. responsabilità – criticità – modelli organizzativi

Organizer: IRCCS Burlo Garofolo (G.A. Zanazzo), Trieste Traduzioni Congressi (A. Dessy)

14-16 December

Thermodynamically Unstable Proteins: Chance or Necessity?

Organizer: *ELETTRA* - Sincrotrone Trieste

16-18 December

Probing Magnetic Dynamics with Ultrashort Coherent X-ray Pulses and *ELETTRA* Users' Assembly

Organizer: *ELETTRA* - Sincrotrone Trieste

PUBLICATIONS

SCIENTIFIC PAPERS

HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS

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External Activities (through Office of External Activities):

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Published (1)

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PUBLICATIONS PREPRINTS AND INTERNAL REPORTS

In 2009, ICTP produced 106 preprints.

Explanatory Note

The names of scientists who participated in the research activities of ICTP in 2009 and submitted their articles for publication are indicated by country codes.

The country codes stand for the countries of origin, according to the following ICTP internal list:

| | | | |
|-----|------------|-----|--------------------|
| ALG | Algeria | NET | The Netherlands |
| BGD | Bangladesh | NIR | Nigeria |
| BRA | Brazil | PAK | Pakistan |
| BUL | Bulgaria | PRC | Rep. of the Congo |
| CHA | China | ROK | Republic of Korea |
| CHI | Chile | RSF | Russian Federation |
| CMR | Cameroon | SAF | South Africa |
| CUB | Cuba | SEN | Senegal |
| GEO | Georgia | SUD | Sudan |
| IND | India | TUN | Tunisia |
| IRA | Iran | UKD | United Kingdom |
| ITA | Italy | UKR | Ukraine |
| JPN | Japan | URU | Uruguay |
| MAG | Madagascar | UZB | Uzbekistan |
| MEX | Mexico | VTN | Viet Nam |
| MOR | Morocco | | |

HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS ⁽¹⁹⁾

| | | | |
|--|-----|--|--------------|
| Yee Ho-Ung | ROK | Fate of Z_N domain wall in hot holographic QCD | IC/2009/1 |
| Kanemura Shinya Tsumura Koji | JPN | A powerful tool for measuring Higgs boson associated lepton flavour violation | IC/2009/2 |
| Berrada K. El Baz M. Hassouni Y. | MOR | Entanglement measure of bipartite system states | IC/IR/2009/2 |
| Dafounansou O. | CMR | BRST symmetry on the universal bundle | IC/IR/2009/5 |
| Asakawa Eri Harada Daisuke Kanemura Shinya Okada Yasuhiro Tsumura Koji | JPN | Higgs boson pair production at the photon linear collider in the two Higgs doublet model | IC/2009/6 |

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| Aoki Mayumi Kanemura Shinya Tsumura Koji Yagyū Kei | JPN | Models of Yukawa interaction in the two Higgs doublet model, and their collider phenomenology | IC/2009/7 |
| Budinich Paolo | ITA | From pure spinors to quantum physics and to some classical field equations like Maxwell's and gravitational | IC/2009/11 |
| Grigoryan Hovhannes R. Lee T.-S.H. Yee Ho-Ung | ROK | Electromagnetic nucleon-to-delta transition in holographic QCD | IC/2009/12 |
| Torabian Mahdi Yee Ho-Ung | IRA ROK | Holographic nonlinear hydrodynamics from AdS/CFT with multiple/non-Abelian symmetries | IC/2009/16 |
| Yee Ho-Ung | ROK | Parity asymmetric boost invariant plasma in AdS/CFT correspondence | IC/2009/29 |
| Verma Murli Manohar | IND | Avoidance of singularity and global non-conservation of energy in general relativity | IC/2009/41 |
| Verma Murli Manohar | IND | The interacting and non-constant cosmological constant | IC/2009/63 |
| Yee Ho-Ung | ROK | Holographic chiral magnetic conductivity | IC/2009/66 |
| Fukuyama Takeshi Sugiyama Hiroaki Tsumura Koji | JPN | Constraints from muon $g-2$ and LFV processes in the Higgs triplet model | IC/2009/76 |
| Tsumura Koji Velasco-Sevilla L.E. | JPN MEX | Phenomenology of flavon at the LHC | IC/2009/78 |
| Sahoo Bindusar Yee Ho-Ung | IND ROK | Holographic chiral shear waves from anomaly | IC/2009/79 |
| An Haipeng Chen Shao-Long Mohapatra Rabindra N. Zhang Yue | CHA | Leptogenesis as a common origin for matter and dark matter | IC/2009/90 |
| Berrada K. El Baz M. Hassouni Y. | MOR | Generalized spin coherent states: Construction and some physical properties | IC/2009/100 |
| Berrada K. El Baz M. Hassouni Y. Eleuch H. | MOR | Negativity of two-qubit system through spin coherent states | IC/2009/101 |

CONDENSED MATTER AND STATISTICAL PHYSICS ⁽²²⁾

| | | | |
|---|-----|--|--------------|
| Kitio Kwuimy C.A. Nana B. Wofo P. | CMR | Bifurcations and chaos in a modified self-sustained macro electromechanical system | IC/IR/2009/1 |
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| Adebayo Gboyega A. Liang Yunfeng Miranda Caetano R. Scandolo Sandro | NIR BRA ITA | Infrared absorption of MgO at high pressures and temperatures: A molecular dynamic study | IC/2009/3 |
| Adebayo G.A. Anusionwu B.C. Njah A.N. Adeniran O.J. Mathew B. Sunmonu R.S. | NIR | Collision frequency of Lennard-Jones fluids at high densities by equilibrium molecular dynamics simulation | IC/2009/4 |
| Bogolubov, Jr. N.N. Prykarpatsky A.K. Taneri U. Prykarpatsky Y.A. | RSF | The electromagnetic Dirac-Fock-Podolsky problem and symplectic properties of the Maxwell and Yang-Mills type dynamical systems | IC/2009/5 |
| Bogolubov, Jr. N.N. Prykarpatsky A.K. Taneri U. | RSF | The relativistic electrodynamics least action principles revisited: New charged point particle and hadronic string models analysis. Part 3 | IC/2009/27 |
| Kale S.N. Mona J. Ganesan V. Choudhary R.J. Phase D.M. | IND | Substrate dependent morphologies of self-assembled nanocrystalline manganite films: An atomic force microscopy study | IC/2009/30 |
| Tabi Conrad Bertrand Mohamadou Alidou Kofané Timoléon Crépin | CMR | Formation of wave packets in the Peyrard-Bishop model with solvent interaction | IC/2009/31 |
| Tabi Conrad Bertrand Mohamadou Alidou Kofané Timoléon Crépin | CMR | Modulational instability of charge transport in the Peyrard-Bishop-Holstein model | IC/2009/33 |
| Tabi Conrad Bertrand Mohamadou Alidou Kofané Timoléon Crépin | CMR | Discrete instability in the DNA double helix | IC/2009/34 |
| Haque A.K.F. Uddin M. Alfaz Shahjahan M. Talukder M.R. Abdullah M.N.A. Basak A.K. | BGD BGD | Electron impact L- and M-shell ionization of atoms at relativistic energies | IC/2009/36 |
| Rahman Md. Mominur Huda Ain-ul Aziz Md. Abdul Choudhuri Nasreen Ahmed Mesbahuddin Mookerjee Abhijit | BGD | Energetic justification of accretion-evaporation based coupled continuum equations modeling surface growth | IC/2009/38 |
| Kitio Kwiimy C.A. Woafó P. | CMR | Modelling and dynamics of a self-sustained electrostatic micro electro mechanical system | IC/2009/39 |
| Kitio Kwiimy C.A. Woafó P. | CMR | Horseshoes chaos and stability of a delayed van der Pol-Duffing oscillator under a bounded double well potential | IC/2009/40 |

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| Daniel Muthiah Sabareesan P. | IND | Spin-transfer induced ultrafast precessional switching enhanced by interface anisotropy in a ferromagnetic nanopillar | IC/2009/46 |
| Haque A.K.F. Talukder M.R. Shahjahan M. Uddin M.A. Basak A.K. | BGD | An empirical formula for inner-shell ionization of atoms | IC/2009/50 |
| Djeraba Aicha Senouci Khaled Zekri Nouredine | ALG | Two dimensional delocalization with correlated disorder | IC/2009/53 |
| Widatallah Hisham M. | SUD | Structural and magnetic characterization of Ti-substituted $\text{Li}_{0.5}\text{Fe}_{2.5}\text{O}_4$ prepared using hydrothermal and solid-state routes | IC/2009/54 |
| Koroutchev K. Korutcheva E. | BUL BUL | Rare segments in temporal signals and video recordings | IC/2009/56 |
| March N.H. | UKD | Partial differential equation for the idempotent Dirac density matrix characterized solely by the exact non-relativistic ground-state electron density for spherical atomic ions | IC/2009/60 |
| Widatallah H.M. Al-Harathi S.H. Johnson C. Al-Shahumi T.H. Al-Omari I.A. Al-Rawas A.D. Gismelseed A.M. Brown D.E. Wynter C.I. | SUD | Synthesis, XRD, ^{151}Eu Mössbauer and XPS studies of nanocrystalline EuCrO_3 formed by mechanical alloying and subsequent sintering | IC/2009/61 |
| Kale S.N. Kitture Rohini Koppikar Soumya J. Kaul-Ghanekar Ruchika Patil S.I. | IND | Role of ZnO bulk and nanopowders in photocatalytic decolorisation of textile industrial dyes | IC/2009/72 |
| Bogolubov, Jr. Nikolai N. Prykarpatsky Yarema A. Ghazaryan Anna A. | RSF | The Bogolubov representation of the polaron model and its completely integrable RPA-approximation. Part 1 | IC/2009/94 |

MATHEMATICS ⁽³⁹⁾

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| Wang Meng | PRC | The asymptotic behavior of Chern-Simons Higgs model on a compact Riemann surface with boundary | IC/2009/8 |
| Ganikhodzhaev R.N. Rozikov U.A. | UZB | Quadratic stochastic operators: Results and open problems | IC/2009/10 |
| Rozikov Utkir A. Tian Jianjun Paul | UZB | Evolution algebras generated by Gibbs measures | IC/2009/13 |

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| Tran Van Tan | VTN | A degeneracy theorem for meromorphic mappings with few hyperplanes and low truncation level of multiplicities | IC/2009/15 |
| Rasulov Tulkin H. | UZB | Asymptotics for the number of negative eigenvalues of a model operator related to a system of three-particles on lattices | IC/2009/17 |
| Alves José F. Dias Carla L. Luzzatto Stefano | ITA | Geometry of expanding absolutely continuous invariant measures and the liftability problem | IC/2009/20 |
| Rozikov U.A. Nazir S. | UZB | Separable quadratic stochastic operators | IC/2009/21 |
| Groisman J. | URU | Expansive and fixed point free homeomorphisms of the plane | IC/2009/23 |
| Tran Van Tan Vu Van Truong | VTN | A general form of the second main theorem for hypersurfaces | IC/2009/24 |
| Wang Yue | CHA | Gradient estimates and Harnack inequalities for the diffusion equation on Riemannian manifolds | IC/2009/25 |
| Jiménez Juan Carlos | CUB | Local linearization methods for the numerical integration of ordinary differential equations: An overview | IC/2009/35 |
| Pham Tien Son | VTN | Invariance of the global monodromies in families of nondegenerate polynomials in two variables | IC/2009/45 |
| Khimshiashvili G. Siersma D. | GEO NET | Cyclic configurations of planar multiple penduli | IC/2009/47 |
| Kumar Shiv Datt Behara Srinivas | IND | G-associated ideals with flat base change of rings and short exact sequences | IC/2009/48 |
| Kumar Shiv Datt | IND | Analogue of Eakin-Sathaye theorem over Rees algebra | IC/2009/49 |
| Pham Tien Son | VTN | The Lojasiewicz exponent of a C^1 -subanalytic mapping at an isolated zero | IC/2009/52 |
| Leadi Liamidi Yechoui Akila | ALG | Principal eigenvalue in an unbounded domain with indefinite potential | IC/2009/55 |
| Guo Cuihua | CHA | Global existence of solutions for a fourth-order nonlinear Schrödinger equation in $n+1$ dimensions | IC/2009/57 |
| Ayupov Sh.A. Abdullaev R.Z. Kudaybergenov K.K. | UZB | On a certain class of operator algebras and their derivations | IC/2009/58 |
| Ayupov Sh.A. Kudaybergenov K.K. | UZB | Additive derivations on algebras of measurable operators | IC/2009/59 |
| Ayadi Adlene Marzougui Habib N'Dao Yahya | TUN | On the dynamic of Abelian groups of affine maps on C^n and R^n | IC/2009/62 |
| Boumazgour Mohamed | MOR | Drazin invertibility of upper triangular operator matrices | IC/2009/64 |

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| Gateva-Ivanova Tatiana Cameron Peter | BUL | Multipermutation solutions of the Yang-Baxter equation | IC/2009/67 |
| Elazzouzi Abdelhai | MOR | Approximation and almost periodicity for partial functional differential equations with delay | IC/2009/68 |
| Bounkhel Messaoud | | Implicit differential inclusions in reflexive smooth Banach spaces | IC/2009/69 |
| Bounkhel M. Al-Yusof R. | | First and second order convex sweeping processes in reflexive smooth Banach spaces | IC/2009/70 |
| Bounkhel M. Al-Senan B. | | General existence results for nonconvex third order differential inclusions | IC/2009/71 |
| Kamran Tayyab | PAK | Fixed point theorems for weakly contractive mappings on a metric space endowed with a graph | IC/2009/73 |
| Dethloff Gerd Tran Van Tan Do Duc Thai | VTN | An extension of the Cartan-Nochka second main theorem for hypersurfaces | IC/2009/80 |
| Li Jiayu Zhu Xiangrong | CHA CHA | Small energy compactness for approximation harmonic mappings | IC/2009/81 |
| Li Jiayu Zhu Xiangrong | CHA CHA | Existence of 2D skyrmions | IC/2009/82 |
| Li Jiayu Zhu Xiangrong | CHA CHA | Energy identity for the maps from a surface with tension field bounded in L^p | IC/2009/83 |
| Enioluwafe Michael | NIR | A vector matrix approach of counting cyclic quotients of some Abelian p-groups | IC/2009/85 |
| Le Hung Son Le Cuong Nguyen Thanh Van | VTN VTN | Some remarks on the singularities of functions taking value in an algebra | IC/2009/86 |
| Ly Idrissa | SEN | On a volume constrained for the first eigenvalue of the p-Laplacian operator | IC/2009/87 |
| Dinar Yassir Ibrahim | SUD | Remarks on bihamiltonian geometry and classical W-algebras | IC/2009/88 |
| Hazrat R. | IRA | Iterated Leavitt path algebras | IC/2009/89 |
| Golenia Jolanta Jolanta Bogolubov, Jr. Nikolai N. Popowicz Ziemowit Pavlov Maxim V. Prykarpatsky Anatoliy K. | RSF | A new Riemann type hydrodynamical hierarchy and its integrability analysis | IC/2009/95 |
| Wang Meng | PRC | The equation $\Delta u + \nabla \phi \cdot \nabla u = 8\pi c(1 - e^u)$ on a Riemann surface | IC/2009/99 |

EARTH SYSTEM PHYSICS AND STRUCTURE AND NONLINEAR DYNAMICS OF THE EARTH ⁽¹³⁾

| | | | |
|--|-------------------|--|--------------|
| Romashkova L. Peresan A. Nekrasova A. | RSF ITA RSF | Analysis of earthquake catalogues for CSEP Testing Region Italy | IC/IR/2009/6 |
| Frezzotti Maria Luce Peccerillo Angelo Panza Giuliano | | Carbonate metasomatism and CO ₂ lithosphere- asthenosphere degassing beneath the Western Mediterranean: An integrated model arising from petrological and geophysical data | IC/2009/9 |
| Fang Lihua Wu Jianping Ding Zhifeng Panza G.F. | ITA | High resolution Rayleigh wave group velocity tomography in North-China from ambient seismic noise | IC/2009/14 |
| Panza Giuliano F. Peresan Antonella Zuccolo Elisa | ITA ITA | Climatic modulation of seismicity in the Alpine- Himalayan mountain range | IC/2009/19 |
| Panza Giuliano Doglioni Carlo Levshin Anatoli | ITA | Asymmetric ocean basins | IC/2009/22 |
| Achyuthan H. Flora O. Braida M. Shankar Navin Stenni B. | IND | Radiocarbon ages of pedogenic calcic nodules formed within vertisols, Coimbatore Region, Tamil Nadu, India | IC/2009/28 |
| De Nisco Gerardo Nunziata Concettina Panza Giuliano F. | ITA | Magma reservoirs at Somma-Vesuvio as seen with non linear joint inversion of local and regional surface waves tomography | IC/2009/51 |
| Tokam Alain-Pierre K. Tabod Charles T. Nyblade Andrew A. Juliá Jordi Wiens Douglas A. Pasyanos Michael E. | CMR | Structure of the crust beneath Cameroon, West Africa, from the joint inversion of Rayleigh wave group velocities and receiver functions | IC/2009/74 |
| Razafindrakoto Hoby N.T. Rambolamanana Gérard Panza Giuliano F. | MAG MAG ITA | Seismic hazard evaluation for major cities in Madagascar | IC/2009/75 |
| Basharin D.V. | UKR | Variability of the surface meteorological fields over Eurasia for the recent 30 years | IC/2009/77 |
| Gorshkov A.I. Soloviev A.A. Jiménez M.J. García-Fernández M. Panza G.F. | RSF RSF ITA | Recognition of earthquake-prone areas ($M \geq 5.0$) in the Iberian Peninsula | IC/2009/91 |
| Wang Guoxin Jiaping Shi Panza Giuliano F. | ITA | Earthquake ground motion from the Wenchuan earthquake and its simulation | IC/2009/92 |

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| Browne Nana Ama Kum Abiodun Babatunde Joseph Tadross Mark Hewitson Bruce | SAF | Simulation of synoptic scale circulation features over Southern Africa using GCMS | IC/2009/93 |
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APPLIED PHYSICS ⁽⁶⁾

| | | | |
|---|-----|---|--------------|
| Mellit A. Massi Pavan A. | ALG | Artificial neural network based prediction of 20kWp grid-connected photovoltaic plant at Trieste (Italy) | IC/IR/2009/3 |
| Irshad Afshan Qamar Shahid | PAK | Velocity selection for ultra-cold atoms using bimodal mazer cavity | IC/2009/26 |
| Khaw M.K. Mohd-Yasin F. Reaz M.B.I. | BGD | ISO 15693-compatible high frequency passive RFID transponder with mixed-signal ESD protection circuit | IC/2009/37 |
| Mohd-Yasin F. Teh Y.K. Choong F. Reaz M.B.I. | BGD | Two CMOS BGR using CM and DTMOST techniques | IC/2009/42 |
| Mohd-Yasin F. Tye K.F. Reaz M.B.I. | BGD | Signal processing circuitry for CMOS-based SAW gas sensors with low power and area | IC/2009/43 |
| Mohd-Yasin F. Yap M.T. Reaz M.B.I. | BGD | CMOS instrumentation amplifier with offset cancellation circuitry and high PSRR for low power application | IC/2009/44 |
| Datta P.K. Cinquegrana P. Nikolov Ivaylo P. Sigalotto P. Demidovich A. Danailov M.B. | IND | Development of mode-locked femtosecond erbium doped fiber laser and its second harmonic generation | IC/2009/65 |

BIOSCIENCES ⁽⁵⁾

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|--|-----|--|------------|
| Jheeta K.S. | IND | Thermo-luminescence glow curve analysis and photoluminescence response of Al ₂ O ₃ irradiated with 100 MeV Ti ions | IC/2009/32 |
| Olajuyigbe Folasade M. Geremia Silvano | NIR | Characteristic ligand-induced crystal forms of HIV-1 protease complexes: A novel discovery of X-ray crystallography | IC/2009/84 |
| Falc3n Dieguez Jos3 E. Rodi Pablo Lores Guevara Manuel A. Gennaro Ana Maria | CUB | Spin label studies of the hemoglobin-membrane interaction during sickle hemoglobin polymerization | IC/2009/96 |

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| Kenfack Jiotsa A. Fotsa-Ngaffo F. | CMR CMR | Simplified model for the population dynamics involved in a malaria crisis | IC/2009/97 |
| Motchongom-Tingue M. Kenfack Jiotsa A. Tsobgni-Fozap D.C. Kofané T.C. | CMR | Dry friction: Motions—map and characterization | IC/2009/98 |

SCIENCE DISSEMINATION UNIT ⁽¹⁾

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| Canessa Enrique Fonda Carlo Zennaro Marco | CHI ITA ITA | One year of ICTP Diploma Courses on-line using the automated EyA recording system | IC/2009/18 |
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ICTP STATISTICS 2009
LIST OF FINANCIAL CONTRIBUTORS

Mandatory contributions are received from:

Italian Government
International Atomic Energy Agency (IAEA)
United Nations Educational, Scientific and Cultural Organization (UNESCO)

Voluntary contributions are received from:

EUROPEAN COMMISSION through:

Central European Initiative, Italy
Danish Meteorological Institute, Denmark
Ecole Polytechnique, Palaiseau, France
Fraunhofer-Gesellschaft, Munich, Germany
Met Office, Exeter, UK
Natural Environmental Research Council, Swindon, UK
Pildo Laboratories, Barcelona, SP
Swedish Institute of Computer Science, Kista, Sweden
University of Geneva, Switzerland
University of Warwick, Coventry, UK

EUROPEAN SCIENCE FOUNDATION (ESF)

FRANCE:

Commissariat à l'Énergie Atomique (CEA)
IEEA Courbevoie

GALILEO JOINT UNDERTAKING (through the France Développement Conseil, Vincennes, France)

GERMANY - Physikalisch-Technische Werkstätten, Freiburg

INTERNATIONAL ASSOCIATION OF SEISMOLOGY AND PHYSICS OF THE EARTH INTERIOR
(IASPEI), c/o Dipartimento di Scienze della Terra, Università di Trieste

INTERNATIONAL ASSOCIATION OF VOLCANOLOGY AND CHEMISTRY OF THE EARTH
INTERIOR (IAVCEI), c/o Institute of Earth Sciences "Jaume Almera", Barcelona, Spain

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

INTERNATIONAL CENTRE FOR GENETIC ENGINEERING AND BIOTECHNOLOGY (ICGEB)

INTERNATIONAL GEOTHERMAL ASSOCIATION

INTERNATIONAL MATHEMATICAL UNION (IMU)

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS (IUPAP)

IRAN - Ministry of Science, Research and Technology

ITALY:

Central European Initiative (CEI)
Centro di Ecologia Teorica ed Applicata (CETA)
Centro Europeo Mediterraneo per i Cambiamenti Climatici (CMCC)
CNR/Istituto Nazionale per la Fisica della Materia (INFN)
CNR/Istituto di Scienza dell'Atmosfera e del Clima (ISAC)
CNR/Istituto per lo Studio dei Materiali Nanostrutturati (ISMN)
CNR/Istituto di Scienze e Tecnologie dell' Informazione (ISTI)
Consorzio Venezia Nuova
Emerging Nations Science Foundation, c/o ICTP
Ente Nazionale per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA)
Eurotech S.p.A.
E4 Computer Engineering S.p.A.
Gruppo Illiria S.p.A.
IBM Italia S.p.A.
Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Trieste (INAF/OAT)
Istituto Nazionale di Fisica Nucleare (INFN)
Istituto Nazionale di Geofisica e Vulcanologia (INGV)

Istituto Nazionale di Oceanografia e Geofisica Applicata (OGS)
Istituto Nazionale di Ricerca Metrologica (INRIM)
Regione Autonoma Friuli Venezia Giulia
Scuola Internazionale Superiore di Studi Avanzati (SISSA)
Sincrotrone Trieste ScpA
Spring Firm S.r.l.
Stazione Zoologica Anton Dohrn
SWG S.r.l.
Università degli Studi di Bologna
Università degli Studi di Firenze
Università degli Studi di Milano
Università degli Studi di Trieste
KOREA - Asian Pacific Centre for Theoretical Physics (APCTP)
NORWAY - Research Council of Norway, through the University of Oslo
SWEDEN:
RTI Electronics AB, Mölndal
Unfors Instruments AB, Billdal
SWITZERLAND:
Centre Européen de Calcul Atomique et Moléculaire (CECAM)
ICTP Swiss Friends
Specs-Zurich GmbH
THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD (TWAS)
UK:
Photron Ltd.
Psi-k, Daresbury Laboratory
Science & Technology Facilities Council, Rutherford Appleton Laboratory
The Wellcome Trust Limited, c/o Imperial College, London
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)
USA:
American Agencies and Institutions (through Dr. S. Abarzhi)
Banco Interamericano de Desarrollo (through ENEA, Italy)
Boston College Trustee
Center for Ocean-Land-Atmosphere Studies (COLA)
European Office of Aerospace Research and Development
International Centre for Materials Research (ICMR)
International Institute for Complex Adaptive Matter (I2CAM)
Massachusetts Institute of Technology (MIT)
Optical Society of America (OSA)
Radcal Corporation
UNAVCO Inc.
WORLD METEOROLOGICAL ORGANIZATION (WMO)

DONATION:
Professor C. Vafa (2008 Dirac Prize)

ICTP STATISTICS 2009

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|-----------------------------------|--|-------------------|---|---|--|-----------------|--------------------|
| 1. RESEARCH AND PROGRAMMES | | | | | | | |
| RESEARCH ACTIVITIES | | | | | | | |
| | Applied Physics (AP) | 01/01/09 31/12/09 | Developed Developing LDCs TOTAL | 13 11 2 26 | 9.34 3.92 0.53 13.79 | | |
| | Condensed Matter and Statistical Physics (CMSP) | 01/01/09 31/12/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 19 111 86 3 4 223 | 20.65 140.68 128.23 2.56 2.99 295.11 | | |
| | Earth System Physics (ESP) | 01/01/09 31/12/09 | CIS Developed Developing LDCs Transition Countries TOTAL CMSP | 18 55 29 3 12 117 | 23.46 92.08 76.90 8.15 12.53 213.12 | | |
| | High Energy, Cosmology and Astroparticle Physics (HECAP) | 01/01/09 31/12/09 | CIS Developed Developing Transition Countries TOTAL | 10 74 54 3 141 | 8.15 161.29 66.41 1.05 236.91 | | |
| | Mathematics (Math) | 01/01/09 31/12/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 10 27 72 7 5 121 | 13.35 11.21 166.68 20.09 3.72 215.04 | | |
| | Multisciplinary Laboratory (Mlab) | 01/01/09 31/12/09 | CIS Developed Developing TOTAL | 5 8 6 19 | 3.09 14.1 7.36 24.55 | | |
| | Miscellaneous Research | 01/01/09 31/12/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 13 32 101 7 3 156 | 12.3 20.22 101.76 10.98 1.98 147.24 | | |
| | ICTP Elettra Users Programme | 01/01/09 31/12/09 | CIS Developing TOTAL | 1 34 35 | 0.46 13.31 13.77 | | |
| | Sandwich Training Educational Programme (STEP) | 01/01/09 31/12/09 | CIS Developing LDCs Transition Countries TOTAL | 6 31 8 1 46 | 14.45 103.35 38.47 0.85 157.12 | | |
| | Training and Research in Italian Laboratories (TRIL) | 01/01/09 31/12/09 | CIS Developed | 2 8 | 11.87 61.91 | | |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS** | N. OF LECTURERS | N. OF APPLICATIONS |
|-----------------------------|--------------------------|----------|----------|--------------------------------------|----------------|-----------------------|-----------------|--------------------|
| | | | | Developing | 88 | 395.04 | | |
| | | | | LDCs | 13 | 66.44 | | |
| | | | | Transition Countries | 4 | 36.95 | | |
| | | | | TOTAL | 115 | 572.21 | | 197 |
| | | | | Total by region: | | | | |
| | | | | CIS | 84 | 107.78 | | |
| | | | | Developed | 328 | 510.83 | | |
| | | | | Developing | 512 | 1062.96 | | |
| | | | | LDCs | 43 | 147.22 | | |
| | | | | Transition Countries | 32 | 60.07 | | |
| | | | | TOTAL RESEARCH AND PROGRAMMES | 999 | 1888.86 | | 197 |
| 2. DIPLOMA PROGRAMME | | | | | | | | |
| 2004 | Condensed Matter Physics | 01/01/09 | 31/08/09 | Developing | 7 | 38.10 | | |
| | | | | LDCs | 4 | 31.96 | | |
| | | | | TOTAL | 11 | 70.06 | | 69 |
| 2108 | Condensed Matter Physics | 01/09/09 | 31/12/09 | CIS | 1 | 4.01 | | |
| | | | | Developing | 5 | 20.05 | | |
| | | | | LDCs | 4 | 16.04 | | |
| | | | | TOTAL | 10 | 40.10 | | 91 |
| 2006 | Earth System Physics | 01/01/09 | 31/08/09 | CIS | 2 | 0.43 | | |
| | | | | Developing | 7 | 52.59 | | |
| | | | | LDCs | 2 | 15.08 | | |
| | | | | TOTAL | 11 | 68.09 | | 41 |
| 2109 | Earth System Physics | 01/09/09 | 31/12/09 | Developing | 7 | 27.84 | | |
| | | | | LDCs | 3 | 12.03 | | |
| | | | | TOTAL | 10 | 39.87 | | 53 |
| 2003 | High Energy Physics | 01/01/09 | 31/08/09 | CIS | 1 | 7.61 | | |
| | | | | Developing | 9 | 61.00 | | |
| | | | | LDCs | 4 | 27.51 | | |
| | | | | TOTAL | 14 | 96.12 | | 65 |
| 2107 | High Energy Physics | 01/09/09 | 31/12/09 | Developing | 7 | 28.08 | | |
| | | | | LDCs | 2 | 8.02 | | |
| | | | | TOTAL | 9 | 36.1 | | 83 |
| 2005 | Mathematics | 01/01/09 | 31/08/09 | Developing | 7 | 41.25 | | |
| | | | | LDCs | 6 | 38.02 | | |
| | | | | TOTAL | 13 | 79.27 | | 62 |
| 2110 | Mathematics | 01/09/09 | 31/12/09 | Developing | 6 | 23.61 | | |
| | | | | LDCs | 3 | 12.03 | | |
| | | | | TOTAL | 9 | 35.64 | | 64 |
| 2111 | Basic Physics | 01/01/09 | 31/08/09 | Developing | 4 | 16.04 | | |
| | | | | LDCs | 5 | 19.63 | | |
| | | | | TOTAL | 9 | 35.67 | | 48 |
| 2007 | Basic Physics | 01/09/09 | 31/12/09 | Developing | 5 | 33.55 | | |
| | | | | LDCs | 5 | 31.96 | | |
| | | | | TOTAL | 10 | 65.50 | | 35 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|---|---|----------|----------|----------------------|----------------|------------------------|-----------------|--------------------|
| Total by region: | | | | CIS | 4 | 12.05 | | |
| | | | | Developing | 64 | 342.11 | | |
| | | | | LDCs | 38 | 212.28 | | |
| TOTAL DIPLOMA PROGRAMMES | | | | | 106 | 566 | | 611 |
| 3. TRAINING ACTIVITIES | | | | | | | | |
| APPLIED PHYSICS (AP): 17 training activities | | | | | | | | |
| 2017 | Preparatory School to the Winter College on Optics in Environmental Science | 26/01/09 | 30/01/09 | CIS | 1 | 0.16 | | |
| | | | | Developed | 7 | 0.72 | | |
| | | | | Developing | 22 | 3.45 | | |
| | | | | LDCs | 5 | 0.72 | | |
| | | | | Transition Countries | 1 | 0.16 | | |
| | | | | TOTAL | 36 | 5.21 | 7 | 147 |
| 2018 | Winter College on Optics in Environmental Science | 02/02/09 | 13/02/09 | CIS | 4 | 1.41 | | |
| | | | | Developed | 44 | 7.96 | | |
| | | | | Developing | 39 | 14.33 | | |
| | | | | LDCs | 8 | 2.93 | | |
| | | | | Transition Countries | 5 | 1.94 | | |
| | | | | TOTAL | 100 | 28.57 | 25 | 196 |
| 2020 | ICTP-ITU School on Wireless ICT Low Cost Solutions in Developing Countries: Best Practices; followed by second Awareness Workshop on Relevance of Low Cost Wireless ICT Solutions for Development | 16/02/09 | 06/03/09 | Developed | 15 | 4.96 | | |
| | | | | Developing | 28 | 15.42 | | |
| | | | | LDCs | 14 | 6.64 | | |
| | | | | Transition Countries | 1 | 0.62 | | |
| | | | | TOTAL | 58 | 27.64 | 21 | 175 |
| 2023 | Workshop on Topics in Quantum Turbulence | 16/03/09 | 20/03/09 | CIS | 3 | 0.49 | | |
| | | | | Developed | 36 | 5.85 | | |
| | | | | Developing | 7 | 1.15 | | |
| | | | | TOTAL | 46 | 7.50 | 33 | 25 |
| 2025 | Satellite Navigation Science and Technology for Africa | 23/03/09 | 09/04/09 | Developed | 36 | 7.30 | | |
| | | | | Developing | 37 | 20.78 | | |
| | | | | LDCs | 12 | 6.64 | | |
| | | | | TOTAL | 85 | 34.72 | 38 | 111 |
| 2026 | Joint ICTP/IAEA Advanced Workshop on Development of Radiation Resistant Materials | 20/04/09 | 24/04/09 | CIS | 7 | 1.15 | | |
| | | | | Developed | 13 | 1.84 | | |
| | | | | Developing | 16 | 2.63 | | |
| | | | | LDCs | 2 | 0.33 | | |
| | | | | Transition Countries | 1 | 0.16 | | |
| | | | | TOTAL | 39 | 6.12 | 10 | 74 |
| 2027 | School on Astrophysical Turbulence and Dynamos | 20/04/09 | 30/04/09 | CIS | 3 | 0.92 | | |
| | | | | Developed | 16 | 5.42 | | |
| | | | | Developing | 33 | 11.93 | | |
| | | | | Transition Countries | 1 | 0.36 | | |
| | | | | TOTAL | 53 | 18.64 | 10 | 56 |
| 2028 | Joint ICTP/IAEA Workshop on Atomic and Molecular Data for Fusion | 20/04/09 | 30/04/09 | CIS | 1 | 0.36 | | |
| | | | | Developed | 11 | 2.14 | | |
| | | | | Developing | 20 | 7.23 | | |
| | | | | LDCs | 3 | 1.08 | | |
| | | | | TOTAL | 35 | 10.82 | 10 | 34 |
| 2032 | Joint ICTP/IAEA Training Workshop on Technology and Performance of Desalination Systems | 11/05/09 | 15/05/09 | Developed | 4 | 0.49 | | |
| | | | | Developing | 19 | 2.96 | | |
| | | | | LDCs | 3 | 0.49 | | |
| | | | | TOTAL | 26 | 3.95 | 5 | 42 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS** | N. OF LECTURERS | N. OF APPLICATIONS |
|-----------------------------------|---|----------|----------|---|------------------------------------|--|-----------------|--------------------|
| 2033 | Joint ICTP/IAEA Advanced School on Dosimetry in Diagnostic Radiology and its Clinical Implementation | 11/05/09 | 15/05/09 | Developed Developing LDCs Transition Countries TOTAL | 28 28 8 3 67 | 4.18 4.60 1.32 0.49 10.59 | 12 | 190 |
| 2037 | Introduction to Optofluidics | 01/06/09 | 05/06/09 | Developed Developing Transition Countries TOTAL | 23 22 3 48 | 3.75 3.29 0.49 7.53 | 10 | 59 |
| 2049 | Second International Conference and Advanced School on Turbulent Mixing and Beyond | 27/07/09 | 07/08/09 | CIS Developed Developing LDCs TOTAL | 30 100 29 1 160 | 9.92 26.04 10.38 0.30 46.63 | 107 | 87 |
| 2090 | Hands-On Research on Complex Systems School | 26/07/09 | 07/08/09 | Developed Developing TOTAL | 3 62 65 | 0.64 13.25 13.89 | 4 | 266 |
| 2059 | Joint ICTP/IAEA School of Nuclear Knowledge Management | 28/09/09 | 02/10/09 | CIS Developed Developing Transition Countries TOTAL | 10 25 18 2 55 | 1.58 3.09 2.96 0.33 7.96 | 15 | 123 |
| 2084 | Joint ICTP/IAEA Workshop on Nuclear Power Plant Simulators for Education | 12/10/09 | 23/10/09 | CIS Developed Developing LDCs TOTAL | 2 10 17 2 31 | 0.53 2.50 6.71 0.79 10.52 | 9 | 26 |
| 2055 | Joint ICTP/IAEA School on Physics and Technology of Fast Reactor Systems | 09/11/09 | 20/11/09 | CIS Developed Developing LDCs TOTAL | 3 12 20 2 37 | 0.92 2.01 7.89 0.79 11.61 | 15 | 56 |
| 2067 | Joint ICTP/IAEA Workshop on Effects of Mechanical Properties and Mechanisms Governing the Irradiation-induced Embrittlement of Pressure Vessel Steels | 23/11/09 | 27/11/09 | CIS Developed Developing LDCs TOTAL | 3 11 20 1 35 | 0.49 1.64 3.29 0.16 5.59 | 7 | 36 |
| Total by region: | | | | CIS | 67 | 17.93 | | |
| | | | | Developed | 394 | 80.53 | | |
| | | | | Developing | 437 | 132.25 | | |
| | | | | LDCs | 61 | 22.19 | | |
| | | | | Transition Countries | 17 | 4.55 | | |
| TOTAL APPLIED PHYSICS (AP) | | | | | 976 | 257.45 | 338 | 1703 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|--|--|----------|----------|---|---------------------|--------------------------------|-----------------|--------------------|
| CONDENSED MATTER AND STATISTICAL PHYSICS (CMSP): 14 training activities | | | | | | | | |
| 2014 | Fourteenth International Workshop on Computational Physics and Materials Science: Total Energy and Force Methods | 08/01/09 | 10/01/09 | CIS Developed Developing LDCs | 1 190 38 1 | 0.10 18.71 3.71 0.10 | | |
| | | | | TOTAL | 230 | 22.61 | 27 | 442 |
| 2071 | Latin American School on Computational Materials Science | 19/01/09 | 30/01/09 | Developed Developing | 8 66 | 3.16 25.64 | | |
| | | | | TOTAL | 74 | 28.80 | 20 | 95 |
| 2031 | Joint ICTP/IAEA School on Novel Synchrotron Radiation Applications | 16/03/09 | 20/03/09 | Developed Developing LDCs Transition Countries | 12 16 2 1 | 1.45 2.63 0.33 0.16 | | |
| | | | | TOTAL | 31 | 4.57 | 11 | 53 |
| 2035 | Conference on Superconductor-Insulator Transitions | 18/05/09 | 23/05/09 | CIS Developed Developing LDCs | 8 42 30 1 | 1.38 7.56 5.85 0.20 | | |
| | | | | TOTAL | 81 | 14.99 | 34 | 76 |
| 2038 | Conference: From DNA-Inspired Physics to Physics-Inspired Biology | 01/06/09 | 05/06/09 | CIS Developed Developing LDCs | 5 78 30 2 | 0.82 12.20 4.87 0.33 | | |
| | | | | TOTAL | 115 | 18.21 | 55 | 95 |
| 2039 | Second Conference on Drug Development for the Third World: from Computational Molecular Biology to Experimental Approaches | 01/06/09 | 05/06/09 | Developed Developing LDCs Transition Countries | 48 32 1 3 | 7.00 5.06 0.16 0.49 | | |
| | | | | TOTAL | 84 | 12.72 | 26 | 114 |
| 2041 | School and Conference: From Biological Networks to Cellular Function: Evolution, Dynamics and Spatial Organization | 08/06/09 | 12/06/09 | CIS Developed Developing | 1 55 28 | 0.13 7.53 4.37 | | |
| | | | | TOTAL | 84 | 12.03 | 32 | 93 |
| 2076 | Advanced Workshop on Spin and Charge Properties of Low Dimensional Systems | 29/06/09 | 04/07/09 | CIS Developed Developing Transition Countries | 4 28 16 9 | 0.79 5.46 3.16 1.78 | | |
| | | | | TOTAL | 57 | 11.18 | 15 | 76 |
| 2046 | Summer College on Nonequilibrium Physics from Classical to Quantum Low Dimensional Systems | 06/07/09 | 24/07/09 | CIS Developed Developing Transition Countries | 11 97 69 3 | 6.39 45.67 39.42 1.22 | | |
| | | | | TOTAL | 180 | 92.69 | 46 | 154 |
| 2078 | Workshop on Trends in Nanoscience: Theory, Experiment, Technology | 23/08/09 | 30/08/09 | Developed Developing LDCs Transition Countries | 18 5 2 40 | 4.73 1.32 0.53 10.52 | | |
| | | | | TOTAL | 65 | 17.10 | 48 | 103 |
| 2058 | Pseudochaos and Stable-Chaos in Statistical Mechanics and Quantum Physics | 21/09/09 | 25/09/09 | CIS Developed Developing | 8 32 20 | 1.22 4.73 3.12 | | |
| | | | | TOTAL | 60 | 9.07 | 25 | 48 |
| 2063 | Joint ICTP/FANAS Conference on Trends in Nanotribology | 19/10/09 | 24/10/09 | CIS Developed Developing | 4 89 25 | 0.79 15.32 4.90 | | |
| | | | | TOTAL | 118 | 21.01 | 34 | 130 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS** | N. OF LECTURERS | N. OF APPLICATIONS |
|--|---|-------------------|--|--|---|---|--------------------|
| 2054 | Structure and Dynamics of Hydrogen-Bonded Systems | 26/10/09 27/10/09 | CIS Developed Developing TOTAL | 2 37 12 51 | 0.13 2.43 0.79 3.35 | 16 | 39 |
| Total by region: | | | | CIS Developed Developing LDCs Transition Countries | 45 859 423 9 58 | 11.91 155.31 110.76 1.65 14.5 | |
| TOTAL CONDENSED MATTER AND STATISTICAL PHYSICS (CMSP) | | | | 1394 | 294.13 | 424 | 1648 |
| EARTH SYSTEM PHYSICS (ESP): 12 training activities | | | | | | | |
| 2022 | Workshop on Theoretical Ecology and Global Change | 02/03/09 13/03/09 | Developed Developing LDCs TOTAL | 20 30 3 53 | 4.87 11.54 1.18 17.59 | 16 | 102 |
| 2029 | Water Resources in Developing Countries: Planning and Management in a Climate Change Scenario | 27/04/09 08/05/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 2 25 26 3 1 57 | 0.56 7.27 9.99 1.18 0.39 19.40 | 15 | 217 |
| 2077 | Workshop on How to Build a Habitable Planet and Conference on Operational Modeling of Oceanographic Coastal | 08/07/09 22/07/09 | Developed Developing LDCs TOTAL | 10 62 8 80 | 1.48 14.53 2.10 18.11 | 5 | 61 |
| 2048 | From Core to Crust: Towards an Integrated Vision of Earth's Interior | 20/07/09 24/07/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 2 53 23 2 3 83 | 0.30 8.19 3.68 0.32 0.49 12.97 | 21 | 81 |
| 2050 | Targeted Training Activity: Predictability of Weather and Climate: Theory and Applications to Intraseasonal Variability | 27/07/09 07/08/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 3 13 29 15 1 61 | 0.95 4.08 9.76 4.55 0.23 19.57 | 10 | 23 |
| 2051 | Workshop on High Resolution Climate Modelling | 10/08/09 14/08/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 4 39 46 4 1 94 | 0.66 6.12 7.45 0.66 0.16 15.04 | 33 | 77 |
| 2053 | Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa | 17/08/09 28/08/09 | Developed Developing LDCs TOTAL | 36 20 25 81 | 7.50 7.74 9.64 24.87 | 29 | 87 |
| 2060 | Advanced School on Non-linear Dynamics and Earthquake Prediction | 28/09/09 10/10/09 | CIS Developed Developing LDCs Transition Countries TOTAL | 11 17 32 1 1 62 | 4.21 5.13 13.55 0.36 0.43 23.67 | 21 | 66 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|------|---|-------------------|--|-------------------------|--|-----------------|--------------------|
| 2019 | Workshop on High-Impact Weather Predictability and Information System for Africa and AMMA-THORPEX Forecasters' Handbook | 05/10/09 08/10/09 | Developed Developing LDCs | 25 14 15 | 2.93 1.71 1.91 | | |
| | | | TOTAL | 54 | 6.54 | 45 | 62 |
| 2061 | Joint ICTP/IAEA Workshop on Alternative Response Actions to Climate Change and Energy Options | 05/10/09 09/10/09 | CIS Developed Developing LDCs Transition Countries | 1 4 21 3 3 | 0.16 0.62 3.42 0.49 0.49 | | |
| | | | TOTAL | 32 | 5.19 | 6 | 71 |
| 2066 | Workshop and Conference on Biogeochemical Impacts of Climate and Land-Use Changes on Marine Ecosystems | 02/11/09 10/11/09 | CIS Developed Developing LDCs | 1 20 19 2 | 0.30 5.52 5.62 0.59 | | |
| | | | TOTAL | 42 | 12.03 | 11 | 134 |
| 2016 | Joint ICTP/IAEA Advanced Workshop on Earthquake Engineering for Nuclear Facilities | 30/11/09 04/12/09 | CIS Developed Developing LDCs Transition Countries | 1 21 17 3 1 | 0.16 2.96 2.79 0.49 0.16 | | |
| | | | TOTAL | 43 | 6.58 | 15 | 61 |
| | | | Total by region: | | | | |
| | | | CIS | 25 | 7.3 | | |
| | | | Developed | 283 | 56.67 | | |
| | | | Developing | 339 | 91.78 | | |
| | | | LDCs | 84 | 23.47 | | |
| | | | Transition Countries | 11 | 2.35 | | |
| | | | TOTAL EARTH SYSTEM PHYSICS (ESP) | 742 | 181.57 | 227 | 1042 |
| | | | | | | | |
| | | | HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS (HECAP): 6 training activities | | | | |
| 2024 | Spring School on Superstring Theory and Related Topics | 23/03/09 31/03/09 | CIS Developed Developing Transition Countries | 2 105 65 1 | 0.59 29.21 18.67 0.30 | | |
| | | | TOTAL | 173 | 48.77 | 11 | 241 |
| 2036 | International Workshop: Quantum Chromodynamics from Colliders to Super-High Energy Cosmic Rays | 25/05/09 29/05/09 | Developed Developing LDCs | 31 16 1 | 4.47 2.63 0.16 | | |
| | | | TOTAL | 48 | 7.26 | 25 | 31 |
| 2040 | Workshop: Eternal Inflation | 08/06/09 12/06/09 | CIS Developed Developing LDCs Transition Countries | 3 30 19 3 1 | 0.49 4.83 3.11 0.47 0.16 | | |
| | | | TOTAL | 56 | 9.06 | 7 | 80 |
| 2043 | Summer School on Particle Physics in the LHC ERA | 15/06/09 26/06/09 | CIS Developed Developing LDCs Transition Countries | 5 56 68 6 4 | 1.89 19.20 26.08 2.30 1.55 | | |
| | | | TOTAL | 139 | 51.02 | 14 | 289 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|---|---|-------------------|--|--------------------------|--|-----------------|--------------------|
| 2045 | Joint ICTP-INFN-SISSA Conference: Topical Issues in LHC Physics | 29/06/09 02/07/09 | CIS Developed Developing LDCs Transition Countries | 2 32 37 3 1 | 0.26 3.52 4.64 0.26 0.13 | | |
| | | | TOTAL | 75 | 8.81 | 20 | 121 |
| 2047 | Workshop Towards Neutrino Technologies | 13/07/09 17/07/09 | CIS Developed Developing | 2 45 17 | 0.33 6.94 2.78 | | |
| | | | TOTAL | 64 | 10.05 | 39 | 58 |
| Total by region: | | | CIS | 14 | 3.56 | | |
| | | | Developed | 299 | 68.17 | | |
| | | | Developing | 222 | 57.91 | | |
| | | | LDCs | 13 | 3.19 | | |
| | | | Transition Countries | 7 | 2.14 | | |
| TOTAL HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS (HECAP) | | | | 555 | 134.97 | 116 | 820 |
| MATHEMATICS (Math): 5 training activities | | | | | | | |
| 2034 | Advanced School and Conference on Knot Theory and its Applications to Physics and Biology | 11/05/09 29/05/09 | CIS Developed Developing LDCs Transition Countries | 11 88 34 2 3 | 5.69 35.34 19.50 1.25 1.18 | | |
| | | | TOTAL | 138 | 62.96 | 29 | 156 |
| 2042 | Co-sponsored School/Workshop on Integrable Systems and Scientific Computing | 15/06/09 20/06/09 | CIS Developed Developing LDCs Transition Countries | 7 30 20 2 2 | 1.38 5.75 3.95 0.39 0.39 | | |
| | | | TOTAL | 61 | 11.86 | 13 | 82 |
| 2044 | Summer School and Advanced Workshop on Trends and Developments in Linear Algebra | 22/06/09 10/07/09 | CIS Developed Developing LDCs Transition Countries | 8 46 46 3 2 | 3.95 14.01 25.56 1.83 0.82 | | |
| | | | TOTAL | 105 | 46.17 | 34 | 156 |
| 2056 | Advanced School and Workshop on p-adic Analysis and Applications | 31/08/09 18/09/09 | CIS Developed Developing Transition Countries | 2 34 37 1 | 0.46 14.63 20.44 0.62 | | |
| | | | TOTAL | 74 | 36.15 | 20 | 85 |
| 2079 | International School and Conference on Foliations, Dynamical Systems, Singularity Theory and Perverse | 06/10/09 21/10/09 | CIS Developed Developing | 58 6 17 | 29.06 2.43 7.56 | | |
| | | | TOTAL | 81 | 39.05 | 12 | 77 |
| Total by region: | | | CIS | 86 | 40.54 | | |
| | | | Developed | 204 | 72.16 | | |
| | | | Developing | 154 | 77.01 | | |
| | | | LDCs | 7 | 3.47 | | |
| | | | Transition Countries | 8 | 3.01 | | |
| TOTAL MATHEMATICS (Math) | | | | 459 | 196.19 | 108 | 556 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS |
|---|--|---------------------|--|--------------------------|--|-----------------|--------------------|
| MULTIDISCIPLINARY LABORATORY (Mlab): 9 training activities | | | | | | | |
| 1928 | PHYSWARE: A Collaborative Workshop on Low-cost Equipment and Appropriate Technologies that Promote Undergraduate Level, Hands-on Physics Education throughout the Developing World | 16/02/09 - 27/02/09 | Developed Developing LDCs Transition Countries | 5 25 5 2 | 1.97 9.83 1.97 0.79 | | |
| | | | TOTAL | 37 | 14.56 | 5 | 201 |
| 2015 | Joint ICTP/IAEA Workshop on Advanced Simulation and Modelling for Ion Beam Analysis | 23/02/09 - 27/02/09 | Developed Developing LDCs Transition Countries | 9 24 2 1 | 1.48 3.95 0.33 0.16 | | |
| | | | TOTAL | 36 | 5.92 | 5 | 110 |
| 2094 | Joint RID/ICTP/IAEA Workshop on "Neutron probing for compositional and structural characterisation of materials and biological samples" | 11/05/09 - 15/05/09 | CIS Developed Developing LDCs | 4 3 11 1 | 0.66 0.49 1.81 0.16 | | |
| | | | TOTAL | 19 | 3.12 | 0 | 20 |
| 2074 | Latin American Tutorial in High Performance and GRID Computing | 22/06/09 - 27/06/09 | Developed Developing | 2 32 | 0.39 6.31 | | |
| | | | TOTAL | 34 | 6.70 | 7 | 53 |
| 2052 | Summer College on Plasma Physics | 10/08/09 - 28/08/09 | CIS Developed Developing LDCs Transition Countries | 8 72 88 2 6 | 3.62 19.56 49.41 1.25 2.40 | | |
| | | | TOTAL | 176 | 76.24 | 74 | 301 |
| 2057 | First Workshop on Open Source and Internet Technology for Scientific Environment: with case studies from Environmental Monitoring | 07/09/09 - 25/09/09 | CIS Developed Developing LDCs | 3 8 24 3 | 1.87 4.04 14.60 1.87 | | |
| | | | TOTAL | 38 | 22.38 | 11 | 168 |
| 2064 | Joint ICTP/IAEA Advanced School on in-situ X-ray Fluorescence and Gamma Ray Spectrometry | 26/10/09 - 30/10/09 | Developed Developing LDCs Transition Countries | 19 23 2 3 | 2.83 3.62 0.33 0.49 | | |
| | | | TOTAL | 47 | 7.27 | 11 | 194 |
| 2065 | Advanced Training Course on FPGA Design and VHDL for Hardware Simulation and Synthesis | 26/10/09 - 20/11/09 | CIS Developed Developing LDCs | 4 11 37 2 | 3.42 5.98 31.13 1.71 | | |
| | | | TOTAL | 54 | 42.24 | 13 | 213 |
| 2068 | Advanced School in High Performance and GRID Computing - Concepts and Applications | 30/11/09 - 11/12/09 | CIS Developed Developing LDCs Transition Countries | 2 51 33 12 5 | 0.79 17.46 12.49 4.73 1.78 | | |
| | | | TOTAL | 103 | 37.25 | 15 | 208 |
| Total by region: | | | | CIS | 21 | 10.36 | |
| | | | | Developed | 180 | 54.2 | |
| | | | | Developing | 297 | 133.15 | |
| | | | | LDCs | 29 | 12.35 | |
| | | | | Transition Countries | 17 | 5.62 | |
| TOTAL MULTIDISCIPLINARY LABORATORY (Mlab) | | | | 544 | 215.68 | 141 | 1468 |

VISITS TO RESEARCH AND TRAINING ACTIVITIES, 2009

| SMR | ACTIVITY TITLE | DATES | REGIONS* | N. OF VISITS** | N. OF PERSON-MONTHS*** | N. OF LECTURERS | N. OF APPLICATIONS | |
|--|---|---------------------|--|--|--|--|--------------------|--|
| PHYSICS AND DEVELOPMENT (PD): 4 training activities | | | | | | | | |
| 2116 | Preparatory Meeting on Science in Africa | 06/05/09 - 06/05/09 | Developed Developing LDCs TOTAL | 4 6 3 13 | 0.13 0.20 0.10 0.43 | 13 | 0 | |
| 2121 | Special Training Programme on Installing and Using High Performance Clusters | 03/06/09 - 19/06/09 | Developed Developing LDCs TOTAL | 8 7 4 19 | 4.47 3.78 2.24 10.49 | 10 | 18 | |
| 2062 | Workshop on Scientific Information in the Digital Age: Access and Dissemination | 12/10/09 - 16/10/09 | Developed Developing LDCs TOTAL | 18 28 5 51 | 2.66 4.57 0.79 8.02 | 12 | 76 | |
| 2021 | School on Geothermics | 26/10/09 - 07/11/09 | Developed Developing LDCs TOTAL | 34 16 13 63 | 11.64 6.84 5.56 24.04 | 17 | 85 | |
| Total by region: | | | Developed Developing LDCs Transition Countries | 64 57 25 1 | 18.9 15.39 8.69 0.62 | | | |
| TOTAL PHYSICS AND DEVELOPMENT (PD) | | | | 147 | 43.6 | 52 | 179 | |
| Total by region: | | | CIS Developed Developing LDCs Transition Countries | 258 2283 1929 228 119 | 91.6 505.94 618.25 75.01 32.79 | | | |
| TOTAL TRAINING ACTIVITIES | | | | 4817 | 1323.59 | 1427 | 7416 | |
| Miscellaneous activities | | | CIS Developed Developing LDCs Transition Countries | 175 1673 1503 182 103 | 17.82 229.36 251.48 22.03 9.37 | | | |
| GRAND TOTAL BY REGION: | | | | CIS Developed Developing LDCs Transition Countries | 521 4284 4008 491 254 | 229.25 1246.43 2274.80 456.54 102.23 | | |
| | | | | 9558 | 4309.25 | 1427 | 8224 | |
| <p>*Regions: LDCs=Least Developed Countries. CIS=Commonwealth of Independent States. **: Number of visits not visitors. ***: Number of average months spent at ICTP by scientific visitors (1 average-month= 30.417 days).</p> | | | | | | | | |

Summary of ICTP Research and Training Activities 2009

| SCIENTIFIC FIELDS | VISITS BY REGION* | | | | | | PERSON-MONTHS BY REGION | | | | | | LECTURERS TOTAL | APPLICATIONS TOTAL | | | | |
|---|-------------------|--------------------|----------------------|--------------------|-------------------|-------------|-------------------------|--------------------|----------------------|--------------|---------------------|---------------|-----------------|--------------------|---------------------|--|--|-------|
| | LDCs | | | Developing Regions | | | Transition Countries | | | CIS | | | | | Developed Countries | | | TOTAL |
| | LDCs | Developing Regions | Transition Countries | CIS | Developed Regions | TOTAL | LDCs | Developing Regions | Transition Countries | CIS | Developed Countries | TOTAL | | | | | | |
| APPLIED PHYSICS (AP) | | | | | | | | | | | | | | | | | | |
| Research | 2 | 11 | 0 | 0 | 13 | 26 | 0.53 | 3.92 | 0.00 | 0.00 | 9.34 | 13.79 | 0 | 0 | | | | |
| Training [17] | 61 | 437 | 17 | 67 | 394 | 976 | 22.19 | 132.25 | 4.55 | 17.93 | 80.53 | 257.45 | 338 | 1703 | | | | |
| Total AP | 63 | 448 | 17 | 67 | 407 | 1002 | 22.72 | 136.17 | 4.55 | 17.93 | 89.87 | 271.24 | 338 | 1703 | | | | |
| CONDENSED MATTER AND STATISTICAL PHYSICS (CMSP) | | | | | | | | | | | | | | | | | | |
| Research | 3 | 86 | 4 | 19 | 111 | 223 | 2.56 | 128.23 | 2.99 | 20.65 | 140.68 | 295.11 | 0 | 0 | | | | |
| Training [14] | 9 | 423 | 58 | 45 | 859 | 1394 | 1.65 | 110.76 | 14.5 | 11.91 | 155.31 | 294.13 | 424 | 1648 | | | | |
| Diploma Programme | 8 | 12 | 0 | 1 | 0 | 21 | 48 | 58.15 | 0.00 | 4.01 | 0.00 | 110.16 | 0 | 160 | | | | |
| Total CMSP | 20 | 521 | 62 | 65 | 970 | 1638 | 52.21 | 297.14 | 17.49 | 36.57 | 295.99 | 699.40 | 424 | 1808 | | | | |
| EARTH SYSTEM PHYSICS (ESP) | | | | | | | | | | | | | | | | | | |
| Research | 3 | 29 | 12 | 18 | 55 | 117 | 8.15 | 76.9 | 12.53 | 23.46 | 92.08 | 213.12 | 0 | 0 | | | | |
| Training [12] | 84 | 339 | 11 | 25 | 283 | 742 | 23.47 | 91.78 | 2.35 | 7.30 | 56.67 | 181.57 | 227 | 1042 | | | | |
| Diploma Programme | 5 | 14 | 0 | 2 | 0 | 21 | 27.11 | 80.43 | 0.00 | 0.43 | 0.00 | 107.97 | 0 | 94 | | | | |
| Total ESP | 92 | 382 | 23 | 45 | 338 | 880 | 58.73 | 249.11 | 14.88 | 31.19 | 148.75 | 502.66 | 227 | 1136 | | | | |
| HIGH ENERGY, COSMOLOGY AND ASTROPARTICLE PHYSICS (HECAP) | | | | | | | | | | | | | | | | | | |
| Research | 0 | 54 | 3 | 10 | 74 | 141 | 0 | 66.41 | 1.05 | 8.15 | 161.29 | 236.90 | 0 | 0 | | | | |
| Training [6] | 13 | 222 | 7 | 14 | 299 | 555 | 3.19 | 57.91 | 2.14 | 3.56 | 68.17 | 134.97 | 116 | 820 | | | | |
| Diploma Programme | 6 | 16 | 0 | 1 | 0 | 23 | 35.53 | 89.08 | 0 | 7.61 | 0.00 | 132.22 | 0 | 148 | | | | |
| Total HECAP | 19 | 292 | 10 | 25 | 373 | 719 | 38.72 | 213.40 | 3.19 | 19.32 | 229.46 | 504.09 | 116 | 968 | | | | |
| MATHEMATICS (Math) | | | | | | | | | | | | | | | | | | |
| Research | 7 | 72 | 5 | 10 | 27 | 121 | 20.09 | 166.68 | 3.72 | 13.35 | 11.21 | 215.05 | 0 | 0 | | | | |
| Training [5] | 7 | 154 | 8 | 86 | 204 | 459 | 3.47 | 77.01 | 3.01 | 40.54 | 72.16 | 196.19 | 108 | 556 | | | | |
| Diploma Programme | 9 | 13 | 0 | 0 | 0 | 22 | 50.05 | 64.86 | 0.00 | 0.00 | 0.00 | 114.91 | 0 | 126 | | | | |
| Total Math | 23 | 239 | 13 | 96 | 231 | 602 | 73.61 | 308.55 | 6.73 | 53.89 | 83.37 | 526.15 | 108 | 682 | | | | |
| MLAB | | | | | | | | | | | | | | | | | | |
| Research | 0 | 6 | 0 | 5 | 8 | 19 | 0.00 | 7.36 | 0.00 | 3.09 | 14.10 | 24.55 | 0 | 0 | | | | |
| Training [9] | 29 | 297 | 17 | 21 | 180 | 544 | 12.35 | 133.15 | 5.62 | 10.36 | 54.20 | 215.68 | 141 | 1468 | | | | |
| Total MLAB | 29 | 303 | 17 | 26 | 188 | 563 | 12.35 | 140.51 | 5.62 | 13.45 | 68.30 | 240.23 | 141 | 1468 | | | | |
| PHYSICS AND DEVELOPMENT (PD) | | | | | | | | | | | | | | | | | | |
| Training [4] | 25 | 57 | 1 | 0 | 64 | 147 | 8.69 | 15.39 | 0.62 | 0.00 | 18.90 | 43.60 | 73 | 179 | | | | |
| Total (PD) | 25 | 57 | 1 | 0 | 64 | 147 | 8.69 | 15.39 | 0.62 | 0.00 | 18.90 | 43.60 | 73 | 179 | | | | |
| OTHER PROGRAMMES | | | | | | | | | | | | | | | | | | |

| SCIENTIFIC FIELDS | VISITS BY REGION* | | | | | | PERSON-MONTHS BY REGION | | | | | | LECTURERS TOTAL | APPLICATIONS TOTAL |
|-------------------------------------|-------------------|--------------------|----------------------|------------|-------------------|-------------|-------------------------|--------------------|----------------------|---------------|---------------------|----------------|-----------------|--------------------|
| | LDCs | Developing Regions | Transition Countries | CIS | Developed Regions | TOTAL | LDCs | Developing Regions | Transition Countries | CIS | Developed Countries | TOTAL | | |
| | | | | | | | | | | | | | | |
| ICTP-Elettra Users | 0 | 34 | 0 | 1 | 0 | 35 | 0.00 | 13.31 | 0.00 | 0.46 | 0.00 | 13.77 | 0 | 0 |
| STEP Programme | 8 | 31 | 1 | 6 | 0 | 46 | 38.47 | 103.35 | 0.85 | 14.45 | 0.00 | 157.12 | 0 | 0 |
| TRIL Programme | 13 | 88 | 4 | 2 | 8 | 115 | 66.44 | 395.04 | 36.95 | 11.87 | 61.91 | 572.21 | 0 | 197 |
| Total PROGRAMMES | 21 | 153 | 5 | 9 | 8 | 196 | 104.91 | 511.70 | 37.80 | 26.78 | 61.91 | 743.10 | 0 | 197 |
| MISCELLANEOUS | | | | | | | | | | | | | | |
| Research | 7 | 101 | 3 | 13 | 32 | 156 | 10.98 | 101.76 | 1.98 | 12.30 | 20.22 | 147.24 | 0 | 0 |
| Dipoma Programme (Basic Physics) | 10 | 9 | 0 | 0 | 0 | 19 | 51.59 | 49.59 | 0.00 | 0.00 | 0.00 | 101.18 | 0 | 83 |
| Total Miscellaneous | 17 | 110 | 3 | 13 | 32 | 175 | 62.57 | 151.35 | 1.98 | 12.30 | 20.22 | 248.42 | 0 | 83 |
| Sub -Totals | | | | | | | | | | | | | | |
| Research | 22 | 359 | 27 | 75 | 320 | 803 | 42.31 | 551.26 | 22.27 | 81.00 | 448.92 | 1145.76 | 0 | 0 |
| Training | 228 | 1929 | 119 | 258 | 2283 | 4817 | 75.01 | 618.25 | 32.79 | 91.60 | 505.94 | 1323.59 | 1427 | 7416 |
| Diploma Programme | 38 | 64 | 0 | 4 | 0 | 106 | 212.28 | 342.11 | 0.00 | 12.05 | 0.00 | 566.44 | 0 | 611 |
| Other Programmes | 21 | 153 | 5 | 9 | 8 | 196 | 104.91 | 511.70 | 37.80 | 26.78 | 61.91 | 743.10 | 0 | 197 |
| Miscellaneous activities | 182 | 1503 | 103 | 175 | 1673 | 3636 | 22.03 | 251.48 | 9.37 | 17.82 | 229.65 | 530.36 | 0 | 0 |
| GRAND TOTAL | 491 | 4008 | 254 | 521 | 4284 | 9558 | 456.54 | 2274.80 | 102.23 | 229.25 | 1246.42 | 4309.24 | 1427 | 8224 |

*Regions:

LDCs= Least Developed Countries.

CIS =Commonwealth of Independent States.

Numbers in [] refer to total number of activities.

Data on training activities include number of course directors, lecturers and tutors.

Data on research activities include number of associates, affiliates, long-term visitors, post-doctoral research fellows and short-term visitors.

Data on TRIL Programme include fellows' visits to ICTP.

Data on Diploma Programme refer to the period 1 January-31 December 2009.

ICTP VISITORS AND PERSON MONTHS BY COUNTRY, 2009

| Region/Country | Total visitors | Male visitors | Female visitors | Person-months |
|--|----------------|---------------|-----------------|---------------|
| Least Developed Countries (LDC's) | | | | |
| Africa (24) | | | | |
| 1 Angola | 1 | 0 | 1 | 0.39 |
| 2 Benin | 10 | 8 | 2 | 12.43 |
| 3 Burkina Faso | 3 | 3 | 0 | 3.42 |
| 4 Burundi | 3 | 3 | 0 | 3.02 |
| 5 Central African Republic | 1 | 1 | 0 | 0.89 |
| 6 Chad | 1 | 1 | 0 | 0.26 |
| 7 Comoros | 1 | 1 | 0 | 0.49 |
| 8 Democratic Republic of the Congo | 7 | 7 | 0 | 2.89 |
| 9 Djibouti | 1 | 1 | 0 | 0.46 |
| 10 Eritrea | 3 | 3 | 0 | 1.55 |
| 11 Ethiopia | 49 | 49 | 0 | 121.12 |
| 12 Gambia | 1 | 1 | 0 | 0.20 |
| 13 Guinea | 1 | 1 | 0 | 0.20 |
| 14 Madagascar | 9 | 4 | 5 | 24.07 |
| 15 Malawi | 10 | 10 | 0 | 12.92 |
| 16 Mozambique | 5 | 5 | 0 | 0.79 |
| 17 Niger | 3 | 3 | 0 | 1.97 |
| 18 Rwanda | 5 | 5 | 0 | 2.83 |
| 19 Senegal | 22 | 18 | 4 | 70.62 |
| 20 Sudan | 23 | 18 | 5 | 64.70 |
| 21 Togo | 1 | 1 | 0 | 3.09 |
| 22 Uganda | 13 | 8 | 5 | 20.81 |
| 23 United Republic of Tanzania | 15 | 15 | 0 | 11.74 |
| 24 Zambia | 8 | 6 | 2 | 12.62 |
| Total Africa (LDCs) | 196 | 172 | 24 | 373.48 |
| <i>% vs. total LDC's</i> | <i>80%</i> | <i>80%</i> | <i>80%</i> | <i>82%</i> |
| Asia (8) | | | | |
| 25 Bangladesh | 34 | 30 | 4 | 55.92 |
| 26 Bhutan | 1 | 1 | 0 | 0.10 |
| 27 Cambodia | 1 | 1 | 0 | 0.26 |
| 28 Lao People's Democratic Republic | 1 | 0 | 1 | 0.23 |
| 29 Maldives | 2 | 2 | 0 | 0.59 |
| 30 Myanmar | 1 | 0 | 1 | 0.46 |
| 31 Nepal | 9 | 9 | 0 | 25.05 |
| 32 Yemen | 1 | 1 | 0 | 0.46 |
| Total Asia (LDCs) | 50 | 44 | 6 | 83.08 |
| <i>% vs. total LDC's</i> | <i>20%</i> | <i>20%</i> | <i>20%</i> | <i>18%</i> |
| Total Least Developed Countries (LDC's) | 246 | 216 | 30 | 456.55 |
| <i>% vs. grand total</i> | <i>5%</i> | <i>5%</i> | <i>3%</i> | <i>11%</i> |
| Developing Regions | | | | |
| Africa (16) | | | | |
| 33 Algeria | 36 | 27 | 9 | 33.53 |
| 34 Botswana | 1 | 1 | 0 | 0.43 |
| 35 Cameroon | 44 | 31 | 13 | 110.83 |
| 36 Congo | 9 | 8 | 1 | 30.74 |
| 37 Côte d'Ivoire | 11 | 10 | 1 | 5.72 |
| 38 Egypt | 63 | 48 | 15 | 101.19 |
| 39 Ghana | 33 | 27 | 6 | 63.19 |
| 40 Kenya | 30 | 24 | 6 | 49.12 |
| 41 Libyan Arab Jamahiriya | 4 | 4 | 0 | 1.15 |

ICTP VISITORS AND PERSON MONTHS BY COUNTRY, 2009

| Region/Country | Total visitors | Male visitors | Female visitors | Person-months |
|--|----------------|---------------|-----------------|---------------|
| 42 Mauritius | 1 | 1 | 0 | 0.33 |
| 43 Morocco | 35 | 28 | 7 | 41.46 |
| 44 Namibia | 3 | 2 | 1 | 0.30 |
| 45 Nigeria | 99 | 87 | 12 | 167.24 |
| 46 South Africa | 86 | 59 | 27 | 33.27 |
| 47 Tunisia | 15 | 9 | 6 | 10.22 |
| 48 Zimbabwe | 7 | 7 | 0 | 6.08 |
| Total Africa | 477 | 373 | 104 | 654.80 |
| <i>% vs. total Developing Regions</i> | <i>24%</i> | <i>25%</i> | <i>21%</i> | <i>29%</i> |
| Latin America and the Caribbean | | | | |
| Caribbean (3) | | | | |
| 49 Cuba | 46 | 31 | 15 | 70.82 |
| 50 Jamaica | 1 | 0 | 1 | 0.46 |
| 51 Trinidad and Tobago | 3 | 2 | 1 | 1.71 |
| Total Caribbean | 50 | 33 | 17 | 72.99 |
| <i>% vs. Total Latin America and the Caribbean</i> | <i>10%</i> | <i>9%</i> | <i>12%</i> | <i>17%</i> |
| Latin America (13) | | | | |
| 52 Argentina | 109 | 72 | 37 | 89.33 |
| 53 Bolivia (Plurinational State of) | 1 | 1 | 0 | 0.49 |
| 54 Brazil | 111 | 82 | 29 | 59.83 |
| 55 Chile | 54 | 40 | 14 | 26.99 |
| 56 Colombia | 58 | 46 | 12 | 49.25 |
| 57 Costa Rica | 6 | 4 | 2 | 4.34 |
| 58 Ecuador | 9 | 8 | 1 | 27.94 |
| 59 Honduras | 1 | 1 | 0 | 0.43 |
| 60 Mexico | 54 | 39 | 15 | 42.81 |
| 61 Panama | 1 | 1 | 0 | 0.26 |
| 62 Peru | 9 | 8 | 1 | 14.83 |
| 63 Uruguay | 16 | 11 | 5 | 8.32 |
| 64 Venezuela (Bolivarian Republic of) | 24 | 18 | 6 | 32.74 |
| Total Latin America | 453 | 331 | 122 | 357.56 |
| <i>% vs. Total Latin America and the Caribbean</i> | <i>90%</i> | <i>91%</i> | <i>88%</i> | <i>83%</i> |
| Total Latin America and the Caribbean | 503 | 364 | 139 | 430.55 |
| <i>% vs. total Developing Regions</i> | <i>25%</i> | <i>24%</i> | <i>28%</i> | <i>19%</i> |
| Asia (27) | | | | |
| 65 Bahrain | 1 | 0 | 1 | 0.46 |
| 66 China* | 137 | 101 | 36 | 172.90 |
| 67 Hong Kong SAR of China | 1 | 1 | 0 | 0.10 |
| 68 India | 323 | 240 | 83 | 388.14 |
| 69 Indonesia | 27 | 21 | 6 | 41.75 |
| 70 Iran (Islamic Republic of) | 127 | 87 | 40 | 130.09 |
| 71 Iraq | 6 | 4 | 2 | 23.70 |
| 72 Israel | 59 | 54 | 5 | 20.22 |
| 73 Jordan | 9 | 7 | 2 | 12.43 |
| 74 Kuwait | 2 | 1 | 1 | 0.76 |
| 75 Lebanon | 2 | 1 | 1 | 2.10 |
| 76 Malaysia | 18 | 11 | 7 | 9.21 |
| 77 Mongolia | 9 | 2 | 7 | 16.64 |
| 78 Occupied Palestinian Territory | 2 | 2 | 0 | 0.76 |
| 79 Oman | 1 | 1 | 0 | 0.26 |
| 80 Pakistan | 92 | 79 | 13 | 91.10 |

ICTP VISITORS AND PERSON MONTHS BY COUNTRY, 2009

| Region/Country | Total visitors | Male visitors | Female visitors | Person-months |
|---|----------------|---------------|-----------------|----------------|
| 81 Philippines | 20 | 10 | 10 | 14.24 |
| 82 Qatar | 1 | 1 | 0 | 0.69 |
| 83 Republic of Korea | 40 | 35 | 5 | 38.17 |
| 84 Saudi Arabia | 9 | 9 | 0 | 3.62 |
| 85 Singapore | 10 | 9 | 1 | 4.80 |
| 86 Sri Lanka | 12 | 9 | 3 | 8.91 |
| 87 Syrian Arab Republic | 13 | 9 | 4 | 13.05 |
| 88 Thailand | 21 | 13 | 8 | 22.78 |
| 89 Turkey | 44 | 27 | 17 | 44.91 |
| 90 United Arab Emirates | 3 | 3 | 0 | 0.99 |
| 91 Viet Nam | 40 | 36 | 4 | 89.98 |
| Total Asia | 1029 | 773 | 256 | 1152.75 |
| <i>% vs. total Developing Regions</i> | 51% | 51% | 51% | 52% |
| Total Developing Regions | 2009 | 1510 | 499 | 2238.09 |
| <i>% vs. grand total</i> | 40% | 38% | 46% | 52% |
| CIS and Transition Countries | | | | |
| CIS Asia (6) | | | | |
| 92 Armenia | 16 | 11 | 5 | 12.72 |
| 93 Azerbaijan | 3 | 2 | 1 | 10.22 |
| 94 Georgia | 13 | 11 | 2 | 27.29 |
| 95 Kazakhstan | 6 | 4 | 2 | 4.67 |
| 96 Kyrgyzstan | 1 | 0 | 1 | 0.59 |
| 97 Uzbekistan | 51 | 46 | 5 | 35.84 |
| Total CIS Asia | 90 | 74 | 16 | 91.33 |
| <i>% vs. total CIS Asia and Europe</i> | 32% | 34% | 24% | 40% |
| CIS Europe (4) | | | | |
| 98 Belarus | 15 | 13 | 2 | 20.09 |
| 99 Republic of Moldova | 3 | 2 | 1 | 6.61 |
| 100 Russian Federation | 130 | 99 | 31 | 77.72 |
| 101 Ukraine | 45 | 28 | 17 | 33.50 |
| Total CIS Europe | 193 | 142 | 51 | 137.92 |
| <i>% vs. total CIS Asia and Europe</i> | 68% | 66% | 76% | 60% |
| Total CIS Asia and Europe | 283 | 216 | 67 | 229.25 |
| <i>% vs. CIS and Transition Countries</i> | 69% | 74% | 55% | 69% |
| Transition Countries (5) | | | | |
| 102 Albania | 1 | 0 | 1 | 0.23 |
| 103 Bulgaria | 17 | 9 | 8 | 31.04 |
| 104 Romania | 77 | 49 | 28 | 54.41 |
| 105 Serbia | 26 | 13 | 13 | 12.72 |
| 106 The Former Yugoslav Republic of Macedonia | 9 | 4 | 5 | 3.25 |
| Total Transition Countries | 130 | 75 | 55 | 101.65 |
| <i>% vs. CIS and Transition Countries</i> | 31% | 26% | 45% | 31% |
| Total CIS and Transition Countries | 413 | 291 | 122 | 330.90 |
| <i>% vs. grand total</i> | 8% | 7% | 11% | 8% |
| Developed Regions | | | | |
| Europe (26) | | | | |
| 107 Austria | 58 | 50 | 8 | 15.52 |
| 108 Belgium | 20 | 18 | 2 | 5.98 |

ICTP VISITORS AND PERSON MONTHS BY COUNTRY, 2009

| Region/Country | Total visitors | Male visitors | Female visitors | Person-months |
|--|----------------|---------------|-----------------|----------------|
| 109 Croatia | 24 | 18 | 6 | 17.69 |
| 110 Czech Republic | 18 | 11 | 7 | 4.93 |
| 111 Denmark | 19 | 14 | 5 | 4.37 |
| 112 Estonia | 2 | 2 | 0 | 0.53 |
| 113 Finland | 21 | 15 | 6 | 6.84 |
| 114 France | 203 | 174 | 29 | 84.46 |
| 115 Germany | 210 | 190 | 20 | 67.03 |
| 116 Greece | 13 | 9 | 4 | 5.13 |
| 117 Hungary | 14 | 10 | 4 | 3.81 |
| 118 Iceland | 2 | 2 | 0 | 0.53 |
| 119 Ireland | 3 | 2 | 1 | 0.95 |
| 120 Italy | 594 | 459 | 135 | 635.89 |
| 121 Latvia | 3 | 2 | 1 | 0.82 |
| 122 Lithuania | 2 | 0 | 2 | 0.53 |
| 123 Netherlands | 34 | 30 | 4 | 7.27 |
| 124 Norway | 10 | 8 | 2 | 2.70 |
| 125 Poland | 45 | 32 | 13 | 14.99 |
| 126 Portugal | 11 | 7 | 4 | 3.19 |
| 127 Slovakia | 5 | 3 | 2 | 1.32 |
| 128 Slovenia | 25 | 20 | 5 | 8.38 |
| 129 Spain | 74 | 55 | 19 | 35.08 |
| 130 Sweden | 36 | 33 | 3 | 9.44 |
| 131 Switzerland | 96 | 83 | 13 | 24.10 |
| 132 United Kingdom | 231 | 201 | 30 | 90.15 |
| Total Europe | 1773 | 1448 | 325 | 1051.62 |
| <i>% vs. Developed Regions</i> | 74% | 74% | 77% | 82% |
| North America (2) | | | | |
| 133 Canada | 45 | 36 | 9 | 14.01 |
| 134 United States of America | 490 | 406 | 84 | 196.76 |
| Total North America | 535 | 442 | 93 | 210.77 |
| <i>% vs. Developed Regions</i> | 22% | 23% | 22% | 16% |
| Oceania (2) | | | | |
| 135 Australia | 13 | 10 | 3 | 3.68 |
| 136 New Zealand | 3 | 3 | 0 | 0.92 |
| Total Oceania | 16 | 13 | 3 | 4.60 |
| <i>% vs. Developed Regions</i> | 1% | 1% | 1% | 0% |
| Asia (1) | | | | |
| 137 Japan | 58 | 55 | 3 | 16.70 |
| Total Asia | 58 | 55 | 3 | 16.70 |
| <i>% vs. Developed Regions</i> | 2% | 3% | 1% | 1% |
| Total Developed regions | 2382 | 1958 | 424 | 1283.69 |
| <i>% vs. grand total</i> | 47% | 49% | 39% | 30% |
| GRAND TOTAL | 5050 | 3975 | 1075 | 4309.24 |
| The Grand total of visitors includes 556 participants to Regional training courses, organized by ICTP but held in other countries. | | | | |
| *Data includes 24 visitors and 15.29 person-months from Taiwan, China. | | | | |

ACRONYMS

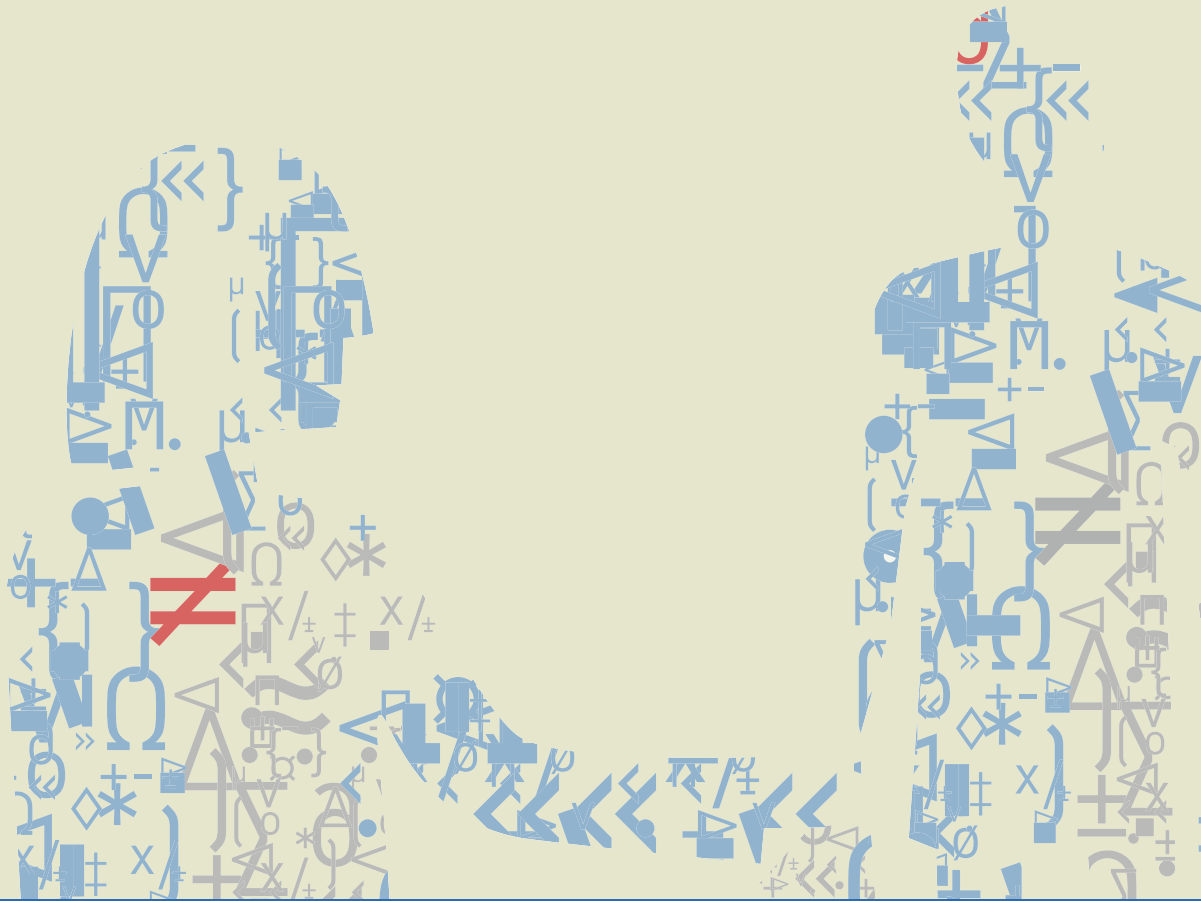
Acronyms of institutions and associations used in the text:

| | |
|-----------|---|
| ANCS | Autoritatea Nationala pentru Cercetare Stiintifica (National Authority for Scientific Research) |
| APCTP | Asia Pacific Center for Theoretical Physics |
| ARPA | Agenzia Regionale per la Protezione dell'Ambiente nella Regione Friuli Venezia Giulia (Regional Agency for the protection of the environment in the Friuli Venezia Giulia region) |
| ASI | Agenzia Spaziale Italiana (Italian Space Agency) |
| AUST | African University of Science and Technology |
| CAECE | Universidad Centro de Altos Estudios en Ciencias Exactas (University Centre for Advanced Study in Exact Sciences) |
| CAPES | Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Upgrading of Higher Level Staff) |
| CBM | Consorzio per la Medicina Biomolecolare (Consortium for Biomolecular Medicine) |
| CEA | Commissariat à l'Énergie Atomique (Atomic Energy Commission) |
| CEADEN | Centro de Estudios Aplicados al Desarrollo Nuclear (Centre of Nuclear Development Applied Studies) |
| CECAM | Centre Européen de Calcul Atomique et Moléculaire (European Centre for Atomic and Molecular Calculus) |
| CEI | Central European Initiative |
| CERN | European Laboratory for Particle Physics |
| CETA | Centro di Ecologia Teorica ed Applicata (Centre for Theoretical and Applied Ecology) |
| CIMPA | Centre International de Mathématiques Pures et Appliquées (International Centre of Pure and Applied Mathematics) |
| CINVESTAV | Centro de Investigación y de Estudios Avanzados (Centre for Research and Advanced Studies) |
| CLAF | Centro Latino Americano de Física (Latin-American Centre for Physics) |
| CMCC | Centro Euro-Mediterraneo per i Cambiamenti Climatici (Euro-Mediterranean Centre for Climatic Change) |
| CNEA | Comision Nacional de Energía Atómica (Argentinean National Commission for Atomic Energy) |
| CNIT | Consorzio Nazionale Interuniversitario per le Telecomunicazioni (Italian National Internuniversity Consortium for Telecommunications) |
| CNPq | Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development) |
| CNR | Consiglio Nazionale delle Ricerche (Italian National Research Council) |
| COLA | Center for Ocean, Land and Atmosphere |
| CONICET | Consejo Nacional de Investigaciones Científicas y Técnicas (Argentinean National Council of Scientific and Technical Research) |

| | |
|--------------------|--|
| CONICYT | Comisión Nacional de Investigación Científica y Tecnológica (Chilean National Commission of Scientific and Technological Research) |
| CPT | Centre de Physique Théorique (Centre of Theoretical Physics) |
| CUA | MIT-Harvard Center for Ultracold Atoms |
| DEMOCRITOS | DEmocritos MOdeling Centre for Research In aTOMistic Simulation |
| DST-UNITS | Department of Earth Sciences, University of Trieste |
| EC | European Commission |
| ECT | European Centre for Theoretical Studies in Nuclear Physics and related Areas |
| EEA | European Environment Agency |
| EFOMP | European Federation of Organizations for Medical Physics |
| EGU | European Geosciences Union |
| eIFL | Electronic Information for Libraries |
| EIONET | European Environment Information and Observation Network |
| EIPAM | Electron Induced Processes at the Molecular Level |
| ENEA | Italian National Agency for New Technologies, Energy and the Environment |
| ENEL | Ente Nazionale Energia Elettrica (Italian National Agency for Electric Power) |
| EOARD | European Office of Aerospace Research and Development |
| EOS | European Optical Society |
| ESA | European Space Agency |
| ESF | European Science Foundation |
| EU | European Union |
| FAPESP | Fundação de Amparo à Pesquisa do Estado de São Paulo (Foundation for Protection of Research of the São Paulo State) |
| FBK | Fondazione Bruno Kessler (Bruno Kessler Foundation) |
| HMAP | History of Marine Animal Populations |
| I ² CAM | International Institute for Complex Adaptive Matter |
| IAEA | International Atomic Energy Agency |
| IAMP | InterAcademy Medical Panel |
| IASPEI | International Association of Seismology and Physics of the Earth's Interior |
| IAVCEI | International Association of Volcanology and Chemistry of the Earth's Interior |
| ICGEB | International Centre for Genetic Engineering and Biotechnology |
| ICMR | International Center for Materials Research |
| ICMS | International Centre for Mathematical Sciences |
| ICO | International Commission for Optics |
| ICS-UNIDO | International Centre for Science and High Technology of UNIDO |
| ICTP | The Abdus Salam International Centre for Theoretical Physics |
| IEPM | Internet End-to-end Performance Monitoring |
| IFIN-HH | Horia Hulubei National Institute of Physics and Nuclear Engineering |
| IGA | International Geothermal Association |
| IIEES | International Institute of Earthquake Engineering and Seismology |

| | |
|-----------|---|
| IIEPT | International Institute of Earthquake Prediction Theory and Mathematical Geophysics |
| IMET | Institute of Metallurgy and Material Science |
| IMU | International Mathematical Union |
| INAF | Istituto Nazionale di Astrofisica (National Institute of Astrophysics) |
| INASP | International Network for the Availability of Scientific Publications |
| INFN | Istituto Nazionale di Fisica della Materia (Italian National Institute for the Physics of Matter) |
| INFN | Istituto Nazionale di Fisica Nucleare (Italian National Institute for Nuclear Physics) |
| INGV | Istituto Nazionale di Geofisica e Vulcanologia (Italian National Institute of Geophysics and Vulcanology) |
| INRIM | Istituto Nazionale di Ricerca Metrologica (Italian National Institute of Metrological Research) |
| IPCC | Intergovernmental Panel on Climate Change |
| IPN | Instituto Politécnico Nacional (Mexican National Polytechnic Institute) |
| IPPLM | Institute of Plasma Physics and Laser Microfusion |
| IS | Immaginario Scientifico Science Centre |
| ISAC | Institute of Atmospheric Sciences and Climate |
| ISMAR-CNR | Istituto di scienze marine del Consiglio nazionale delle ricerche (Institute of Marine Sciences of the Italian National Research Council) |
| ISMN | Istituto per lo Studio dei Materiali Nanostrutturati (Institute for the Study of Nanostructured Materials) |
| ISOC | Internet Society |
| ISPRA | Istituto Superiore per la Protezione e la Ricerca Ambientale (Institute for Environmental Protection and Research) |
| ISRT | Istituto per la ricerca scientifica e tecnologica (Institute for Scientific and Technological Research) |
| ISTI | Istituto di Scienze e Tecnologie dell' Informazione (Institute of Information Science and Technology) |
| ITU/BDT | Telecommunication Development Bureau of the International Telecommunication Union |
| IUPAP | International Union of Pure and Applied Physics |
| JAXA | Japan Aerospace Exploration Agency |
| KFAS | Kuwait Foundation for the Advancement of Sciences |
| KTH | Kungliga Tekniska Högskolan (Royal Institute of Technology of Sweden) |
| MIT | Massachusetts Institute of Technology |
| MITPAN | International Institute of Earthquake Prediction Theory and Mathematical Geophysics |
| MIUR | Ministero dell'Istruzione, dell'Università e della Ricerca (Ministry of Education, University and Research) |
| MOHESR | Iraqi Ministry of Higher Education and Scientific Researches |
| MPS | Moscow Physical Society |
| NASA | National Aeronautics and Space Administration |

| | |
|---------------|--|
| NSF | National Science Foundation |
| NSRC | Network Startup Resource Center |
| OAT | Astronomical Observatory of Trieste |
| OGS | Istituto Nazionale di Oceanografia e Geofisica Sperimentale (National Institute of Oceanography and Experimental Geophysics) |
| OSA | Optical Society of America |
| OSMER-FVG | OSservatorio MEteorologico Regionale – Friuli Venezia Giulia (Friuli Venezia Giulia Regional Meteorological Observatory) |
| ROSCOSMOS | Russian Federal Space Agency |
| SESAME | Synchrotron light for Experimental Science and Applications in the Middle East |
| SIDA/Sarec | Swedish International Development Cooperation Agency/Department for Research Cooperation |
| SIOF | Società italiana di ottica e fotonica (Italian Society of Optics and Photonics) |
| SISSA | Scuola Internazionale Superiore di Studi Avanzati (International School for Advanced Studies) |
| SLAC | Stanford Linear Accelerator Center |
| SPIE | The International Society for Optical Engineering |
| ST | Sincrotrone Trieste |
| STFC | Science and Technology Facilities Council |
| TASC | TASC National Laboratory: Tecnologie Avanzate e nanoSCienza (Advanced Technology and nanoSCience) |
| TWAS | The Academy of Sciences for the Developing World |
| TWOWS | Third World Organization for Women in Science |
| UFRJ | Universidade Federal do Rio de Janeiro (Federal University of Rio de Janeiro) |
| UGI | Unione Geotermica Italiana (Italian Geothermal Union) |
| ULB | Université Libre de Bruxelles |
| UNAB | Universidad Andrés Bello |
| UNAVCO | University Navstar Consortium |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNESCO-BRESCE | UNESCO Regional Bureau for Science and Culture in Europe |
| UNIDO | United Nations Industrial Development Organization |
| UNMdP | Universidad Nacional de Mar del Plata (National University of Mar del Plata) |
| USAID | United States Agency for International Development |
| WCRP | World Climate Research Programme |
| WMO | World Meteorological Organization |



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