THE INSTITUTE OF MATHEMATICAL SCIENCES

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ANNUAL REPORT

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Foreword

I am pleased to present this year's annual report with the happy news that several of the Institute members received national and international recognitions. Our members received nine awards ranging from fellowship of Academies, DAE SRC Outstanding research fellowship, Young Scientist medals, APS outstanding referee award, M. K. Singal Memorial award and Google research award.

Our student strength has exceeded 100 for the first time, with the numbers standing at 106. Also significant is the fact that the incoming students are better prepared than a decade ago. We are proud to say that, this has been possible due to the on-going outreach programmes and efforts of our faculty, both at an individual and institutional level.

As with every year, this year continues to be academically productive for the members of our Institute. There were several significant publications reported in national and international journals and our faculty authored a book. Six students were awarded Ph.D., four submitted their Ph.D. thesis and five students submitted master's thesis under the supervision of our faculty.

We organised fifteen conferences and workshops at IMSc this year. These include the Discussion meeting on Complex Networks of Trade and Credit, Functional Analysis Workshop, Instructional Workshop in Free Probability, ICM Satellite Conference on Operator Algebra, ICMzeta 2010, School on Loop Quantum Gravity, 2nd IMSc workshop on Modelling Infectious Diseases, National Level Workshop on Quantum Information Science, Foundations of Software Technology and Theoretical Computer Science, Discussion Meeting on the Economy as a Complex System II: Economic Dynamics, Special year in Number Theory, Mechanics and Physics of Fractures, IMPECS School on Parameterized and Exact Computation and the Fifth International Symposium on Parameterized and Exact Computation.

The list of off-site conference organization by IMSc faculty also continues to be impressive. This academic year the conferences organized outside are: Advanced Instructional School in Representation Theory, Workshop on Quantum Chaos and Quantum Information, Aarhus-Chennai Computational Complexity Workshop. Algebraic and Combinatorial approaches to Representation Theory, ICM Satellite Conference on Logic and Set Theory, Conference on Modelling of Infectious Diseases, Lorentz Workshop on Kernelization, and Functional Analysis Workshop-II. The Subashish Nag Memorial lecture was given this year by Prof Sunil Mukhi of Tata Institute of Fundamental Research, Mumbai.

This report was compiled through the efforts of an Annual Report Committee comprising of Drs. Rahul Sinha, R. Ramanujam, Anilesh Mohari, Krishna Maddaly, Paul Pandian and Usha Devi. I owe my gratitude to all of them.

June, 2011 **R. Balasubramanian**

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The Institute

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Dr. **K. Ponmudi**, Hon'ble Minister for Higher Education, Government of Tamil Nadu, Fort St. George, Chennai 600 009
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(**Member Secretary**)

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Tamil Mani, M.
Varadaraj, M.
Vasudevan, T.V.
Vidhya Lakshmi

Chapter 2

Research and Teaching

2.1 Mathematics

2.1.1 Research Summary

Algebraic Geometry

Stability properties of some naturally defined vector bundles on second symmetric power of curve were investigated.[**N3**]

Analytic Number Theory

For a positive integer g, let $N_g(X)$ denote the number of positive square-free $D \leq X$ such that the class number $h(-D)$ of $\mathbb{Q}(\sqrt{-D})$ is divisible by g. Soundararajan's result, which is the best known, states that $N_g(X) \gg X^{\frac{1}{2}+\frac{2}{g}-\epsilon}$ provided $g \equiv 0 \pmod 4$. This result has been extended to function field case.[**Ba**].

The problem of 'non-vanishing of Rankin-Selberg L-function in weight aspect', has been considered under present study.

Cryptology

A cryptosystem based on non-commutative properties of groups have been investigated. The cryptosystem is based on the hardness of the problem of factoring over these groups. This problem, interestingly, boils down to discrete logarithm problem on some Abelian groups. Further, this method is illustrated in three different non-Abelian groups $\mathrm{GL}_n(\mathbb{F}_q)$, $\mathrm{UT}_n(\mathbb{F}_q)$ and the Braid Groups.[**Ko**].

Ergodic Theory

Positive characteristic versions of the logarithm laws of Sullivan and Kleinbock-Margulis were proved and related results in Metric Diophantine Approximation were obtained [**P1**].

Group Theory

New light was shed on the more than hundred-year-old problem of classifying the orbits under automorphisms in a finite abelian group by the systematic use of modern combinatorial techniques [**D2**].

The well known problem of lifting and extension of group automorphisms in abelian group extensions was investigated. Conditions were found for such extensions and liftings to be possible and the problem was reduced to p-groups [**Si1**].

Mathematical Physics

A new and very simple proof for the regularity of density of states was given [**M2**], in addition to showing analyticity of the density of states for a class of random operators on the lattice [**M3**]. The operators considered allow the single site distributions to have singular components, which could not be achieved by earlier results in this area.

A new class of random Schrödinger operators with independent random potentials was discovered [**M1**] which exhibit absolutely continuous spectrum for large energies. This result is a surprising development in this area of study where exhibiting absolutely continuous spectrum for even operators with slowly decaying random potential is hard.

Modular forms

Serre proved that any holomorphic cusp form of weight one for $\Gamma_1(\mathrm{N})$ is lacunary while a holomorphic modular form for $\Gamma_1(\mathrm{N})$ of higher integer weight is lacunary if and only if it is a linear combination of cusp forms of CM-type. In [**G8**], it is shown that when a non-zero modular function of arbitrary real weight for any finite index subgroup of the modular group $\mathrm{SL}_2(\mathbf{Z})$ is lacunary, it is necessarily holomorphic on the upper-half plane, finite at the cusps and has non-negative weight.

In [**G7**], the transcendence of certain Eichler integrals associated to Eisenstein series and more generally to modular forms using functional identities due to Ramanujan, Grosswald, Weil et al has been studied. A link has been established between the special values of such integrals at algebraic points in the upper half plane to the Riemann zeta values at odd positive integers.

In [**G6**], the values of modular forms with algebraic Fourier coefficients at algebraic arguments has been studied. As a consequence, the nature of zeros of such modular forms has been deduced. In particular, it has been established that the singular values of modular forms (that is, values at CM points) are related to the recent work of Nesterenko. As an application, the transcendence of critical values of certain Hecke L-series has been deduced. Moreover, generalisations of these investigations to the case of quasi-modular forms with algebraic Fourier coefficients has been done

Non Commutative Geometry

We construct compact quantum metric spaces (CQMS) starting with some C*algebra extension with a positive splitting. As special cases we discuss the case of Toeplitz algebra, quantum SU(2) and Podles sphere.

Operator Algebras

While the theory of E_0 semigroups of type I factors is well developed, almost nothing definitve has been obtained in the corrsponding theory for II_1 factors. A group of us have been running a seminar meeting twice weekly to try and get an understanding/toe-hold into this theory. This is the content of preprint [**Bi**].

After a few false starts, we managed to 'clean up' as well as to generalise some of the findings of earlier work of ours on a 'GJS construction for graphs'. While our earlier work had been confined to bipartite graphs and their 'Perron-Frobenius weighting', we saw that many conclusions persisted for the most general graphs, and saw some pretty free probabilistic constructions arising naturally in this model. This is the subject of [**Bas**].

Free Probability Theory

The work in [**Gu**] was motivated by an attempt to understand the following conjecture of Vaughan Jones and Kevin Walker:

The category of affine representations of a finite depth subfactor planar algebra is equivalent to the Drinfeld center of the bimodule category associated to the subfactor.

As a step forward towards this, in [**Gu**] (partly done when the third named author was at K U Leuven, Belgium), given a finite index subfactor, an isomorphism between the affine morphisms at zero level with the fusion algebra of the bimodule category was established (as suggested to the second named author by Vaughan Jones and Dietmar Bisch); this, paved the way to analyze the structure of affine P-modules with weight zero for any subfactor planar algebra P (possibly having infinite depth).

Further, for irreducible depth two subfactor planar algebras, we establish an equivalence between the category of affine P-modules and the center of the category of N-N-bimodules generated by $L^2(M)$ for a depth-2 subfactor $N \subset M$; this partially verifies the above conjecture of Jones and Walker. This was a joint work with Paramita Das and Shamindra Kumar Ghosh [**Gu**].

[**Mu3**] studies singular masas inside finite von Neumann algebras from a bimodule point of view. More emphasis is given to masas for which the orthocomplement of the range of the associated Jones' projection is a coarse correspondence in the language of Connes. An example of a Tauer masa of product class is cited. The author doesn't know to decide if this masa arises from an action of integers, a problem related to a long standing question of Banach. Given any nonempty subset S of the extended natural numbers which contains infinity, there exist uncountably many pairwise non-conjugate singular masas in the free group factors each with Pukánszky invariant S.

[**Mu2**] studies weak mixing (singular) and mixing masas in type II_1 factors. Several necessary and sufficient conditions to characterize the normalizing algebra of a masa are presented. In the context of mixing masas, special attention has been paid to masas of product class. A

recent result of Jolissaint and Stalder concerning mixing masas arising out of inclusions of groups is strengthened. The analysis prohibits the existence of Koopman-realizable measures which are absolutely continuous but not Lebesgue whenever the crossed products associated to the dynamical systems can be realized from semidirect product of groups in a canonical way, a problem whose answer in the most general setting is unknown for a long time.

Jolissaint and Stalder introduced the definitions of mixing and weak mixing for von Neumann subalgebras of finite von Neumann algebras. In [**Mu1**] various algebraic and analytical properties of mixing and weakly mixing von Neumann subalgebras are studied. Some basic results about mixing inclusions of von Neumann algebras are proved and connections between mixing properties and normalizers of von Neumann subalgebras are established. The special case of mixing subalgebras arising from inclusions of group von Neumann algebras finds applications to ergodic theory. For a finite von Neumann algebra M and von Neumann subalgebras A, B of M a notion of weak mixing of $B \subset M$ relative to A is introduced and various properties of such inclusions are studied.

In [**Mu4**] the notion of weak asymptotic homomorphism property for masas in semifinite factors is defined and is shown to be equivalent to singularity.

Representation Theory

The invariant subspaces for the Weil representation associated to a finite abelian group were classified [**D1**] using the combinatorial techniques developed in [**D2**].

The representation theory of general linear groups over a finite principal ideal local ring of length two (such as $\mathbf{Z}/p^2\mathbf{Z}$, where p is a prime number) is a hard and possibly intractable problem. Recent work [**Sin**] has demonstrated that this problem is equivalent to that of constructing representations of centralizers of elements in general linear groups over the residue field. As a consequence, it is found that the numbers and dimensions of irreducible representations depend on the ring only through the order of its residue field. A similar correspondence was found for conjugacy classes as well.

The study of certain special functions associated to finite and affine root systems. More specifically, the goal is to understand the Macdonald (q, t) polynomials and the underlying representation theory of the double affine Hecke algebra in relation to the representation theory of affine Kac-Moody algebras.

Topology

A new class of compact complex manifolds which are non-Kähler and non-symplectic manifolds are constructed which have the structure of a product of two circle bundles associated to negative ample line bundles over simply connected homogeneous complex varieties. The construction generalizes the work of Loeb and Nicolau who considered the case of complex projective spaces. This is reported in [**S2**].

Parametrized versions of the classical Borsuk-Ulam theorem were obtained for fiber bundles whose fibers are cohomology real or complex projective spaces [**Si2**].

Transcendental number theory

New constructions of rational approximations to $\zeta(2)$ and $\zeta(3)$ are being studied. The equivalence of proofs of irrationality of these constants by classical methods (Padé approximation, continued fractions and real integrals) has also been studied.

2.1.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**B1**]
R. Balasubramanian and F. Luca*.
On the number of factorisations of an integer.
Integers, 11, 2011.
(To be Published).

[**B2**]
R. Balasubramanian, F. Luca***, and R. Thangadurai***.
On the exact degree of $\mathbb{Q}(\sqrt{a_1}, \sqrt{a_2}, ..., \sqrt{a_\ell})$ over $\mathbb{Q}$.
Proceedings of AMS, **138(7)**, 2283–2288, 2010.

[**Ba**]
Pradipto Banerjee and Srinivas Kotyada.
Divisibility of class numbers of imaginary quadratic function fields by a fixed odd number.
in.arxiv.org, 2011.
(Preprint: 1102.3769 v1).

[**Bas**]
Madhushree Basu, Vijay Kodiyalam, and V. S. Sunder.
From graphs to free products.
International J. of Mathematics, 2011.
arXiv:1102.4413[math.OA](Submitted).

[**Bi**]
Panchugopal Bikram, Kunal Mukherjee, R. Srinivasan***, and V. S. Sunder**.
Hilbert von Neumann modules.
2011.
(Submitted).

[**Bo1**]
Debashish Bose and Shobha Madan*.
Spectrum is periodic for n-intervals.
Journal of Functional Analysis, **260(1)**, 308, 2011.

[**Bo2**]
Debashish Bose, Anil Kumar C. P., Krishnan R., and Shobha Madan*.
On fugledeś conjecture for three intervals.
Online Journal of Analytic Combinatorics, **(5)**, 1, 2010.

[**C1**]
Partha Sarathi Chakraborty.
From c^*-algebra extensions to cqms, quantum su(2), *podleś* sphere and other examples.
Journal of the Australian Mathematical Society, 2010.
(To be published).

[**C2**]
Partha Sarathi Chakraborty and Arupkumar Pal*.
Equivariant spectral triples and poincaré duality for $su_q(2)$.
Transactions of the American Mathematical Society, **362(8)**, 4099, 2010.

[**C3**]
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2.2 Physics

2.2.1 Research Summary

Astro-particle Physics

In the model of the neutrino condensate as the dark energy that was constructed earlier (J R Bhatt etal, Phys Lett B 687,75 (2010)), the condensate was formed by the singlet neutrino whereas mass eigenstate is a superposition of singlet and doublet neutrinos. An extension of the gap equation to two channels is required to deal with this problem and this is being done. (Collaboration with B Desai* and E Ma*).

Our model of neutrino condensate requires neutrinos to be pseudo-Dirac. Tests for the pseudo-Dirac nature of neutrinos are under study. (Collaboration with B Desai* and E Ma*)

Biological Physics

A program of research initiated with the group of Sandhya Koushika (NCBS, Bangalore) on modeling axonal transport is yielding a variety of remarkable results. In nerve cells, groups of motors transport cargo encapsulated in vesicles across long cellular extensions called axons. The cargo can be transported either anterogradely (away from the cell body) or retrogradely (towards the cell body). The experiments invovle imaging such transport in an effort to understand what regulatory mechanisms might exist and whether at least some of these mechanisms might involve physical mechanisms. Our results include the explanation of vesicle"clusters" seen in many imaging experiments over the years, the prediction that microtubule ends may play a role in the formation of such clusters in addition to the direct interactions of oppositely directed vesicles, the prediction of currents and their composition and the direct comparison of kymographs in the experiments and the simulations. This is the most detailed theory of axonal transport available so far and the implications of the model for experiments such as axotomy (in which the axon is cut with a laser beam and the subsequent motion of vesicle cargo imaged) are currnently being explored. Experiments on the motion of kinesin motors conducted in the laboratory of Krishanu Ray (TIFR, Mumbai) are also being analysed.

The epidemiological dynamics of influenza A (H1N1)v outbreak in India has been studied. The first confirmed case of this influenza was diagnosed on 16 May 2009. The quantity R0, the basic reproduction number has been determined for India from the timeseries data of infections. The basic reproduction number for the pandemic in India was found to be somewhat smaller than that reported in other countries. Our study also indicates that seasonal and country-wise variations need to be studied for devising strategies for dealing with such pandemic influenza outbreaks.

In certain situations (e.g., in people suffering from an ischemic heart), the normal periodic activity of the heart can be hampered by arrhythmias, i.e., disturbances in the natural rhythmic activity of the heart. A fatal arrhythmia occurring in the ventricles is Ventricular Fibrillation (VT), during which there is no coherent activation of the muscle cells so that the heart stops beating. Death follows within minutes, unless large electrical shocks are applied to "reset" the heart to its normal rhythm. The problem with such treatment is that not only is it painful, but it also causes damage to the heart tissue, creating scars which can act as substrate for future arrhythmias. The underlying cause for VF is the onset of spatiotemporal chaos, through the spontaneous formation and subsequent breakup of electrical spiral waves. For this reason, physicists have tried to devise control methods (based on the principles of nonlinear dynamics) that use electrical pulses of extremely low magnitude. Very recently it was seen that even signals which are otherwise incapable of exciting resting tissue can nevertheless suppress spatiotemporal chaos [**Sri1**]. This happens under specific conditions which can be analytically derived and is related to the lengthening of the refractory period of excitable cells by a very weak stimulus. Heterogeneities in heart tissue, such as a gradient in the parameter values governing excitability of the medium, often play an important role in arrhythmia genesis and termination. While it is known that spiral waves can drift in such a gradient, the direction was always thought to be in the direction of lower excitability. However, recent work has shown that anomalous drift is possible in certain circumstances, where the spiral wave drifts towards the region of higher excitability [**Sri2**]. This is of great importance, as this can result in spiral breakup and thus initiate the potentially life-threatening ventricular fibrillation. Understanding the conditions for the occurrence of anomalous drift may have consequences for better treatment of arrhythmias.

The recent swine flu pandemic that spread throughout the world in a remarkably short time and even affected India has shown once again the importance of understanding the dynamics of epidemic spreading. In order to be able to come up with meaningful countermeasures to combat an epidemic, one needs to quantitatively characterize its initial rate of amplification. With the help of data obtained during the recent Indian swine flu epidemic, the basic reproduction number of A(H1N1)v was calculated for India [**M1**]. The numbers obtained through a variety of rigorous statistical methods lie towards the lower end of the range of values reported from different countries. Region-wise analysis of the incidence of the disease showed that local climatic conditions and public response played an important role in spreading it.

Contactin-1 (CNTN1) is the one of the axonal cell adhesion protein molecules which belongs to the neural immunoglobulin family and mainly involved in neurite outgrowth. Using NAMD 2.6 simulation package and CHARMM27 force fields, the Steered Molecular Dyanamics (SMD) simulation technique has been employed to unfold CNTN1. The intermediate features of folded to unfolded state of CNTN1 clearly observed from the unfolding forces averaged over many realizations. The Jarzynski equality estimates of change in free energy profile for folded to unfolded state of CNTN1 along the specified reaction co-ordinates shows that the free energy estimates strongly depends on the pulling velocity.

Classical and Quantum Gravity, Black Holes, Cosmology

Loop Quantum Gravity is a promising approach to a quantum theory of gravity. A school was conducted to introduce this program to graduate students in the country. This was a sequel to a similar school conducted last year. The lecture notes of are being prepared and will be available in the near future.

Classical and Quantum Optics

After finding out the effect of local Markovian heat baths on two-qubit systems and thereby studying the quantum-to-classical transition of two mode Gaussian states under local Markovian heat baths [**Go2**], different processes of controlling decoherence as well as entanglement decay of two-qubit states, using the formalism of Choi-Jamiolkowski isomorphism, have been looked at [**Go1**]. In this paper, the effect of a number of mechanisms designed to suppress decoherence in open quantum systems have been studied with respect to their effectiveness at slowing down the loss of entanglement. The effect of photonic band-gap materials and frequency modulation of the system-bath coupling were shown to be along expected lines in this regard. However, other control schemes, like resonance fluorescence, achieved quite the contrary: increasing the strength of the control killed entanglement off faster. The effect of dynamic decoupling schemes on two qualitatively different system-bath interactions has been studied in depth. Dynamic decoupling control has the expected effect of slowing down the decay of entanglement in a two-qubit system coupled to a harmonic oscillator bath under non-demolition interaction. However, non-trivial phenomena were observed when a Josephson charge qubit, strongly coupled to a random telegraph noise bath, was subject to decoupling pulses. The most striking of these, that has been reflected in the resonance fluorescence scenario, is that due to an increase in the pulse strength decrease in decoherence has been seen but it also helped in speeding up the sudden death of entanglement. This demonstrates that the behaviour of decoherence and entanglement in time can be qualitatively

different in the strong-coupling non-Markovian regime.

Based upon the above-mentioned results, using a method of successive measurement, the process of generating a completely positive non-Markovian dynamics which can provide good approximations to some well-known exactly solvable open quantum system dynamics is in progress.

In our paper [**P**], joint measurement of two and three unsharp qubit observables through an Arthur-Kelly type joint measurement model for qubits were considered. The effect of initial state of the detectors on quality of the the POVMs of the measurement as well as the post-measurement state of the system were investigated. Two approaches for characterizing the quality of unsharp measurement and the resulting measurement uncertainty relations were considered. The corresponding measures of unsharpness were connected for the case where both the measurements were equally unsharp. The connection between the POVM elements and symmetries of the underlying Hamiltonian of the measurement interaction was made explicit and had been used to perform joint measurement in arbitrary directions. Finally, in the case of three observables, a necessary condition for the approximate joint measurement had been derived and had been used it show the relative freedom available when the observables were non-orthogonal.

The issue of entanglement between the measuring apparatuses and the system (after the action of the pre-measurement interaction) is currently being studied to characterize the quality of the unsharpness of the joint measurement scheme. The question applying the above-mentioned concept of unsharp joint measurement (in Arthur-Kelley model) is also being under consideration for different information theoretic purposes.

Condensed Matter Physics

A detailed theory of lineshapes and moments obtained in muon-spin-rotation experiments in the classic layered superconductor BSCCO has been developed. This is work in collaboration with the group of S.L. Lee (St. Andrews). The experiments obtain complex behaviour of the moments of the field distribution function within the vortex glass regime, which can be captured in a theory based on the correlation functions of the pancake vortex systems. These results constitute the more detailed link between experiments which probe structure in vortex glass phases and theories which predict correlations in such phases. As such, they are expected to be important in the understanding and interpretation of a host of data on the magnetic and structural properties of vortex lines in high-Tc superconductors.

CP-Violation, Neutrinos, B-Physics and New Models

The activity in B-physics and CP-violation was focused towards both theory ans the Belle collaboration of which IMSc is a member.

The consequences of an extra generation of quark in future hadron colliders has been studied. It has been shown that, if an extra generation of quark exists then its dominant decay mode will be the CKM suppressed two body decay and it can form hadron bound state if the CKM matrix element is large. Such bound states can be used as QCD laboratory in the limit of infinite quark mass. The CKM matrix element $V_{t'b'}$ can also be measured by looking at the CKM suppressed two-body decay and kinematically suppressed three body decay [**D**].

New beauty baryon decay modes were proposed to determine the photon helicity of the penguin transition $b \to s\gamma$. These are of great interest to flavour physic studies at the Large hadron collider [**Sinha1**].

Progress was made as part of the Belle collaboration on observation of several decay modes of B mesons and the measurements of the branching ratios [**Sinha2**, **Sinha4**, **?**, **Sinha3**]

Neutrino factories are one of the advanced neutrino oscillation facilities that have been proposed for determining the unknown and precision measurements of the already measured, neutrino oscillation parameters. The platinum channel (electron neutrino or antineutrino appearance) has been proposed for removing correlations and degeneracies in determination of parameters at the neutrino factories. The role of the tau contamination to the electron events sample was examined and it was found that it plays a significant role in the platinum channel, not only at high energy neutrino factories but surprisingly even at low energy neutrino factories [**Du**].

Foundations of Quantum Mechanics

Non-locality without inequality is an elegant argument introduced by L. Hardy for two qubit systems, and later generalised to n qubits, to establish contradiction of quantum theory with local realism. Interestingly, for $n = 2$ this argument is actually a corollary of Bell-type inequalities, viz. the CH-Hardy inequality involving Bell correlations, but for n greater than 2 it involves n-particle probabilities more general than Bell-correlations. In our paper [2010.5], a chain of completely new local realistic inequalities involving joint probabilities for n qubits has been derived, and then, associated to each such inequality, a new Hardy-type local reality constraint without inequalities has been provided. Quantum mechanical maximal violations of the chain of inequalities and of the associated constraints have also been also studied by deriving appropriate Cirel'son type theorems. These results involving joint probabilities more general than Bell correlations are expected to provide a new systematic tool to investigate entanglement.

With Dr. K. V. S. Chaitanya (post-doc at IMSc), we are now trying to explore some of the afore-said nonlocality-without-inequality arguments to check whether our earlier work [**Cho2**] on analytical proof of Gisin's theorem can also be extended for four or more than four qubit systems. This will hopefully put some (or, all) of the non-locality-without-inequality arguments in the same platform, so far as Gisin's theorem is concerned.

Mathematical Physics

The particle and kinetic-energy densities for a system of N fermions confined in a potential V (r) are investigated. Local virial theorems relate the particle kinetic energy and potential energy densitites. Such local virial theorems are formulated for a very general form of V(r) in arbitrary space dimensions.It is shown that these local virial theorems (LVTs) hold exactly for for harmonic oscillator potential and linear potentials in arbitrary dimensions and for the one-dimensional box. Generalized LVTs, that are suggested by a semiclassical theory which relates the density oscillations to the closed non-periodic orbits of the classical system, are tested for their validity numerically for various local potentials. Although formally they are only valid asymptotically for large particle numbers N, we show that practically they are

surprisingly accurate also for moderate values of N. [**Mur2**].

It is demonstrated that the (s-wave) geometric spectrum of the shallow Efimov energy levels is generated by the radial motion of a primitive periodic orbit of the corresponding classical system and its harmonics. The action of the primitive orbit is given by the logarithm of the energy. This is shown to be consistent with the leading term of an inverse-squared radial potential with a lower cut-off radius. The lowest-order WKB quantization, including the Langer correction, is shown to reproduce the geometric scaling of the energy spectrum. The (WKB) mean-squared radii of the Efimov states scale geometrically like the inverse of their energies. The WKB wavefunctions, regularized at the classical turning point using Langers connection formula, are practically indis- tinguishable from the exact wave functions even for the lowest (n = 0) state, apart from a tiny shift of its zeros that remains constant for large n.[**Mur1**].

Nonlinear Dynamics, Solitons and Chaos

The dark soliton solution for the condensate density of weakly repulsive bosons described by the Gross-Pitaevskii equation (GPE), is shown to have the same form as that of a strongly repulsive system of hard-core bosons in the continuum description of the exactly half-filled extended Bose-Hubbard lattice model. However, the phase of the condensate wave function in the two cases are quite different.The GPE soliton gets related to the magnetic soliton of an easy-plane ferromagnet, where it describes the square of the in-plane magnetization of the spin system. This relationship is useful in understanding the various characterisitics of solitons in these two distinct many-body systems [**B2**]

After a review of dark and bright soliton propagation in the Bose-Einstein condensate of a system of weakly repulsive and attractive bosons, respectively, our results for a system of hard-core bosons are presented. In contrast to the weakly repulsive case which supports a dark soliton that dies at the speed of sound, the strongly repulsive hard-core system supports both bright and dark solitons for the particle density. Further, if the filling factor of the background density is greater than half (less than half) the dark (bright) soliton survives even at the speed of sound. This intriguing prediction has been called the 'Everlasting quantum wave'.(See, for e.g., www.physorg.com/news180207149.html)[**B1**]

A statistical mechanical theory of the spatio-temporally chaotic dynamics seen in experiments on sheared nematic liquid crystals has been developed. This is the first coupled-map lattice approach to the problem of rheological chaos in driven complex fluids. This work suggests that the basic ingredient of chaos in these systems is the local map representing the complex time-dependent behaviour of nematics under shear, and that complex spatio-temporal structure arises simply from coupling these maps in space[**Ka**].

Complex networks occur all around us, especially in the biological context, ranging from the protein contact network at the level of molecules to food webs at the level of ecological communities. Over the past few years, research has focussed on the issue of how network structure affects the dynamics that such a system is capable of (e.g., this is very important in economic systems where instabilities generated by financial networks can result in global depression as has happened recently [**Sinhas3**]), and in turn, how does any constraint on dynamics affect the kind of structure that the network will have. The first question has

recently been addressed in a study looking at the role that modular structure plays in the functioning of networks. The existence of modules (i.e., subgroups of nodes which have a higher connection density than the overall network) has been observed in a large class of complex networks in nature. Independently, many of these networks have also been reported to exhibit the clustered small-world property of having low average path length, while at the same time having local clustering of nodes. The recent study has shown that these two properties are in fact related, with a modular network being almost indistinguishable from a small-world network with respect to any kind of structural measure. However, the two are found to have quite different dynamical properties, with the former exhibiting a characteristic time-scale separation between intra- and inter-modular activity. This is important for a large class of systems, including the nervous system, where fast local synchronization of activity is essential for information processing but global synchronization is undesirable and is considered to be clinically pathological (e.g., in epilepsy). Such meso-level organization has recently been observed in an actual nervous system, that of the invertebrate *C. elegans*, whose entire somatic inter-neuronal wiring diagram has been analyzed. To understand the role of modularity in the function of neuronal networks, a study of the basin structure of modular Hopfield neural networks has show significant increase in system performance at an optimal modularity [**Sinhas2**].

In a follow-up study of Ising spins placed on networks where the interactions are arrange in a modular fashion (with all intra-modular interactions being ferromagnetic and all inter-modular interactions being anti-ferromagnetic), it has been shown that the network structure can result in a novel kind of dynamic ordering corresponding to the "chimera" state seen earlier in systems of interacting oscillators with non-local coupling [**Sin**]. This involves spins in some modules being completely ordered, while spins in the other modules are disordered, although all of them are subjected to the same thermal environment and magnetic field. This study has ramifications to the study of how the same phenomenon or information can result in differential response among different communities in society which have mutually antagonistic relations with each other.

QFT, Topological QFT, Conformal Field Thoery

A unified description of order-disorder variables and their correlation functions in different models and dimensions is obtained. This is applied to extract topological degrees of freedom in Yang-Mills theory and their role in confinement. It is also used to clarify 'bosonization' in two and higher dimensions.

A new technique for analytic evaluation of one-loop Feynman diagrams with an arbitrary number of external legs is developed.

Quantum Computations

The question of perfect local distinguishability of mutually orthogonal bipartite quantum states, with the property that every state can be specified by a unitary operator acting on the local Hilbert space of Bob, has been considered in [**G2**]. It has been shown that if the states can be exactly discriminated by one-way LOCC where Alice goes first, then the unitary operators can also be perfectly distinguished by an orthogonal measurement on Bob's Hilbert space. This necessary condition has been shown to also hold good for two-way LOCC protocols if Alice goes first provided Alice's system has dimension two. Then

examples of sets of $N \leq d$ maximally entangled states in $d \otimes d$ for $d = 4, 5, 6$ have been given that are not perfectly distinguishable by one-way LOCC. It has been conjectured (and, we (myself, Dr. Somshubhro Bandyopadhyay of Bose Institute and Dr. Guruprasad Kar of I.S.I., Kolkata) are currently trying to prove this conjecture) that these states cannot be perfectly discriminated by two-way LOCC.

Statistical Mechanics

Pressurised self-avoiding ring polymers in two dimensions have been studied using Monte Carlo simulations, scaling arguments and Flory-type theories, through models which generalise the model of Leibler, Singh and Fisher (LSF) [Phys. Rev. Lett. **59**, 1989 (1987)]. In some limits, the existence of a thermodynamic phase transition at a non-zero scaled pressure is demonstrated, where $= Np/4\pi$, with the number of monomers $N \to \infty$ and the pressure $p \to 0$, keeping constant. This transition is driven by bond energetics rather than fluctuations, and can be either continuous or discontinuous. The transition can be interpreted as a shape transition in which the ring polymer takes the shape, above the critical pressure, of a regular N-gon whose sides scale smoothly with pressure, while staying unfaceted below this critical pressure. Away from these limits, it is shown that the transition is replaced by a sharp crossover. The area, however, scales with N^2 for all positive p in all such models, validating earlier scaling theories.

The contact lines and interfaces in disordered systems and fracture lines in brittle materials are rough with anomalously high roughness exponent. These lines grow in presence of an underlying Laplacian field. The growth of random walks under the influence of a Laplacian field is studied. It is found that for a certain critical strength of the field, the walk is self-affine with a high roughness exponent matching to those found in fracture or random-field systems [**Ra1**].

A local domain-size dependent dynamical rule is shown to change the coarsening universality class. The stability of the new class is studied with various modifications of the rule. Such dynamics can have interesting consequences in the studies of opinion dynamics models [**Ra2**].

In recent times there has been a surge of interest in applying statistical mechanics to understand socio-economic phenomena [**S**]. The aim is to seek out patterns in the aggregate behavior of interacting agents, which can be individuals or groups or companies or nations. One such well-known phenomenon is that of the emergence of popularity. In many areas, we see that out of the large number of compering products or ideas, a small minority emerges as the choice of a large number of individuals. Puzzlingly, often the successful product or idea is quality-wise indistinguishable (and indeed, sometimes inferior) to its competitors which did not meet popular approval. This has led to several attempts at modeling the processes that underlie the emerhence of a popular entity. In order to understand better the empirical features of popularity dynamics that a model should seek to reproduce, the case of movies have been look at in detail [**Sinhas1**]. The detailed quantitative study shows that the following basic features that characterize popularity: a bimodal log-normal distribution and a power-law decay in time. This discovery suggests an interesting parallel with failure processes studied in statistical physics.

A prominent feature of modern economic life is the existence of financial markets. The availability of large quantities of electronic data recording transactions in such markets has

meant that physicists interested in looking for universalities in economics have found such data irresistible. Based on the study of price fluctuations, it had been suggested that the corresponding distribution has a power law with exponent -3. To explain the universality of this "inverse cubic law" and other empirical features of the market, a simple mean-field-like model has been proposed that quantitatively reproduces them [**Sinhas6**]. Apart from price fluctuations there are other quantitative variables which characterize financial markets, and there has been a running debate in the econophysics literature whether these too have universal distributions having the form of a power law. A detailed analysis of the Indian market has shown that, at least for this market, the universality of the power-law proposed for volume and number of trades distributions do not hold [**Sinhas5**].

Statistical methods can be used to infer the existence of generating rules underlying symbol sequences in nature. Recently, a method has been developed for reconstructing the syntactic structure of linguistic sequences and it has been applied on the corpus of undeciphered inscriptions obtained from the ruins of the Indus Valley Civilization (2500-1900 BCE) [**Sinhas4**]. This method, based on the concepts of complex network theory, uncovers the regularities in the sign associations and is used to build segmentation trees of the sequences. These results are currently being used to reconstruct the grammar underlying the sequences.

The nonequilibrium phase transition in a system of diffusing-aggregating particles in the presence of deposition and evaporation of monomers is studied. The transition is between a growing phase in which the total mass increases for all time and a non-growing phase in which the total mass is bounded. In addition to deriving rigorous bounds on the position of the transition point, it is analytically shown that the growing phase is in the same universality class as the model with no evaporation. In this regime, the constant flux of mass exactly determines the scaling of the two-point mass correlation function with mass in all dimensions while higher order mass correlation functions exhibit nonlinear multi-scaling in dimension less than two. A scaling theory of the model near the critical point is developed, which yields non-trivial scaling laws for the critical two-point mass correlation function with mass [**R1**].

A collection of particles that are transported ballistically and undergo inelastic collisions is a simple model for granular systems as well as a tractable model of nonequilibrium statistical mechanics. Two lattice models with stochastic dynamics are proposed to mimic the continuum model. It is demonstrated that the long-time and large-distance behaviour of the lattice models are identical to that of the continuum model. It is hoped that these lattice models will be the starting point for developing field theoretic methods for tackling inelastic gases [**R2**].

Conformational properties of a single flexible polyelectrolyte chain in a poor solvent are studied using constant temperature molecular dynamics simulation. Structural properties of various phases and the transition between these phases are studied by tracking the values of asphericity, radius of gyration, fraction of condensed counterions, number of non-bonded neighbours and Coulomb interaction energies. From simulations, strong evidence is found for a first-order phase transition from extended to collapsed phase consistent with earlier theoretical predictions. A continuous phase transition associated with Manning condensation of counter ions is identified and the critical exponents associated with such transition are estimated. It is also argued that previous suggestions of the existence of an independent intermediate phase between extended and collapsed phases is only a finite size effect [**V**].

Long rods interacting only through excluded volume interactions have been studied for a long time as models for liquid crystals. In the current study, the Bethe approximation for a system of long rigid rods of fixed length k is obtained by solving the problem exactly on the Bethe and the random locally tree-like layered lattices. For large enough k, this system undergoes an isotropic-nematic phase transition as a function of density of the rods. It is shown that for a 4-coordinated lattice, k-mers with $k \geq 4$ undergo a continuous phase transition. For even coordination number $q \geq 6$, the transition exists only for $k_{min}(q)$, and is first order [**R3**].

Attractive bonding interactions between molecules typically have inherent conservation laws which influence the statistical properties of such systems in terms of corresponding sum rules. Hydrogen bonding interaction in water is an example. It implies a sum rule that relates densities of dangling bond, hydrogen bond and water molecules. We considered lattice water as an example and enunciated consequences of the sum rule through a general computational procedure called "Molecular mean field" theory. Fluctuations about mean field are computed and many of the liquid properties have been deduced and compared with Monte Carlo simulation, molecular dynamics and experimental results. Large correlation lengths are seen to be a consequence of the sum rule in liquid phase. Long range Coulomb interactions are shown to have minor effects on our results [**Kan**].

The generalized detailed fluctuation theorem has been derived for the stochastic system driven under nonequilibrium feedback control. The central finding of the result indicate that for the same feedback information measure, the repeated measurements of the feedback controller in both forward and reversed directions does not modify the detailed fluctuation theorem. It is well known that the exponential average in one direction limits the accurate calculation of free energy differences in simulation. The knowledge of measurements from both directions usually gives improved results. The generalized detailed fluctuation theorem can be very useful in free energy simulations for systems driven under nonequilibrium feedback control [**Po1**].

String Theory

A new treatment of the problem of quantum conformal invariance for generalized non-linear sigma model has been attempted in Hamiltonian framework. This is an interacting two-dimensional quantum field theory which is classically conformal invariant and describes quantum mechanics of a bosonic string moving in an arbitrary curved background. The approach maps the problem to that of the quantum mechanics of a single particle moving in an infinite dimensional curved background subject to certain potential. The quantum mechanical description is obtained by following an approach developed by DeWitt in 1952. An analog of the conformal algebra, termed DeWitt-Virasoro (DWV) algebra, has been obtained in infinite dimensions in a background independent manner. A review of this work has been written in [**Mu2**].

The above construction shows how to do the infinite dimensional computations in spin-zero representation (i.e. in scalar quantum state). In [**Mu1**] a generalization of this analysis to higher rank tensor representations has been performed. The DWV algebra, viewed as an operator algebra, re-computed in tensor representations turns out to be same. This shows the consistency of the analysis.

2.2.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**B1**]
Radha Balakrishnan and Indubala I. Satija*.
Solitons in Bose-Einstein condensates.
Pramana, 2011.
(To be published).

[**B2**]
Indubala I. Satija* and Radha Balakrishnan.
Other incarnations of the Gross-Pitaevskii dark soliton.
Phys. Lett. A, **375**, 517, 2011.

[**Bh**]
A. K. Bhattacharjee, R. Adhikari, and Gautam I. Menon.
Fluctuating Nematodynamics using the Stochastic Method of Lines.
Journal of Chemical Physics, **133**, 044112, 2010.

[**C1**]
C. M. Chandrashekar.
Zeno subspace in quantum-walk dynamics.
Phys. Rev. A, **82**, 052108, 2010.

[**C2**]
C. M. Chandrashekar.
Disordered-quantum-walk-induced localization of a bose-einstein condensate.
Phys. Rev. A, **83**, 022320, 2011.

[**C3**]
C. M. Chandrashekar.
Quantum walk through lattice with temporal, spatial, and fluctuating disordered operations.
2011.
arXiv:1103.2704 (Submitted).

[**C4**]
C. M. Chandrashekar and Subhashish Banerjee*.
Parrondos game using a discrete-time quantum walk.
Phys. Lett. A, **375(14)**, 1553, 2011.

[**C5**]
C. M. Chandrashekar, Sandeep K. Goyal, and Subhashish Banerjee*.
Entanglement generation in spatially separated systems using quantum walk.

2010.
arXiv:1005.3785 (Submitted).

[**C6**]
Balaji Rao*, **R. Srikanth***, **C. M. Chandrashekar, and Subhashish Banerjee***.
Quantumness of noisy quantum walks: a comparison between measurement-induced disturbance and quantum discord.
2010.
arXiv:1012.5040 (Submitted).

[**C7**]
R. Srikanth*, **Subhashish Banerjee***, **and C M. Chandrashekar**.
Quantumness in decoherent quantum walk using measurement-induced disturbance.
Phys. Rev. A, **81**, 062123, 2010.

[**Ch**]
Chandrasekhar Chatterjee.
Some non perturbative aspects of gauge theories.
2011.
(Preprint: arXiv:1104.1922).

[**Cho1**]
Sujit K. Choudhary, Sibasish Ghosh, Guruprasad Kar*, **Samir Kunkri***, **Ramij Rahaman***, **and Anirban Roy***.
Hardyś non-locality and generalized non-local theory.
Quantum Information and Computation, **10(9 10)**, 859, 2010.

[**Cho2**]
Sujit K. Choudhary, Sibasish Ghosh, Guruprasad Kar*, **and Ramij Rahaman***.
Analytical proof of gisinś theorem for three qubits.
Physical Review A, **81(04)**, 042107–1, 2010.

[**Cho3**]
Sujit K. Choudhary, Sibasish Ghosh, Guruprasad Kar*, **and Ramij Rahaman***.
Comment on "gisinś theorem for arbitrary dimensional multipartite states".
Physical Review Letters, **105(21)**, 218901–1, 2010.

[**D**]
Diganta Das, David London*, **Rahul Sinha, and Abner Soffer***.
Measuring the magnitude of the fourth-generation CKM_4 matrix element $V_{t\acute{b}}$

.
$Physical Review D$, **82**, 093019, 2010.

[**Du**]
Rupak Dutta, D. Indumathi, and Nita Sinha.
Tau contamination in the platinum channel at neutrino factories.

Physical Rev. D, 2011.
1103.5578 (Submitted).

[**G1**]
Siddharth Karumanchi*, **Srinatha Narayanaswamy***, **R. Srikanth***, **and Sibasish Ghosh**.
Quantum secure direct communication by superdense coding.
Mar 2011.
Presented at the International Conference on Quantum Optics and Quantum Computing (ICQOQC - 11), held at Jaypee Institute of Information Technology, Noida, from 24 March to 26 March, 2011. (Submitted).

[**G2**]
Somshubhro Bandyopadhyay*, **Sibasish Ghosh, and Guruprasad Kar***.
Locc distinguishability of unilaterally transformable quantum states.
Quantum Information and Computation, 2011.
arXiv:1102.0841 (quant-ph) (Submitted).

[**G3**]
Sibasish Ghosh and Shasanka M. Roy*.
Chain of hardy-type local reality constraints for n qubits.
Journal of Mathematical Physics, **51(12)**, 122204–1, 2010.

[**Go1**]
Sandeep K. Goyal, Subhashish Banerjee*, **and Sibasish Ghosh**.
Effect of control procedures on the evolution of entanglement in open quantum systems.
Physical Review A, 2011.
arXiv:1102.4403 (quant-ph) (Submitted).

[**Go2**]
Sandeep K. Goyal and Sibasish Ghosh.
Quantum-to-classical transition and entanglement sudden death in gaussian states under local heat-bath dynamics.
Physical Review A, **82(04)**, 042337–1, 2010.

[**J**]
T. Jesan, Gautam I. Menon, and Sitabhra Sinha.
Epidemiological Dynamics of the 2009 Influenza A(h1n1)v Outbreak in India.
Current Science, **100(7)**, 1051, 2010.

[**K**]
S. Kalyana Rama, Swarnendu Sarkar*, **B. Sathiapalan, and Nilanjan Sircar***.
Strong coupling bcs superconductivity and holography.
2011.
(Preprint: IMSC/2011/04/2).

[**Ka**]
S. M. Kamil, Gautam I. Menon, and Sudeshna Sinha.
A Coupled Map Lattice Model for Rheological Chaos in Sheared Nematic Liquid Crystals.
Chaos, **20**, 043123, 2010.

[**Kan**]
Jampa Maruthi Pradeep Kanth and Ramesh Anishetty.
Molecular mean field theory for liquid water.
2010.
(Preprint: arXiv:1004.1547v1).

[**M1**]
T. Jesan*, Gautam I. Menon, and Sitabhra Sinha.
Epidemiological dynamics of the 2009 influenza a(h1n1)v outbreak in india.
Current Science, 2011.
arxiv:1006.0685 (To be published).

[**M2**]
Gautam I. Menon.
Active matter.
In Murali Krishnan Abhijit Deshpande and P.B. Sunil Kumar, editors, *Rheology of Complex Fluids*, page 193. Springer, 2010.

[**M3**]
Ankush Sengupta*, Surajit Sengupta*, and Gautam I. Menon.
Driven Disordered Polymorphic Solids: Phases and Phase Transitions, Dynamical Coexistence and Peak Effect Anomalies.
Physical Review B, **81**, 144521, 2010.

[**Mi**]
Mithun K. Mitra, Gautam I. Menon, and R. Rajesh.
Asymptotic Behaviour of Convex and Column Convex Polygons with Fixed Area and Varying Perimeter.
Journal of Statistical Mechanics: Theory and Experiment, **2010**, P07029, 2010.

[**Mu1**]
Partha Mukhopadhyay.
DeWitt-Virasoro construction in tensor representations.
2010.
(Preprint: arXiv:1004.2396 [hep-th]).

[**Mu2**]
Partha Mukhopadhyay.
DeWitt-Virasoro construction.
Pramana journal of physics, **76(3)**, 407, 2010.

[**Mur1**]
R. Bhaduri*, **M. Brack***, **and M. Murthy**.
A semiclassical analysis of the efimov energy spectrum.
Submitted to Physcial Review A, 2011.
arXiv: 1103.1737v1 [quant-ph] (Submitted).

[**Mur2**]
R. Bhaduri*, **M. Murthy, and Diptiman Sen***.
The virial expansion of a classical interacting gas.
Journal of Physics: Mathematical and Theoretical, **43**, 045002, 2010.

[**P**]
Rajarshi Pal and Sibasish Ghosh.
Approximate joint measurement of qubit observables through an arthur-kelly type model.
2010.
(Preprint: arXiv:1010.2878 (quant-ph)).

[**Po1**]
M. Ponmurugan.
Generalized detailed fluctuation theorem under nonequilibrium feedback control.
Physical Review E, **82**, 031129, 2010.

[**Po2**]
M. Ponmurugan, V. Sridhar*, **S. L. Narasimhan***, **and K. P. N. Murthy***.
flatIGW An inverse algorithm to compute the density of states of lattice self avoiding walks.
Physica A, **390**, 1258, 2011.

[**R1**]
C. Connaughton *, **R. Rajesh, and O. Zaboronski***.
On the non-equilibrium phase transition in evaporation-deposition models.
J. Stat. Mech, **-**, P09016, 2010.

[**R2**]
S. Dey*, **D. Das***, **and R. Rajesh**.
Lattice models for ballistic aggregation in one-dimension.
Euro. Phys. Lett., **93**, 44001, 2011.

[**R3**]
D. Dhar*, **R. Rajesh, and J. Stilck***.
Bethe approximation for a system of hard rigid rods: the random locally tree-like layered lattice.
Phys. Rev. E, 2011.
(Submitted).

[**Ra1**]
J. O. H. Bakke*, **P. Ray, and A. Hansen***.

Morphology of laplacian random walks.
Europhysics Letters, **92**, 36004, 2010.

[**Ra2**]
S. Biswas*, P. Sen*, and P. Ray.
Opinion dynamics model with domain size dependent dynamics: novel features and new universality class.
Journal of Physics: Conference Series, 2011.
(Submitted).

[**Ro1**]
A.K. Bhattacharjee, G.I. Menon, and R. Adhikari.
Fluctuating dynamics of nematic liquid crystals using the stochastic method of lines.
Journal of Chemical Physics, 133, 2010.

[**Ro2**]
A. Dua and R. Adhikari.
Non-markovian fluctuations in markovian models of protein dynamics.
Journal of Statistical Mechanics: Theory and Experiment, **2011(04)**, P04017, 2011.

[**Ro3**]
K. Gangal, M.N. Vahia, and R. Adhikari.
Spatio-temporal analysis of the indus urbanization.
Current Science, **98(6)**, 846–852, 2010.

[**Ro4**]
Somdeb Ghose and R. Adhikari.
Endogenous quasicycles and stochastic coherence in a closed endemic model.
Physical Review E, 82, 2010.

[**Ro5**]
M. Gross, R. Adhikari, M.E. Cates, and F. Varnik.
Thermal fluctuations in the lattice boltzmann method for non-ideal fluids.
Physical Review E, 82, 2010.

[**Ro6**]
M. Gross, M.E. Cates, F. Varnik, and R. Adhikari.
Langevin theory of fluctuations in the discrete boltzmann equation.
Journal of Statistical Mechanics: Theory and Experiment, **2011(03)**, P03030, 2011.

[**Ro7**]
R.W. Nash, R. Adhikari, J. Tailleur, and M.E. Cates.
Run-and-tumble particles with hydrodynamics: Sedimentation, trapping, and upstream swimming.
Physical Review Letters, 104(25), 2010.

[**Ro8**]
R.P.N. Rao, N. Yadav, M.N. Vahia, H. Joglekar, R. Adhikari, and I. Mahadevan.
Entropy, the indus script, and language: A reply to r. sproat.
Computational Linguistics, **36(4)**, 795–805, 2010.

[**Ro9**]
P.T. Sumesh, I. Pagonabarraga, and R. Adhikari.
Lattice-boltzmann-langevin simulations of binary mixtures.
arXiv cond-mat/1104.0078, 2011.
arxiv.org/abs/1104.0078.

[**Ro10**]
N. Yadav, H. Joglekar, R.P.N. Rao, M.N. Vahia, R. Adhikari, and I. Mahadevan.
Statistical analysis of the indus script using n-grams.
Plos One, 5(03), 2010.

[**S1**]
J. S. Ivan*, Krishnakumar Sabapathy, and R. Simon.
Operator-sum representation for bosonic gaussian channels.
2010.
(Preprint: arXiv: 1012.4266).

[**S2**]
Krishnakumar Sabapathy, J. S. Ivan*, and R. Simon.
Robustness of non-Gaussian entanglement against noisy amplifier and attenuator environments.
2011.
(Preprint: arXiv: 1102.1311).

[**Si1**]
J. S. Ivan*, S. Chaturvedi*, E. Ercolessi*, G. Marmo*, G. Morandi*, N. Mukunda*, and R. Simon.
Entanglement and nonclassicality for multimode radiation-field states.
Phys. Rev. A, **83**, art. no. 032118, pp. 1–20, 2011.

[**Si2**]
V. K. Jaiswal*, R. P. Singh*, and R. Simon.
Producing optical vortices through forked holographic grating: study of polarization.
Jour. Mod. Opt., **57**, 2031–2038, 2010.

[**Si3**]
K. S. Mallesh*, S. Chaturvedi*, V. Balakrishnan*, R. Simon, and N. Mukunda*.
Symmetries and conservation laws in classical and quantum mechanics: 1. Classical mechanics.
Resonance, **18**, 129–151, 2011.

[**Si4**]
K. S. Mallesh*, S. Chaturvedi*, V. Balakrishnan*, R. Simon, and N. Mukunda*.

Symmetries and conservation laws in classical and quantum mechanics: 2. Quantum mechanics.
Resonance, **18**, 254–273, 2011.

[**Sin**]
Rajeev Singh, Subinay Dasgupta*, **and Sitabhra Sinha**.
Chimera order in spin systems.
2011.
arXiv:1011.5032 (Submitted).

[**Sinh**]
Nita Sinha.
Tau contributions to muon/electron events at a neutrino factory.
In *AIP conference proceedings, Proceedings of the 12th International Workshop on Neutrino Factories, Superbeams and Beta BeamsNuFact10*. AIP, Mar 2011.
(Submitted).

[**Sinha1**]
L. Oliver *, **J. C. Raynal***, **and R. Sinha**.
Note on new interesting baryon channels to measure the photon polarization in $b \to s\gamma$.
Physical Review D, **82**, 117502, 2010.

[**Sinha2**]
A. Bozek*, **M. Rozanska***, **...***, **R. Sinha, ...***, **and (Belle Collaboration)***.
Observation of $B^+ \to \bar{D}^{*0}\tau^+\nu_\tau$ and evidence for $B^+ \to \bar{D}^0\tau^+\nu_\tau$ at Belle.
Physical Review D, **82**, 072005, 2010.

[**Sinha3**]
C. . Chiang*, **H. Aihara***, **...***, **R. Sinha, ...***, **and (Belle Collaboration)***.
Search for $B^0 \to K^{*0}\bar{K}^{*0}$, $B^0 \to K^{*0}k^{*0}$ and $B^0 \to K^+\pi^-K^\mp\pi^\pm$ Decays.
Physical Review D, **81**, 071101, 2010.

[**Sinha4**]
A. Das*, **T. Aziz***, **...***, **R. Sinha, ...***, **and (Belle Collaboration)***.
Measurements of branching fractions for $B^0 \to D_s^+\pi^-$ and $\bar{B}^0 \to D_s^+K^-$.
Phys. Rev. D, **82**, 051103(R), 2010.

[**Sinhas1**]
Raj K. Pan* **and Sitabhra Sinha**.
The statistical laws of popularity: Universal properties of the box office dynamics of motion pictures.
New Journal of Physics, **12**, 115004, 2010.

[**Sinhas2**]
Neeraj Pradhan*, **Subinay Dasgupta***, **and Sitabhra Sinha**.
Modular organization enhances the robustness of attractor network dynamics.

EPL, 2011.
arxiv:1101.5853 (To be published).

[**Sinhas3**]
Sitabhra Sinha.
Are large complex economic systems unstable?
Science and Culture, **76(9-10)**, 454, 2010.

[**Sinhas4**]
Sitabhra Sinha, Ashraf M. Izhar, Raj K. Pan, and Bryan K. Wells.
Network analysis of a corpus of undeciphered indus civilization inscriptions indicates syntactic organization.
Computer Speech and Language, **25(3)**, 639, 2011.

[**Sinhas5**]
V. S. Vijayraghavan* **and Sitabhra Sinha**.
Are the trading volume and the number of trades distributions universal?
In A. Chakraborti F. Abergel, B. K. Chakrabarti and M. Mitra, editors, *Econophysics of Order-Driven Markets*, page 17. Springer, 2011.

[**Sinhas6**]
S. V. Vikram* **and Sitabhra Sinha**.
Emergence of universal scaling in financial markets from mean-field dynamics.
Physical Review E, **83(1)**, 016101, 2011.

[**Sr1**]
S. Sridhar, Sitabhra Sinha, and Alexander V. Panfilov*.
Anomalous drift of spiral waves in heterogeneous excitable media.
Physical Review E, **82**, 051908, 2010.

[**Sr2**]
S. Sridhar and Sitabhra S Sinha.
Response to sub-threshold stimulus is enhanced by spatially heterogeneous activity.
Europhysics Letters, **92**, 60006, 2010.

[**Sri1**]
S. Sridhar and Sitabhra Sinha.
Response to sub-threshold stimulus is enhanced by spatially heterogeneous activity.
EPL, **92(6)**, 60006, 2010.

[**Sri2**]
S. Sridhar, Sitabhra Sinha, and Alexander V. Panfilov*.
Anomalous drift of spiral waves in heterogeneous excitable media.
Physical Review E, **82(5)**, 051908, 2010.

[**V**]
A. Varghese, V. Vemparala, and R. Rajesh.
Phase transitions of a single polyelectrolyte in a poor solvent with explicit counterions.
Phys. Rev. E, 2010.
(Submitted).

Books/Monographs Authored/Edited

The list below follows the same conventions as those followed for the list of publications.

[**S**]
Sitabhra Sinha, Arnab Chatterjee*, Anirban Chakraborti*, and Bikas K. Chakrabarti*.
Econophysics: An Introduction.
Wiley-VCH, Berlin, 2010.

2.3 Theoretical Computer Science

2.3.1 Research Summary

Algorithms and Complexity

In the k-means problem, a finite set S of points in $\Re^m$, and an integer $k \geq 1$, are given, and the goal is to find k points (centers) so as to minimize the sum of the square of the Euclidean distance of each point in S to its nearest center. It is shown that this well-known problem is NP-hard even for instances in the plane, answering an open question posed by Dasgupta in 2007.
This work is reported in [**M5**].

Parameterized Complexity

In parameterized complexity each problem instance comes with a parameter k and the parameterized problem is said to admit a *polynomial kernel* if there is a polynomial time algorithm (the degree of polynomial is independent of k), called a *kernelization* algorithm, that reduces the input instance down to an instance with size bounded by a polynomial $p(k)$ in k, while preserving the answer. This reduced instance is called a $p(k)$ *kernel* for the problem. If $p(k) = O(k)$, then it is called a *linear kernel*. A central notion in parameterized complexity is *fixed parameter tractability (FPT)*, which means, for a given instance (x, k), solvability in time $f(k) \cdot p(|x|)$, where f is an arbitrary function of k and p is a polynomial in the input size.

In [**S2**] an algorithmic study of Boxicity, a combinatorially well studied graph invariant, is initiated from the viewpoint of parameterized algorithms. The boxicity of an arbitrary graph G with the vertex set $V(G)$ and the edge set $E(G)$, denoted by $\mathbf{box}(G)$, is the minimum number of interval graphs on the same set of vertices such that the intersection of the edges

sets of the interval graphs is $E(G)$. In the BOXICITY problem a graph G together with a positive integer k is given, and the question is whether the $\mathbf{box}(G)$ is at most k. The problem is notoriously hard and is known to be NP-complete even to determine whether the boxicity of a graph is at most two. This rules out any possibility of having an algorithm with running time $|V(G)|^{O(f(k))}$, where f is an arbitrary function depending on k alone. Thus one looks for other structural parameters like "vertex cover number" and "max leaf number" and see its effect on the problem complexity. In particular,in [**S2**] an algorithm is obtained that given a vertex cover of size k finds $\mathbf{box}(G)$ in time $2^{O(2^k k^2)}|V(G)|$. The paper also gives a faster additive one approximation algorithm for finding $\mathbf{box}(G)$ that given a graph with vertex cover of size k runs in time $2^{O(k^2 \log k)}|V(G)|$. The next result in [**S2**] is an additive two approximation algorithm for BOXICITY when parameterized by the max leaf number running in time $2^{O(k^3 \log k)}|V(G)|^{O(1)}$. These results are based on structural relationships between boxicity and the corresponding parameter and could be of independent interest.

Computing the *Dodgson Score* of a candidate in an election is a hard computational problem, which has been analyzed using classical and parameterized analysis. In [**S3**] we resolve two open problems regarding the parameterized complexity of DODGSON SCORE are resolved. It is shown that DODGSON SCORE parameterized by the target score value k has no polynomial kernel unless the polynomial hierarchy collapses to the third level; this complements a result of Fellows, Rosamond and Slinko who obtain a non-trivial kernel of exponential size for this problem. It is also proved that DODGSON SCORE parameterized by the number n of cast votes is hard for $W[1]$.

In [**S9**] a study of a "dynamic" variant of the classical VERTEX COVER problem, the ETERNAL VERTEX COVER problem introduced by Klostermeyer and Mynhardt, is initiated from the perspective of parameterized algorithms. This problem consists in placing a minimum number of guards on the vertices of a graph such that these guards can protect the graph from any sequence of attacks on its edges. In response to an attack, each guard is allowed either to stay in his vertex, or to move to a neighboring vertex. However, at least one guard has to fix the attacked edge by moving along it. The other guards may move to reconfigure and prepare for the next attack. Thus at every step the vertices occupied by guards form a vertex cover. It is shown that the problem admits a kernel of size $4^k(k+1)+2k$, which shows that the problem is fixed parameter tractable when parameterized by the number of available guards k. Finally, an algorithm with running time $O(2^O(k^2)nm)$ is provided for ETERNAL VERTEX COVER, where n is the number of vertices and m the number of edges of the input graph. In passing it is also observed that ETERNAL VERTEX COVER is NP-hard, yet it has a polynomial time 2-approximation algorithm.

In [**Ram1**] a fast local search algorithm that finds an improved solution (if there is any) in the k-exchange neighborhood of the given solution to an instance of WEIGHTED FEEDBACK ARC SET IN TOURNAMENTS is presented. More precisely, given an arc weighted tournament T on n vertices and a feedback arc set F (a set of arcs whose deletion from T turns it into a directed acyclic graph), the algorithm decides in time $O(2^{o(k)}n \log n)$ if there is a feedback arc set of smaller weight and that differs from F in at most k arcs. This is the first known algorithm searching the k-exchange neighborhood of an NP-complete problem that runs in (parameterized) subexponential time. Using this local search algorithm for WEIGHTED FEEDBACK ARC SET IN TOURNAMENTS, subexponential time algorithms for a local search variant of KEMENY RANKING – a problem in social choice theory and of ONE-SIDED CROSS MINIMIZATION – a problem in graph drawing are obtained.

Given a permutation π of $\{1, \ldots, n\}$ and a positive integer k, an algorithm with running time $2^{O(k^2 \log k)} n^{O(1)}$ that decides whether π can be partitioned into at most k increasing or decreasing subsequences is given in [**Ram2**]. Thus resolving affirmatively the open question of whether the problem is fixed parameter tractable. This NP-complete problem is equivalent to deciding whether the cochromatic number, partitioning into the minimum number of cliques or independent sets, of a given permutation graph on n vertices is at most k. In fact in [**Ram2**], a more general result is given: within the mentioned running time, it can be decided that the cochromatic number of a given perfect graph on n vertices is at most k. These results are obtained by a combination of two well-known techniques within parameterized algorithms, namely greedy localization and iterative compression. The power of this new combination is further demonstarted by obtaining a $2^{O(k^2 \log k)} n \log n$ time algorithm for deciding whether a given set of n non-overlapping axis-parallel rectangles can be stabbed by at most k of a given set of horizontal and vertical lines. Whether such an algorithm exists was mentioned as an open question in several papers.

In the Imbalance Minimization problem a graph $G = (V, E)$ and an integer k are given and asked whether there is an ordering $v_1 \ldots v_n$ of V such that the sum of the imbalance of all the vertices is at most k. The imbalance of a vertex v_i is the absulute value of the difference between the number of neighbours to the left and right of v_i. The problem is also known as the Balanced Vertex Ordering problem and finds applications in graph drawing. It is shown in [**Mi7**] that this problem is fixed parameter tracable and gives an algorithm that runs in time $2^{O(k \log k)} \cdot n^{O(1)}$. This resolves an open problem of Kára et al. [COCOON 2005].

The article [**Mi10**] is a survey containing recent lower bounds machinery and some concrete results in the area.

A central problem in parameterized algorithms is to obtain algorithms with running time $f(k) \cdot n^{O(1)}$ such that f is as slow growing function of the parameter k as possible. In particular, the first natural goal is to make $f(k)$ single-exponential, that is, c^k for some constant c. This has led to the development of parameterized algorithms for various problems where $f(k)$ appearing in their running time is of form $2^{O(k)}$. However there are still plenty of problems where the "slightly superexponential" $f(k)$ appearing in the best known running time has remained non single-exponential even after a lot of attempts to bring it down. A natural question to ask is whether the $f(k)$ appearing in the running time of the best-known algorithms is optimal for any of these problems. In [**S6**] parameterized problems where $f(k)$ is $k^{O(k)} = 2^{O(k \log k)}$ in the best known running time are examined and for a number of such problems, it is shown that the dependence on k in the running time cannot be improved to single exponential. More precisely following tight lower bounds are proved, for three natural problems, arising from three different domains:

- The pattern matching problem Closest String is known to be solvable in time $2^{O(d \log d)} \cdot n^{O(1)}$ and $2^{O(d \log |\Sigma|)} \cdot n^{O(1)}$. It is shown that there is no $2^{o(d \log d)} \cdot n^{O(1)}$ and $2^{o(d \log |\Sigma|)} \cdot n^{O(1)}$ time algorithm, unless Exponential Time Hypothesis (ETH) fails.
- The graph embedding problem Distortion, that is, deciding whether a graph G has a metric embedding into the integers with distortion at most d can be done in time $2^{O(d \log d)} \cdot n^{O(1)}$. We show that there is no $2^{o(d \log d)} \cdot n^{O(1)}$ time algorithm, unless ETH fails.
- The Disjoint Paths problem can be solved in time in time $2^{O(w \log w)} \cdot n^{O(1)}$ on graphs

of treewidth at most w. We show that there is no $2^{o(w \log w)} \cdot n^{O(1)}$ time algorithm, unless ETH fails.

To obtain these result first the lower bound for variants of basic problems like finding cliques, independent sets, and hitting sets are proved. These artificially constrained variants form a good starting point for proving lower bounds on natural problems without any technical restrictions and could be of independent interest. It is believed that many further results of this form can be obtained by using the framework of the current paper.

In [**S4**] a number of lower bounds on the running time of algorithms solving problems on graphs of bounded treewidth are obtained. The results are proved under the Strong Exponential Time Hypothesis of Impagliazzo and Paturi. In particular, assuming that SAT cannot be solved in $(2-\epsilon)^n m^{O(1)}$ time, it is shown that for any $\epsilon > 0$;

- Independent Set cannot be solved in $(2-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time,
- Dominating Set cannot be solved in $(3-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time,
- Max Cut cannot be solved in $(2-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time,
- Odd Cycle Transversal cannot be solved in $(3-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time,
- For any $q \geq 3$, q-Coloring cannot be solved in $(q-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time,
- Partition Into Triangles cannot be solved in $(2-\epsilon)^{\mathbf{tw(G)}}|V(G)|^{O(1)}$ time.

These lower bounds match the running times for the best known algorithms for the problems, up to the ϵ in the base.

Bidimensionality theory appears to be a powerful framework for the development of meta-algorithmic techniques. It was introduced by Demaine et al. [*J. ACM 2005*] as a tool to obtain sub-exponential time parameterized algorithms for problems on H-minor free graphs. Demaine and Hajiaghayi [*SODA 2005*] extended the theory to obtain polynomial time approximation schemes (PTASs) for bidimensional problems, and subsequently improved these results to EPTASs. Fomin et. al [*SODA 2010*] established a third meta-algorithmic direction for bidimensionality theory by relating it to the existence of linear kernels for parameterized problems. In [**Ram4**] bidimensionality theory is revisited from the perspective of approximation algorithms and the framework for obtaining EPTASs is redesigned to be more powerful, easier to apply and easier to understand. One of the important conditions required to obtain an EPTAS for a graph optimization problem Π using the framework developed by Demaine and Hajiaghayi [*SODA 2005*] is to have a constant-factor approximation algorithm for Π. The first contribution of [**Ram4**] is that the proposed framework removes this strong requirement which makes it amenable to more problems. At the heart of this framework is a decomposition lemma which states that for "most" bidimensional problems, there is a polynomial time algorithm which given an H-minor-free graph G as input and an $\epsilon > 0$ outputs a vertex set X of size $\epsilon \cdot OPT$ such that the treewidth of $G \setminus X$ is $f(\epsilon)$. Here, OPT is the objective function value of the problem in question and f is a function depending only on ϵ. This allows it to obtain EPTASs on (apex)-minor-free graphs for all problems covered by the previous framework, as well as for a wide range of packing problems, partial covering problems and problems that are neither closed under taking minors, nor contractions. To the best of our knowledge for many of these problems including Cycle Packing,

VERTEX-$\mathcal{H}$-PACKING, MAXIMUM LEAF SPANNING TREE, and PARTIAL r-DOMINATING SET no EPTASs on planar graphs were previously known.

A bipartite graph $G = (A \cup B, E)$ is called a chain graph if there exists an ordering $\rho =< v_1, v_2, \ldots v_n >$ of the vertices in $A = \{v_1, \ldots, v_n\}$ such that $N(v_1) \subseteq N(v_2) \ldots \subseteq N(v_n)$. Here $N(v)$ denotes the set of neighbors of the vertex v in G. The vertex-deletion problem corresponding to the class of chain graphs is called as the MINIMUM CHAIN VERTEX DELETION problem and the induced subgraph problem corresponding to chain graphs is called as the MAXIMUM INDUCED CHAIN SUBGRAPH problem. A weighted version of these problems is obtained by assigning positive weights on vertices and asking for a minimum weight deletion set to get into the class of chain graphs or asking for maximum weight induced chain subgraph. Using a rounding technique it is shown in [**S5**] that the weighted version of MINIMUM CHAIN VERTEX DELETION, has a factor 2 approximation algorithm on bipartite graphs. A factor 3/2 approximation algorithm for a weighted version of MAXIMUM INDUCED CHAIN SUBGRAPH on bipartite graphs is also given. It is also shown that both these problems are APX-complete.

Many divide-and-conquer algorithms employ the fact that the vertex set of a graph of bounded treewidth can be separated in two roughly balanced subsets by removing a small subset of vertices, referred to as a separator. In [**S1**] a trade-off between the size of the separator and the sharpness with which one can fix the size of the two sides of the partition is proven. This result appears to be a handy and powerful tool for the design of exact and parameterized algorithms for NP-hard problems. It is illustrated by showing two applications. Its first application is a parameterized algorithm with running time $O(16^{k+o(k)} + n^{O(1)})$ for the MAXIMUM INTERNAL SUBTREE problem in directed graphs. This is a significant improvement over the best previously known parameterized algorithm for the problem by [Cohen et al.'09], running in time $O(49.4^k + n^{O(1)})$. The second application is a $O(2^{n+o(n)})$ time algorithm for the DEGREE CONSTRAINED SPANNING TREE problem: find a spanning tree of a graph with the maximum number of nodes satisfying given degree constraints. This problem generalizes some well-studied problems, among them HAMILTONIAN PATH, FULL DEGREE SPANNING TREE, BOUNDED DEGREE SPANNING TREE, MAXIMUM INTERNAL SPANNING TREE and their edge weighted variants.

The effect of certain natural connectivity constraints on the parameterized complexity of two fundamental graph covering problems, namely k-VERTEX COVER and k-EDGE COVER, is investigated. Specifically, the additional requirement that each connected component of a solution have at least t vertices (resp. edges from the solution) is imposed, and the resulting problem is given the name t-TOTAL VERTEX COVER (resp. t-TOTAL EDGE COVER). It is shown that

- both problems remain fixed-parameter tractable with these restrictions, with running times of the form $O^\star(c^k)$ for some constant $c > 0$ in each case;
- for every $t \geq 2$, t-TOTAL VERTEX COVER has no polynomial kernel unless the Polynomial Hierarchy collapses to the third level;
- for every $t \geq 2$, t-TOTAL EDGE COVER has a linear vertex kernel of size $(t+1)k/t$. These results significantly improve earlier work on these problems.

This no-poly-kernel result for t-TOTAL VERTEX COVER, and the known NP-hardness

result for t-TOTAL EDGE COVER , are in stark contrast to the fact that k-VERTEX COVER has a $2k$ vertex kernel, and that k-EDGE COVER is solvable in polynomial time. This illustrates how even the slightest connectivity requirement results in a drastic change in the tractability of problems [**Ph1**].

Parameterized subexponential-time algorithms for p-Kemeny Aggregation (p-KAGG) — a problem in social choice theory — and for p-One-Sided Crossing Minimization (p-OSCM) — a problem in graph drawing — are obtained. These algorithms run in time $O^\star(2^{O(\sqrt{k}\log k)})$, where k is the parameter, and significantly improve the previous best algorithms with running times $O^\star(1.403^k)$ and $O^\star(1.4656^k)$, respectively. Natural above-guarantee versions of these problems are also studied, and they are shown to be fixed parameter tractable. In fact, it is shown that the above-guarantee versions are equivalent to a weighted variant of p-Directed Feedback Arc Set. These results for the above-guarantee version of p-KAGG reveal an interesting contrast. It is shown that when the number of votes in the input to p-KAGG is odd the above guarantee version can still be solved in time $O^\star(2^{O(\sqrt{k}\log k)})$, while if it is even then the problem cannot have a subexponential time algorithm unless the exponential time hypothesis fails (equivalently, unless FPT=M[1]) [**Ph2**].

The Colorful Motif problem asks if, given a vertex-coloured graph G, there exists a subset S of vertices of G such that the graph induced by G on S is connected and contains every colour in the graph exactly once. The problem is motivated by applications in computational biology and is also well-studied from the theoretical point of view. In particular, it is known to be NP-complete even on trees of maximum degree three [Fellows et al, ICALP 2007]. In their pioneering paper that introduced the color-coding technique, it is shown by Alon et al. [STOC 1995], *inter alia*, that the problem is FPT on general graphs. More recently, it was shown by Cygan et al. [WG 2010] that Colorful Motif is NP-complete on comb graphs, a special subclass of the set of trees of maximum degree three. In the same work, it was also shown that the problem is not likely to admit polynomial kernels on forests.

The study of the kernelization complexity of the Colorful Motif problem restricted to simple graph classes is continued in this work. Surprisingly, the infeasibility of polynomial kernelization persists even when the input is restricted to comb graphs. This is demonstrated by showing a simple but novel composition algorithm. Further, it is shown that the problem restricted to comb graphs admits polynomially many polynomial kernels. There are very few examples of problems with many polynomial kernels known in the literature. Hardness of polynomial kernelization for certain variants of the problem on trees is also shown; this rules out a general class of approaches for showing many polynomial kernels for the problem restricted to trees. Finally, it is shown that the problem is unlikely to admit polynomial kernels on another simple graph class, namely the set of all graphs of diameter two. As an application of these results, the classical complexity of Connected Dominating Set on graphs of diameter two is settled — specifically, it is shown that this problem is NP-complete.

The pathwidth of a graph is a measure of how path-like the graph is. Given a graph G and an integer k, the problem of finding whether there exist at most k vertices in G whose deletion results in a graph of pathwidth at most one is NP-complete. The study of the parameterized complexity of this problem, parameterized by k, is initiated in this work. It is shown that the problem has a quartic vertex-kernel: It is shown that, given an input instance $(G = (V, E), k)$ where $|V| = n$, an instance (G', k') can be constructed in polynomial time

such that (i) (G, k) is a YES instance if and only if (G', k') is a YES instance, (ii) G has $O(k^4)$ vertices, and (iii) $k' \leq k$. A fixed parameter tractable (FPT) algorithm for the problem that runs in $O^\star(7^k \cdot n^3)$ time is also given. These figures compare favourably with the best results known for the closely related, and extensively studied, Feedback Vertex Set problem [**Ph3**].

In the CONNECTED DOMINATING SET problem the input is a graph G and a positive integer k, and the question is whether there is a set S of at most k vertices of G such that S is a dominating set of G and the subgraph induced by S is connected. This is a basic connectivity problem that is known to be NP-complete, and it has been extensively studied using several algorithmic approaches. The effect on the kernelization complexity of CONNECTED DOMINATING SET of excluding short cycles as a subgraph is studied in this paper. Kernelization algorithms are polynomial-time algorithms that take an input and a positive integer k (the parameter) and output an equivalent instance where the size of the new instance and the new parameter are both bounded by some function $g(k)$. The new instance is called a $g(k)$ kernel for the problem. If $g(k)$ is a polynomial then it is said that the problem admits polynomial kernels. The girth of a graph G is the length of a shortest cycle in G. It turns out that CONNECTED DOMINATING SET is hard on graphs with small cycles, and becomes progressively easier as the girth increases. More specifically, the following interesting trichotomy is obtained: CONNECTED DOMINATING SET

- does not have a kernel of any size on graphs of girth 3 or 4 (since the problem is W[2]-hard);
- admits a $g(k)$ kernel, where $g(k)$ is roughly $k^{O(k)}$, on graphs of girth 5 or 6 but has no polynomial kernel (unless the Polynomial Hierarchy (PH) collapses to the third level) on these graphs;
- has a cubic ($O(k^3)$) kernel on graphs of girth at least 7.

While there is a large and growing collection of parameterized complexity results available for problems on graph classes characterized by excluded minors, these results add to the very few known in the field for graph classes characterized by excluded subgraphs [**Mi2**].

A general class of problems called F-Deletion problems is investigated. In an F-Deletion problem, the question is whether a subset of at most k vertices can be deleted from a graph G such that the resulting graph does not contain as a minor any graph from the family F of forbidden minors. A number of algorithmic results on the F-Deletion problem, when F contains a planar graph, are obtained, including:

- a linear vertex kernel on graphs excluding the t-claw $K_{1,t}$, the star with t leaves, as an induced subgraph, where t is a fixed integer.
- an approximation algorithm achieving an approximation ratio of $O/(log^{3/2}OPT)$, where OPT is the size of an optimal solution on general undirected graphs.

Finally, polynomial kernels for the case when F only contains the graph Θ_c as a minor for a fixed integer c are obtained. The graph Θ_c consists of two vertices connected by c parallel edges. Even though this may appear to be a very restricted class of problems

it already encompasses well-studied problems such as Vertex Cover, Feedback Vertex Set and Diamond Hitting Set. The generic kernelization algorithm is based on a non-trivial application of protrusion techniques, previously used only for problems on topological graph classes [**Mi8**].

It is shown that the Dominating Set problem parameterized by solution size is fixed-parameter tractable (FPT) in graphs that do not contain the claw ($K_{1,3}$, the complete bipartite graph on four vertices where the two parts have one and three vertices, respectively) as an *induced* subgraph. An algorithm that uses $2^{O(k^2)}n^{O(1)}$ time and polynomial space to decide whether a claw-free graph on n vertices has a dominating set of size at most k is presented. Note that this parameterization of Dominating Set is W[2]-hard on the set of all graphs, and thus is unlikely to have an FPT algorithm for graphs in general.

The most general class of graphs for which an FPT algorithm was previously known for this parameterization of Dominating Set is the class of $K_{i,j}$-free graphs, which exclude, for some fixed $i, j \in \mathbb{N}$, the complete bipartite graph $K_{i,j}$ as a *subgraph*. For $i, j \geq 2$, the class of claw-free graphs and any class of $K_{i,j}$-free graphs are not comparable with respect to set inclusion. The range of graphs over which this parameterization of Dominating Set is known to be fixed-parameter tractable is thus *extended* by this work.

It is also shown that, in some sense, it is the presence of the claw that makes this parameterization of the Dominating Set problem hard. More precisely, it is shown that for any $t \geq 4$, the Dominating Set problem parameterized by the solution size is W[2]-hard in graphs that exclude the t-claw $K_{1,t}$ as an induced subgraph. These arguments also imply that the related Connected Dominating Set and Dominating Clique problems are W[2]-hard in these graph classes.

Finally, it is shown that for any $t \in \mathbb{N}$, the Clique problem parameterized by solution size, which is $W[1]$-hard on general graphs, is FPT in t-claw-free graphs. These results add to the small and growing collection of FPT results for graph classes defined by excluded *subgraphs*, rather than by excluded *minors* [**Ph6**].

Automata, Logic and Concurrency

[**R**] continues our investigations into the complexity of Dolev-Yao theories underlying security protocols. The former investigates term algebras in which a binary operator is distributive over encryption, and the term derivability problem for such theories is shown to be complete for deterministic exponential time. This is in contrast to standard theories for which the problem is in polynomial time and abelian groups where only non-elementary bounds are known. While it is clear that reasoning about security protocols involves epistemic attitudes of agents, natural formalizations lead to undecidability and [**Ra5**] sets out the challenges involved. [**Ra3**] answers a set of questions addressed to a group of logicians on epistemic logic.

Large games, in which the number of players is so large that players do not have the resources to compute best response to all strategies of other players, are investigated in [**P**] and the stability of imitative strategies characterized. [**Ra2**] studies distributed games of partial information, proposes a new solution concept, that of *locally consistent equilibrium* and presents decidability results for a model in which players communicate by public announcement. In [**Ra1**] extensive form games are studied in which a player may be playing

several games concurrently against different opponents, employing strategies learnt in one in another.

Computational Complexity

The class of polynomials computable by polynomial size log depth arithmetic circuits (VNC^1) is known to be computable by constant width polynomial degree circuits ($VsSC^0$), but whether the converse containment holds is an open problem. As a partial answer to this question, a construction which shows that *syntactically multilinear* circuits of constant width and polynomial degree can be depth-reduced is given, yielding sm-$VsSC^0 \subseteq$ sm-VNC^1. This inclusion is further strengthened by giving a separate construction that provides a width-efficient simulation for constant width syntactically multilinear circuits by constant width syntactically multilinear algebraic branching programs (thus sm-$VsSC^0 \subseteq$sm-VBWBP). Next, polynomial-size syntactically multilinear circuits are investigated, and relationships between classes of functions obtained by imposing various resource (width, depth, degree) restrictions on these circuits are explored. Along the way, a characterisation of the class NC^1 in terms of a restricted class of planar branching programs of polynomial size is observed. Finally, in contrast to the general case, coefficient functions for the syntactically multilinear classes studied in this work are shown to possess closure and stability.
This work is reported in [**M3**]

In [**M4**], an $\#NC^1$ upper bound is shown for the problem of counting accepting paths in any fixed visibly pushdown automaton. The algorithm involves a non-trivial adaptation of the arithmetic formula evaluation algorithm of Buss, Cook, Gupta, Ramachandran (BCGR: SICOMP 21(4), 1992). It is also shown that the problem is $\#NC^1$ hard. These results show that the difference between #BWBP and $\#NC^1$ is captured exactly by the addition of a visible stack to a nondeterministic finite-state automata.
This work is reported in [**M4**].

The class NC^1 of problems solvable by bounded fan-in circuit families of logarithmic depth is known to be contained in logarithmic space DLOG, but not much about the converse is known. In [**M2**], the structure of classes in between NC^1 and DLOG based on counting functions or, equivalently, based on arithmetic circuits, is examined. The classes PNC^1 and $C_=NC^1$, defined by a test for positivity and a test for zero, respectively, of arithmetic circuit families of logarithmic depth, sit in this complexity interval. The landscape of Boolean hierarchies, constant-depth oracle hierarchies, and logarithmic-depth oracle hierarchies over PNC^1 and $C_=NC^1$ is studied. Complete problems are provided, the upper bound DLOG is obtained for all these hierarchies, and partial hierarchy collapses are proven — in particular, the constant-depth oracle hierarchy over PNC^1 collapses to its first level PNC^1, and the constant-depth oracle hierarchy over $C_=NC^1$ collapses to its second level.
This work is reported in [**M2**].

In [**L1**], a transformation from longest paths to shortest paths in sub-classes of directed acyclic graphs (DAGs) is presented. The transformation needs log-space and oracle access to reachability in the same class of graphs. As a corollary, it yields the main result of [**L1**]: Longest Paths in planar DAGs is in UL∩UL. The result also extends to toroidal DAGs. Further, it is shown show that Longest Paths in max-unique DAGs where the target node is the unique sink is also in UL∩UL.

It is then shown that for planar DAGs with the promise that the number of distinct paths is bounded by a polynomial, counting paths can be done by an unambiguous pushdown automaton equipped with an auxiliary log-space worktape and running in polynomial time. This bound also holds if the goal is to compute the number of longest paths, or shortest paths, and this number is bounded by a polynomial (irrespective of the total number of paths). Along the way, it is shown that counting paths in general DAGs can be done by a deterministic pushdown automaton with an auxiliary log-space worktape and running in polynomial time, and hence is in the complexity class LogDCFL, provided the number of paths is bounded by a polynomial and the target node is the only sink.
This work is reported in [**L1**].

The parallel complexity class NC^1 has many equivalent models such as polynomial size formulas and bounded width branching programs. Arithmetizations of two of these classes, $\#NC^1$ and #BWBP, have been studied in the literature. In [**L2**], this study is taken further to include arithmetization of other classes. In particular, it is shown that counting paths in branching programs over visibly pushdown automata is in FLogDCFL, while counting proof-trees in logarithmic width formulae has the same power as $\#NC^1$. Polynomial-degree restrictions of SC^i, denoted sSC^i, are also considered, and it is shown that the Boolean class sSC^1 is sandwiched between NC^1 and DLOG, whereas sSC^0 equals NC^1. On the other hand, the arithmetic class $\#sSC^0$ contains #BWBP and is contained in FLog, and $\#sSC^1$ contains $\#NC^1$ and is in SC^2. Some closure properties of the newly defined arithmetic classes are also investigated.
This work is reported in [**L2**].

Graph Theory and Combinatorics

In [**Su8**], it is shown that the 3-colorability problem can be solved in $O(1.296^n)$ time on any n-vertex graph with minimum degree at least 15. This algorithm is obtained by constructing a dominating set of the graph greedily, enumerating all possible 3-colorings of the dominating set, and then solving the resulting 2-list coloring instances in polynomial time. It is also shown that a 3-coloring can be obtained in $2^{o(n)}$ time for graphs having minimum degree at least $\omega(n)$ where $\omega(n)$ is any function which goes to ∞. Also, it is shown that if the lower bound on minimum degree is replaced by a constant (however large it may be), then neither a $2^{o(n)}$ time nor a $2^{o(m)}$ time algorithm is possible (m denotes the number of edges) for 3-colorability unless Exponential Time Hypothesis (ETH) fails. Also, a description of an algorithm which obtains a 4-coloring of a 3-colorable graph in $O(1.2535^n)$ time is provided.

In [**Su4**], new lower bounds are obtained for the independence number of K_r-free graphs and linear k-uniform hypergraphs in terms of the degree sequence. This answers some old questions raised by Caro and Tuza. The proof technique is an extension of a method of Caro and Wei, and also provided is a new short proof of the main result of Caro and Tuza using this approach. As byproducts, we also obtain some non-trivial identities involving binomial coefficients.

In [**Su10**], an improved algorithm for the graph isomorphism problem parameterized by the feedback vertex number is obtained. Given an instance (G_1, G_2, k) where G_1 and G_2 are both graphs each of which can be made acyclic by removing at most k vertices, the algorithm correctly determines in $O((42k)^k \cdot n^{O(1)})$ time if G_1 and G_2 are isomorphic. This asymptotically improves the previous best known algorithm of time complexity $O((4k \log k +$

$2k)^k \cdot n^{O(1)}$). No attempt has been made to optimize the constant (presently 42) or the degree of the polynomial factor and both are likely to be brought down further.

Reed conjectured that for any graph G, $\chi(G) \leq \left\lceil \frac{\Delta(G)+\omega(G)+1}{2} \right\rceil$, where $\chi(G)$, $\omega(G)$, and $\Delta(G)$ respectively denote the chromatic number, the clique number and the maximum degree of G. In [**T1**], the conjecture was verified for some special classes of graphs which are defined by families of forbidden induced subgraphs.

In [**T2**], the class of claw-free b-perfect graphs was characterized and also a complete description of their structure was obtained.

2.3.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**A**]
V. Arvind and Partha Mukhopadhyay*.
The monomial ideal membership problem and polynomial identity testing.
Information and Computation, **208(4)**, 351, 2010.

[**L1**]
Nutan Limaye, Meena Mahajan, and Prajakta Nimbhorkar.
Longest paths in planar dags in unambiguous log-space.
Chicago Journal of Theoretical Computer Science, **2010**, 8, 2010.

[**L2**]
Nutan Limaye, Meena Mahajan, and B. V. Raghavendra Rao.
Arithmetizing classes around NC^1 and L.
Theory of Computing Systems, **46(3)**, 499–522, 2010.

[**M1**]
Andreas Krebs*, **Nutan Limaye***, **and Meena Mahajan**.
Counting paths in VPA is complete for $\#NC^1$.
In My Thai and Sartaj Sahni, editors, *Proceedings of 16th International Computing and Combinatorics Conference COCOON. LNCS 6196.*, pages 44–53. Springer., Jul 2010.

[**M2**]
Samir Datta*, **Meena Mahajan, Raghavendra Rao B V***, **Michael Thomas***, **and Heribert Vollmer***.
Counting classes and the fine structure between NC^1 and L.
In Antonín Kučera and Petr Hliněný, editors, *Proceedings of 35th International Symposium on Mathematical Foundations of Computer Science MFCS, LNCS vol 6281*, pages 306–317. Springer, Aug 2010.

[**M3**]
Maurice Jansen*, **B. V. Raghavendra Rao***, **and Meena Mahajan**.
Resource trade-offs in syntactically multilinear arithmetic circuits.
Computational Complexity, 2011.
(To be published).

[**M4**]
Andreas Krebs*, **Nutan Limaye***, **and Meena Mahajan**.
Counting paths in VPA is complete for $\#\mathrm{NC}^1$.
Algorithmica (special issue for COCOON 2010), 2011.
(To be published).

[**M5**]
Meena Mahajan, Prajakta Nimbhorkar, and Kasturi Varadarajan*.
The planar k-means problem is NP-hard.
Theoretical Computer Science, 2010.
(To be published).

[**M6**]
Meena Mahajan and B. V. Raghavendra Rao*.
Small-space analogues of Valiant's classes and the limitations of skew formulas.
Computational Complexity, 2011.
(To be published).

[**Mi1**]
Abhimanyu M. Ambalath*, **Radheshyam Balasundaram***, **Chintan H. Rao** *, **Venkata Koppula***, **Neeldhara Misra, Geevarghese Philip, and Ramanujan M. S.**
On the kernelization complexity of colorful motifs.
In Venkatesh Raman and Saket Saurabh, editors, *Parameterized and Exact Computation - 5th International Symposium, IPEC 2010, Chennai, India, December 13-15, 2010. Proceedings*, page 14. Springer, Dec 2010.

[**Mi2**]
Neeldhara Misra, Geevarghese Philip, Venkatesh Raman, Saket Saurabh, and Saket Saurabh.
The effect of girth on the kernelization complexity of Connected Dominating Set.
In Kamal Lodaya and Meena Mahajan, editor, *IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science, FSTTCS 2010, December 15-18, 2010, Chennai, India*, page 96. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Dec 2010.

[**Mi3**]
Abhimanyu M. Ambalath*, **Radheshyam Balasundaram***, **Chintan R. H***, **Venkata Koppula***, **Neeldhara Misra, Geevarghese Philip, and M. S. Ramanujan**.
On the kernelization complexity of colorful motifs.

In Venkatesh Raman and Saket Saurabh, editor, *Parameterized and Exact Computation - 5th International Symposium, IPEC 2010, Chennai, India, December 13-15, 2010. Proceedings (2010)*, page 14. Springer, Dec 2010.

[**Mi4**]
Neeldhara Misra, Geevarghese Philip, Venkatesh Raman, and Saket Saurabh.
The effect of girth on the kernelization complexity of connected dominating set.
In Kamal Lodaya and Meena Mahajan, editors, *Proceedings of the FSTTCS 2010, LIPIcs series*, page 96. Dagstuhl, Dec 2010.

[**Mi5**]
Neeldhara Misra, N. S. Narayanaswmay*, Venkatesh Raman, and Balsri Shankar.
Solving min-ones-2sat as fast as vertex cover.
In Peter Hlineny and Antoni Kucera, editors, *Proceedings of the Mathematical Foundations of Computer Science (MFCS)*, pages 549–555. Springer Verlag, LNCS 6281, Aug 2010.

[**Mi6**]
Neeldhara Misra, Geevarghese Philip, Venkatesh Raman, and Saket Saurabh.
The effect of girth on the kernelization complexity of connected dominating set.
In Meena Mahajan Kamal Lodaya, editor, *IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science, (FSTTCS)*, pages 96–107. Lipics, Dec 2010.

[**Mi7**]
Daniel Lokshtanov*, Neeldhara Misra, and Saket Saurabh.
Imbalance is fixed parameter tractable.
In Sartaj Sahni My T. Thai, editor, *16th Annual International Conference on Computing and Combinatorics*, pages 199–208. Springer, Jul 2010.

[**Mi8**]
Neeldhara Misra, Geevarghese Philip, Fedor V. Fomin*, Saket Saurabh, and Daniel Lokshtanov*.
Hitting Forbidden Minors: Approximation and Kernelization.
In Schwentick, Thomas and Dürr, Christoph, editor, *28th International Symposium on Theoretical Aspects of Computer Science, STACS 2011, March 10-12, 2011, Dortmund, Germany*, page 189. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Mar 2011.

[**Mi9**]
Fedor Fomin*, Daniel Lokshtanov*, Neeldhara Misra, Geevarghese Philip, and Saket Saurabh.
Hitting forbidden minors: Approximation and kernelization.
In Christoph Durr Thomas Schwentick, editor, *28th International Symposium on Theoretical Aspects of Computer Science, STACS*, pages 189–200. Lipics, Mar 2011.

[**Mi10**]
Neeldhara Misra, Venkatesh Raman, and Saket Saurabh.

Lower bounds on kernelization.
Discrete Optimization, **8(1)**, 110–128, 2011.

[**P**]
Soumya Paul and R. Ramanujam.
Imitation in large games.
In Parente Montanari, Napoli, editor, *Games, Automata, Logic, and Formal Verification*, page 162. EPTCS, vol 25, Jun 2010.

[**Ph1**]
Henning Fernau*, Fedor V. Fomin*, Geevarghese Philip, and Saket Saurabh.
The Curse of Connectivity: t-Total Vertex(Edge) Cover.
In My T. Thai and Sartaj Sahni, editors, *Proceedings of the 16th Annual International Computing and Combinatorics Conference (COCOON 2010)*, page 34. Springer, Jul 2010.

[**Ph2**]
Henning Fernau*, Fedor V. Fomin*, Daniel Lokshtanov*, Matthias Mnich*, Geevarghese Philip, and Saket Saurabh.
Ranking and Drawing in Subexponential Time.
In Iliopoulos, Costas S. and Smyth, William F., editor, *Combinatorial Algorithms - 21st International Workshop, IWOCA 2010, London, UK, July 26-28, 2010, Revised Selected Papers*, page 337. Springer, Jul 2010.

[**Ph3**]
Geevarghese Philip, Venkatesh Raman, and Yngve Villanger*.
A Quartic Kernel for Pathwidth-One Vertex Deletion.
In Thilikos, Dimitrios M., editor, *Graph Theoretic Concepts in Computer Science - 36th International Workshop, WG 2010, Zarós, Crete, Greece, June 28-30, 2010 Revised Papers*, page 196. Springer, Jun 2010.

[**Ph4**]
Henning Fernau*, Fedor Fomin*, Daniel Lokshtanov*, Matthias Mnich*, Geevarghese Philip, and Saket Saurabh.
Ranking and drawing in subexponential time.
In Costas S. Iliopoulos and William F. Smyth, editors, *21st International Workshop on Combinatorial Algorithms (IWOCA)*, pages 337–348. Springer, Jul 2010.

[**Ph5**]
Henning Fernau*, Fedor Fomin*, Geevarghese Philip, and Saket Saurabh.
The curse of connectivity: t-total vertex (edge) cover.
In Sartaj Sahni My T. Thai, editor, *16th Annual International Conference on Computing and Combinatorics*, pages 34–43. Springer, Jul 2010.

[**Ph6**]
Marek Cygan*, Geevarghese Philip, Marcin Pilipczuk*, and MichałPilipczuk*.
Dominating Set is Fixed Parameter Tractable in Claw-free Graphs.

Theoretical Computer Science, 2010.
(Submitted).

[**Ph7**]
Geevarghese Philip, Venkatesh Raman, and Somnath Sikdar*.
Polynomial Kernels for Dominating Set in Graphs of Bounded Degeneracy and Beyond.
ACM Transactions on Algorithms, 2011.
(To be published).

[**Pr1**]
M. Praveen.
Does treewidth help in modal satisfiability?
In Petr Hlinen and Antonn Kucera, editors, *Mathematical Foundations of Computer Science*, page 580. Springer-Verlag, Aug 2010.

[**Pr2**]
M. Praveen.
Small vertex cover makes petri net coverability and boundedness easier.
In Venkatesh Raman and Saket Saurabh, editors, *International Symposium on Parameterized and Exact Computation*, page 216. Springer, Dec 2010.

[**R**]
A. Baskar*, **R. Ramanjam, and S. P. Suresh***.
A dexptime-complete dolev-yao theory with distributive encryption.
In Hilneny and Kucera, editors, *Mathematical Foundations of Computer Science, Brno, LNCS 6281*, page 102. Springer Verlag, Aug 2010.

[**Ra1**]
Sujata Ghosh*, **R. Ramanujam, and Sunil Simon***.
Playing extensive form games in parallel.
In Leite Dix and Jamroga, editors, *Computational Logic in Multi-Agent Systems, Lisbon, LNCS 6245*, page 153. Springer-Verlag, Aug 2010.

[**Ra2**]
R. Ramanujam and Sunil Simon*.
A communication based model for games of imperfect information.
In Gastin and Laroussinie, editors, *Concurrency theory, Paris, LNCS 6269*, page 509. Springer Verlag, Sep 2010.

[**Ra3**]
R. Ramanujam.
Responses: R ramanujam.
In Vincent Hendricks and Olivier Roy, editors, *Epistemic Logic: 5 Questions*, page 137. New York/London: Automatic Press, 2010.

[**Ra4**]
R. Ramanujam.

Memory and logic: a tale from automata theory.
Journal of Indian Council of Philosophical Research, **27(1)**, 305, 2011.

[**Ra5**]
R. Ramanujam and S. P. Suresh*.
Challenges for epistemic theory from security protocols.
In Johan van Benthem and Eric Pacuit, editors, *Games, norms and reasons*, page 121. Amsterdam University Press, 2011.

[**Ram1**]
Fedor Fomin*, **Daniel Lokshtanov***, **Venkatesh Raman, and Saket Saurabh**.
Fast local search algorithms for weighted feedback arc set in tournaments.
In Maria Fox and David Poole, editors, *Proceedings of the 24th AAAI Conference on Artificial Intelligence*, Jul 2010.

[**Ram2**]
Pinar Heggernes*, **Dieter Kratsch***, **Daniel Lokshtanov***, **Venkatesh Raman, and Saket Saurabh**.
Fixed-parameter algorithms for cochromatic number and disjoint rectangle stabbing.
In Haim Kaplan, editor, *12th Scandinavian Symposium and Workshops on Algorithm Theory (SWAT).*, pages 334–345. Springer, Jun 2010.

[**Ram3**]
Fedor Fomin*, **Daniel Lokshtanov***, **Venkatesh Raman, and Saket Saurabh**.
Fast local search algorithm for weighted feedback arc set in tournaments.
In David Poole Maria Fox, editor, *Proceedings of the Twenty-Fourth AAAI Conference on Artificial Intelligenc*. AAAI Press, Jul 2010.

[**Ram4**]
Fedor Fomin*, **Daniel Lokshtanov***, **Venkatesh Raman, and Saket Saurabh**.
Bidimensionality and eptas.
In Dana Randell, editor, *22nd ACM-SIAM Symposium on Discrete Algorithms (SODA).*, pages 748–759, Jan 2011.

[**Ram5**]
Daniel Lokshtanov*, **Venkatesh Raman, Saket Saurabh, and Somnath Sikdar**.
On the directed full degree spanning tree problem.
Discrete Optimization, **8(1)**, 97–109, 2011.

[**S1**]
Fedor Fomin*, **Daniel Lokshtanov***, **Fabrizio Grandoni***, **and Saket Saurabh**.
Sharp separation and applications to exact and parameterized algorithms.
In Alejandro López-Ortiz, editor, *9th Latin American Symposium on Theoretical Informatics (LATIN)*, pages 72–83. Springer, Apr 2010.

[**S2**]
Abhijin Adiga*, **Rajesh Chitnis***, **and Saket Saurabh**.

Parameterized algorithms for boxicity.
In Kunsoo Park Otfried Cheong, Kyung-Yong Chwa, editor, *21st International Symposium on Algorithms and Computation (ISAAC)*, pages 366–377. Springer, Dec 2010.

[**S3**]
Michael Fellows*, Bart Jansen*, Daniel Lokshtanov*, Frances Rosamond*, and Saket Saurabh.
Determining the winner of a dodgson election is hard.
In Meena Mahajan Kamal Lodaya, editor, *IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science, FSTTCS*. Lipics, Dec 2010.

[**S4**]
Daniel Lokshtanov*, Daniel Marx*, and Saket Saurabh.
Known algorithms on graphs of bounded treewidth are probably optimal.
In Dana Randall, editor, *22nd ACM-SIAM Symposium on Discrete Algorithms (SODA 2011)*, pages 777–789. SIAM, Jan 2011.

[**S5**]
Mrinal Kumar*, Sounaka Mishra*, N. Safina Devi*, and Saket Saurabh.
Approximation algorithms for minimum chain vertex deletion.
In Amit Kumar Naoki Katoh, editor, *5th International Workshop on Algorithms and Computation (WALCOM)*, pages 21–32. Springer, Feb 2011.

[**S6**]
Daniel Lokshtanov*, Daniel Marx*, and Saket Saurabh.
Slightly superexponential parameterized problems.
In Dana Randall, editor, *22md ACM-SIAM Symposium on Discrete Algorithms (SODA).*, pages 760–776, Jan 2011.

[**S7**]
Nathann Cohen*, Fedor Fomin*, Gregory Gutin*, Eun Jung Kim*, Saket Saurabh, and Anders Yeo*.
Algorithm for finding k-vertex out-trees and its application to k-internal out-branching problem.
Journal of Computer and System Sciences (JCSS), **76(7)**, 650–662, 2010.

[**S8**]
Michael Fellows*, Fedor Fomin*, Daniel Lokshtanov*, Frances Rosamond*, Saket Saurabh, Srefan Szeider*, and Carsten Thomassen*.
On the complexity of some colorful problems parameterized by treewidth.
Information and Computation, **209(2)**, 143–155, 2011.

[**S9**]
Fedor Fomin*, Serge Gaspers*, Petr Golovach*, Dieter Kratasch*, and Saket Saurabh.
Parameterized algorithm for eternal vertex cover.
Information Processing Letters, **110(16)**, 702–706, 2010.

[**Si**]
Neeldhara Misra*, **Geevarghese Philip***, **Venkatesh Raman***, **Saket Saurabh***, **and Somnath Sikdar**.
FPT algorithms for Connected Feedback Vertex Set.
Journal of Combinatorial Optimization, **10.1007/s10878-011-9394-2**, http://dx.doi.org/10.1007/s10878, 2011.

[**Su1**]
N.R. Arvind, N. Narayanan, and C.R. Subramanian.
Oriented colouring of some graph products.
Discussiones Mathematicae Graph Theory.
(To Appear).

[**Su2**]
N.R. Arvind and C.R. Subramanian.
Bounds on edge colourings with restrictions on the union of color classes.
SIAM Journal on Discrete Mathematics, **24(3)**, 841–852, August 2010.

[**Su3**]
N.R. Arvind and C.R. Subramanian.
Bounds on vertex colorings with restrictions on the union of color classes.
Journal of Graph Theory, **66**, 213–234, January 2011.

[**Su4**]
Kunal Dutta, Dhruv Mubayi*, **and C.R. Subramanian**.
New lower bounds for the independence number of sparse graphs and hypergraphs.
Information Processing Letters, 2011.
(Preprint).

[**Su5**]
Kunal Dutta and C.R. Subramanian.
Induced acyclic subgraphs in random digraphs: Improved bounds.
Proceedings of AofA 2010: 21st International meeting on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms, Vienna, Austria, June 2010. DMTCS Proceedings, pages 159–174, 2010.

[**Su6**]
Kunal Dutta and C.R. Subramanian.
Largest induced acyclic tournament in random digraphs: A 2-point cocentration.
Proceedings of LATIN-2010: 9th American Theoretical Informatics Symposium, Oaxaca, Mexico, pages 627–637, April 2010.

[**Su7**]
Rahul Muthu, N. Narayanan, and C.R. Subramanian.
Optimal acyclic edge colouring of grid like graphs.
Discrete Mathematics, **310(21)**, 2769–2775, 2010.

[**Su8**]
N.S. Narayanaswamy and C.R. Subramanian.
Dominating set based exact algorithms for 3-coloring.
Information Processing Letters, **111(6)**, 251–255, 2011.

[**Su9**]
C.R. Subramanian.
List hereditary colorings of graphs.
Ramanujan Mathematical Society Lecture Notes Series, **13**, 191–205, 2010.

[**Su10**]
C.R. Subramanian.
Improved FPT algorithms for graph isomorphism.
Information Processing Letters, 2010.
(Preprint).

[**T1**]
N.R. Aravind*, **T. Karthick, and C.R. Subramanian**.
Bounding χ in terms of ω and $\triangle$ for some classes of graphs.
Discrete Mathematics, **311(12)**, 911–920, 2011.

[**T2**]
T. Karthick and F. Maffray *.
A characterization of claw-free b-perfect graphs.
2010.
(Submitted).

Books/Monographs Authored/Edited

The list below follows the same conventions as those followed for the list of publications.

[**L**]
Kamal Lodaya and Meena Mahajan, editors.
Proceedings of the IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS 2010), volume 8 of *Leibniz International Proceedings in Informatics (LIPIcs)*.
Schloss Dagstuhl–Leibniz-Zentrum für Informatik, Dagstuhl, Germany, 2010.

[**R**]
Venkatesh Raman and Saket Saurabh, editors.
Proceedings of the 5th International Symposium on Parameterized and Exact Computation, volume 6478 of *Lecture Notes in Computer Science*.
Springer Verlag, Germany, 2010.

2.4 Student Programmes

2.4.1 Degrees Awarded

Doctoral Degrees Awarded during 2010 – 2011

Mathematics

Name: **Singla, Pooja**
Thesis Title: Representations and conjugacy classes of general linear groups over principal ideal local rings of length two
Thesis Advisor: Prasad, Amritanshu
University: Homi Bhabha National Institute

Name: **Chattopadhyay , Pratyusha**
Thesis Title: 'Equality of Elementary orbits and Elementaray symplectic orbits'
Thesis Advisor: Nagaraj, D. S.
University: HBNI

Name: **Shanmugasundaram, Sundar**
Thesis Title: The Geometry of Some Quantum Homogeneous Spaces and the Weak Heat Kernel Expansion
Thesis Advisor: Chakraborty, Partha S.
University: HBNI

Theoretical Computer Science

Name: **Das, Bireswar**
Thesis Title: Some Complexity Theoretic Aspects of Graph Isomorphism and Related Problems
Thesis Advisor: Arvind, V.
University: Homi Bhabha National Institute

Name: **Nimbhorkar, Prajakta**
Thesis Title: Complexity Analysis of Some Problems in Planar Graphs, Bounded Tree-width Graphs and Planar Point Sets.
Thesis Advisor: Mahajan, Meena B.
University: HBNI

Name: **Sikdar, Somnath**
Thesis Title: Parameterizing from the Extremes: Feasible parameterizations of some NP-hard problems
Thesis Advisor: Raman, Venkatesh
University: HBNI

Doctoral Theses Submitted during 2010 – 2011

Mathematics

Name: **Samuel, Preena**
Thesis Title: RSK Bases in invariant theory and representation theory
Thesis Advisor: Raghavan, K. N.
University: HBNI

Physics

Name: **Sircar, Nilanjan**
Thesis Title: Aspects of AdS/CFT
Thesis Advisor: Sathiapalan, Balachandran
University: HBNI

Name: **Sridhar, S.**
Thesis Title: Nonlinear dynamics of wave propagation in heterogeneous excitable media
Thesis Advisor: Sinha, Sitabhra
University: Madras University

Name: **Kamil, Syed M.**
Thesis Title: Problems in the Statics and Dynamics of Nematic Liquid Crystals
Thesis Advisor: Menon, Gautam I.
University: HBNI

Theoretical Computer Science

Name: **Arvind, N.R.**
Thesis Title: Forbidden Subgraph Colorings, Oriented Colorings and Intersection Dimensions of Graphs
Thesis Advisor: Balasubramanian, R. and Subramanian, C.R.
University: HBNI

Masters Degrees Awarded during 2010 – 2011

Mathematics

Name: **Maiti, Arun**
Thesis Title: An Analytic Proof Of The Atiyah-Singer Index Theorem Using Heat Equation Method
Thesis Advisor: Chakraborty, Partha S.
University: Chennai Mathematical Institute

Physics

Name: **Gandhi, C**
Thesis Title: Infrared behaviour of Massless QED—3
Thesis Advisor: Sharatchandra, H.S.
University: Madras

Theoretical Computer Science

Name: **Sreenivasaiah, Karteek**
Thesis Title: Lower bound techniques for Formula Size and Monotone Circuit Depth.
Thesis Advisor: Mahajan, Meena B.
University: HBNI

Masters Theses Submitted during 2010 – 2011

Physics

Name: **Virgin Jenisha, B.**
Thesis Title: An overview of the reversibility of an adiabatic process
Thesis Advisor: Ponmurugan, M.
University: Loyola College, University of Madras.

Theoretical Computer Science

Name: **Yadu Vasudev**
Thesis Title: Partial Derivative Methods in Arithmetic Circuit Complexity
Thesis Advisor: Arvind, V.
University: HBNI

2.4.2 Lecture Courses During 2010 – 2011.

The following **lecture courses** were offered during 2010 – 2011.

Course Title	Period	Lecturer
Mathematics		
Complex Analysis	Jan-Apr 2010	Srinivas, K.
Quantum Mechanics	Jan-Mar 2010	Krishna, M.
Topology II	Jan-May 2010	Prasad, Amritanshu
Algebra	Aug-Dec 2010	Kodiyalam, Vijay
Lie Algebras	Aug-Nov 2010	Viswanath, Sankaran

Spectral Theory	Aug-Dec 2010	Krishna, M.
Complex Analysis	Sep-Dec 2010	Sunder, V. S.
Differentiable Manifolds and Lie Groups	Sep-Dec 2010	Chatterjee, Pralay
Measure Theory	Sep-Dec 2010	Mukhopadhyay, Anirban
Topology	Sep-Dec 2010	Chakraborty, Partha S.
Combinatorics in Representation Theory	Jan-Apr 2011	Prasad, Amritanshu
Differential Geometry	Jan-Apr 2011	Chakraborty, Partha S.
Functional Analysis	Jan-Mar 2011	Kesavan, S.
Number Theory and Cryptography	Jan-Apr 2011	Srinivas, K.

Physics

Advanced Particle Physics	Aug-Apr 2010	Sinha, Rahul
Particle Physics	Jan-Apr 2010	Sinha, Nita
Classical Mechanics (reading course)	May-Jul 2010	Murthy, M.V.N.
Advanced Particle Physics	Aug-Dec 2011	Murthy, M.V.N.
Classical Electrodynamics	Aug-Dec 2010	Sinha, Rahul
Mathematical Methods I	Aug-Dec 2010	Rajesh, R.
Mathematical Methods II	Aug-Dec 2010	Rajesh, R.
Nonlinear Dynamics	Aug-Dec 2010	Sinha, Sitabhra
Quantum Mechanics I	Aug-Dec 2010	Menon, Gautam I.
String Theory	Aug-Dec 2010	Mukhopadhyay, Partha
Advanced Particle Physics	Nov-Nov 2010	Rajasekaran, G.
Advanced computational Physics	Jan-Apr 2011	Ray, Purusattam
General Relativity	Jan-Apr 2011	Date, G.
Quantum Information Theory	Jan-May 2011	Ghosh, Sibasish
Statistical Mechanics	Jan-May 2011	Murthy, M.V.N.

Theoretical Computer Science

Advance Graph Theory	Jan-Apr 2010	Saurabh, Saket
Matchings in Graphs	Jan-Apr 2010	Mahajan, Meena B.
Parameterized Complexity	Jan-Apr 2010	Saurabh, Saket
Logic	Feb-May 2010	Lodaya, Kamal
Topological Graph Theory (Reading course)	Jul-Nov 2010	Saurabh, Saket
Design and Analysis of Algorithms	Aug-Dec 2010	Raman, Venkatesh
Randomized Algorithms	Aug-Dec 2010	Subramanian, C.R.
Theory of Computation	Aug-Dec 2010	Ramanujam, R.
Circuit Lower Bounds (reading course)	Jan-Apr 2011	Mahajan, Meena B.
Computational Complexity	Jan-Apr 2011	Mahajan, Meena B.
Kernelization	Jan-Apr 2011	Saurabh, Saket
Logic I	Jan-May 2011	Ramanujam, R.

In addition, the following **lecture courses** were offered during 2010 – 2011 by IMSC faculty in the National Undergraduate programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer
Physics		
Particle Physics (for CMI students at IMsc)	Jan-Apr 2010	Sathiapalan, Balachandran
Particle Physics	Aug-Dec 2010	Rajasekaran, G.
Quantum Field Theory	Jan-Apr 2011	Rajasekaran, G.

2.4.3 Summer Students

Every summer, a small number of students from various institutes/universities come to our institute and work on some learning/research projects with some faculty member for a period of four to six weeks. The following students visited the institute during April 2010 - March 2011.

Student	Faculty
Mathematics	
Das, Sayan, RKM Vivekananda Univ., Kolkata	Chakraborty, Partha S.
Nayak, Soumyashant, Indian Statistical Institute, Bangalore	Chakraborty, Partha S.
Mukhopadhyay, Shirsho, CMI, Chennai	Chakraborty, Partha S.
Sengupta, Akash, CMI, Chennai	Chakraborty, Partha S.
P. Venkata, IISER, Pune	Gun, S.
Nijoying , Pranabesh, RKM Vivekananda Univ., Kolkata	Gun, S.
Goswami, Ankush, NISER, Bhubaneswar	Gun, S.
Dutta, Arpan, CMI, Chennai	Gun, S.
Chakraborty, Debopam, RKM Vivekananda Univ., Kolkata	Prasad, Amritanshu
Mahatab, Kamalakshya, IMA, Bhubaneswar	Prasad, Amritanshu
Dutta, Yajnaseni , CMI, Chennai	Prasad, Amritanshu
Acharya, Ratnadeep, RKM Vivekananda Univ., Kolkata	Prasad, Amritanshu
Zachariah, Alisha, St. Stephens' College	Sunder, V. S.
Rajagopal, Varshini, St. Stephens' College	Sunder, V. S.
Nayak, Soumyashant, Indian Statistical Institute	Sunder, V. S.
Malik, Amita, IISc, Bangalore	Viswanath, Sankaran
Verma, Abhinav, IISc, Bangalore	Viswanath, Sankaran

Physics

Ganesan, Vasantharajan, Theoretical Physics Dept, Madras University	Date, G.
Srinivasan, M., Theoretical Physics Dept, Madras University	Date, G.
Bawane, Aditya, BITS, Pilani	Date, G.
Deshmukh, Amol, IISER, Mohali	Date, G.
Shuddhodan, K. V., IIT Madras	Ghosh, Sibasish
Soni, Ronak , CMI, Chennai	Ray, Purusattam
Roy, Nilanjan, IIT Kanpur	Ray, Purusattam
Shankar, Alok, Central University Hyderabad	Sathiapalan, Balachandran
Gandhi, C., Loyola College	Sharatchandra, H.S.
Kumar, Saravana, Madras University	Sinha, Nita
Ramsiya, M., M. G. University, Kottayam	Sinha, Nita
Banadyupadhyay, Aritra, IIT Kanpur	Sinha, Rahul
Krishnan, Prasanth K., Madras University	Sinha, Rahul
Sriram, B., IIT Kanpur	Sinha, Sitabhra
Kanjilal, Som, CMI	Sinha, Sitabhra
Shankar, Alok, Hyderabad Central University	Sinha, Sitabhra

Theoretical Computer Science

Misra, Pranabendu, CMI, Chennai	Saurabh, Saket
Venkata, K., IIT Kanpur	Saurabh, Saket
Kolay, Sudeshna, CMI, Chennai	Saurabh, Saket
Maheshwari, Gaurav, IIT Madras	Saurabh, Saket
Kumar, Mrinal , IIT Madras	Saurabh, Saket
Rao, Chintan, IISc, Bangalore	Saurabh, Saket
Chitnis, Rajesh, CMI, Chennai	Saurabh, Saket

2.4.4 Other Students

Students also do their projects under the supervision of our faculty during the academic year. The following students visited the institute during April 2010 - March 2011.

Student	Faculty

Physics

Alase, Abhijeet, IIT - Bombay	Ghosh, Sibasish
Karumanchi, Siddharth, BITS-Pilani	Ghosh, Sibasish
Krishnan, Subashini, Ponndicherry University (M.Phil Student)	Murthy, M.V.N.

Bhattacharya, Soumyadeep, BITS, Pilani

Nath, Atanu, SN Bose National Centre for Basic Sciences, Kolkata

Ray, Purusattam

Sharatchandra, H.S.

Theoretical Computer Science

Mehta, Jenish C., BITS-Pilani, Goa Campus

Mahajan, Meena B.

2.5 Honours and Awards

Gun, S. was awarded Associatship, for 2010, by the Indian Academy of Sciences.

Menon, Gautam I. was awarded DAE-SRC Outstanding Researcher Fellowship, for 2010, by the DAE-Science Research Council for The DAE-SRC awards augment support to individual workers with highly innovative ideas and with proven abilities to pursue advanced research in frontier areas of science and engineering at an accelerated pace.

Menon, Gautam I. was awarded APS Outstanding Referee, for 2011, by the American Physical Society. This lifetime award recognizes scientists who have been exceptionally helpful in assessing manuscripts for publication in APS journals. 143 referees from 22 countries were recognized in 2011, of a referee pool of 43,000.

Prasad, Amritanshu was awarded Young Scientist Medal, for 2010, by the Indian National Science Academy.

Praveen, M. was awarded Excellent Student Paper Award, for 2010, by the International Symposium on Parameterized and Exact Computation.

Raghavan, K. N. was awarded Fellow, for 2011, by the Indian Academy of Sciences.

Ronojoy Adhikari was awarded the Google Research Award by Google for proposal on "Machine Learning of Syntax in Undeciphered Scripts".

Sankaran, Parameswaran was awarded M. K. Singal Memorial Award, for 2011, by the Indian Science Congress Association. The award was presented by the Hon'ble Prime Minister during the 98th Annual Meeting of the Indian Science Congress Association held in Chennai.

Sunder, V. S. was awarded Distinguished Alumnus Award (DAA 2011), for 2011, by the IIT Madras.

Chapter 3

Other Professional Activities

This chapter lists the activities carried out by the individual members of the institute in their professional capacity.

Balakrishnan, Radha

Chairperson of National Review Selection Committee for Fulbright Science and Technology Award, 2011 during May – May, 2010.

Balasubramanian, R.

Member of Governing Council of Institute of Mathematics and Applications, Bhubaneshwar.

Member of Governing Council, HRI, Allahabad.

Member of Advisory Board of Indian Journal of Pure and Applied Mathematics.

Member of Academic Advisory Committee of IISER, Trivandrum.

Chairman of Indian delegate for 16th general assembly of IMU during Aug - Aug, 2010.

Chakraborty, Partha S.

Convener of National Organising Committee for Functional Analysis Workshop-I held at IMSc during Jun 28 – Jul 16, 2010.

Convener of National Organising Committee for Funational Analysis Workshop-II held at Indian Statistical Institute, Delhi during Dec 6 – Dec 22, 2010.

Date, G.

As an external member of the Local Organizing Committee for the Seventh International Conference on Gravitation and Cosmology (ICGC), to be held at Goa during Dec 14 - 19,

2011.

Convener of Local Organising Committee for School on Loop Quantum Gravity held at IMSc during Sep 22 – Sep 30, 2010.

Ghosh, Sibasish

Speaker at Homi Bhabha National Centre for Science Education, TIFR, V. N. Purav Marg, Mankhurd, Mumbai. on Jun 16, 2010. Gave a series of lectures on quantum information theory at the 1st National Initiative on Undergraduate Science (NIUS) at the Centre on 16 and 17 June, 2010.

Member of Local Organising Committee for Workshop on Quantum Chaos and Quantum Information held at IIT - Madras during Jul 21 – Jul 25, 2010.

Speaker at Lady Doak College, Madurai on Oct 12, 2010. Gave a set of two talks on introduction to quantum computation at "Recent Trends in Physics", a programme supported by the three Indian academies and was held at the physics department of Lady Doak College, Madurai from 11 to 13 October, 2010.

Convener of National Organising Committee for National level workshop on quantum information science held at IMSc during Nov 22 – Dec 4, 2010.

Speaker at Kongu Engineering College, Erode on Dec 17, 2010. Gave a set of two talks on introduction to quantum computation at the CSIR sponsored national level seminar on quantum computation and quantum information, held at Kongu Engineering college from 17 to 18 December, 2010.

Speaker at St. Xavier's College, Kolkata on Feb 23, 2011. Gave an introductory talk at the college on quantum information science to the undergraduate students.

Gun, S.

Lectured in the Mathematics Appreciation Course at IMSc on Sep 24, 2010.

Gupta, Ved Prakash

Tutored for "Appreciation Course in Mathematics" at IMSc, Chennai on Sep 22, 2010. Conducted two tutorials for a mini course on "Basic Analysis" for college students of Chennai.

Kesavan, S.

Convenor of Academic Council, Chennai Mathematical Institute during Apr 2009 – Jul 2010.

Reviewer of Mathematical Reviews

Member of Board of Studies in Mathematics, Kanchi Mamunivar PG Centre, Pondicherry

Fellow of Forum d' Analystes

Member of Editorial Board, Journal of the Kerala Mathematical Association

Member of Executive Committee, ICM, 2010 during Apr – Aug, 2010.

Member of National Board for Higher Mathematics

Member of Academic Council, Chennai Mathematical Institute during Jul 2010 – Mar 2011.

Secretary (Grants) of Commission for Developing Countries (CDC) of the International Mathematical Union (IMU) during Jan – Mar, 2011.

Krishna, M.

Convener of International Organising Committee for ICM Satellite Conference on Quantum Systems held at IMSc during Aug 14 – Aug 18, 2010.

Lodaya, Kamal

Member of Programme Committee, 6th conference on Computability in Europe, Ponta Delgada (Açores) during Jul 2009 – Jun 2010.

Member of Programme committee, ICM satellite conference on Mathematical logic and set theory, Chennai during Jan – Aug, 2010.

Co-chair of Programme committee, 30th FSTTCS, Chennai during Jan – Dec, 2010.

Member of Programme committee, workshop on Games, automata, logic and formal verification, Minori during Feb – Jun, 2010.

Madaiah, Chandrashekar C.

Invited Speaker at Karnataka Rajya Vignana Parishat, Bangaluru on Oct 13, 2010. Lecture series to celebrate 50 years of lasers :"Laser Cooling of Atoms"

Invited Speaker at BMS college for Women, Bengaluru on Feb 28, 2011. National Science Day Celebration :

"How hot is your cup of coffee ? A journey from hottest to the coldest temperature in the universe"

Invited Speaker at JSS Academy for Technical Education, Bengaluru on Feb 28, 2011. National Science Day Celebration : "Engineering Challenges for 21st Century"

Mahajan, Meena B.

co-Chair of Programme Committee of 30th FSTTCS conference, Dec 2010 during Jun – Dec, 2010.

Member of International Organising Committee for Aarhus-Chennai Computational Complexity Workshop held at Aarhus University, Denmark during Aug 2 – Aug 6, 2010.

Convener of Local Organising Committee for Foundations of Software Technology and Theoretical Computer Science held at IMSc during Dec 15 – Dec 18, 2010.

Convener of Local Organising Committee for International Symposium on Parameterized and Exact Computation held at IMSc during Dec 13 – Dec 14, 2010.

Meena Devi, J.

Science article writing in Tamil at Madurai on Apr 16, 2010. Wrote a Tamil Science article on Oli-II(Light-II) for a popular monthly Tamil Science journal "Mulumai Ariviyal Udhayam" in the issue Vol.3 No.4, April 2010.

Science article writing in Tamil at Madurai on Feb 16, 2011. Wrote a Tamil Science article on interview with Physics Nobel Laureate Tony Legget(He visited IMSc this year) for a popular monthly Tamil Science journal "Mulumai Ariviyal Udhayam" in the issue Vol.4 No.2, February 2011.

Invited Speaker at Science club(119th meet), CLRI, Chennai on Mar 12, 2011. Gave a talk on "Molecular Dynamics simulation study of gold particles"

Menon, Gautam I.

Member of Expert Committee on Infectious Disease Modeling, MOHFW during Aug 2009 – Aug 2010.

Convener of Local Organising Committee for IInd Workshop on Modeling Infectious Diseases held at IMSc during Sep 13 – Sep 18, 2010.

Convener of Local Organising Committee for IInd Conference on Modeling Infectious Diseases held at Radisson Temple Bay during Sep 20 – Sep 22, 2010.

Mukhopadhyay, Anirban

Member of Local Organising Committee for ICMzeta 2010 held at IMSc during Aug 29 – Sep 3, 2010.

Murthy, M.V.N.

National Children Science Congress at Chennai on Dec 27, 2010. Meet the scientist program and demonstration of experiments in Physics

National Science Day, Arul Anandar College organised by TNSF at Madurai on Feb 27, 2011. Lecture on "How the Sun shines".

Member of International Organising Committee for 7th International Workshop on Neutrino-Nucleus Interaction in few-Gev Region (NuInt 11). held at HNBG Unviersity (Srinagar), Dehradun during Mar 7 – Mar 11, 2011.

Prasad, Amritanshu

Lectured in the Mathematics Appreciation Course at IMSc on Sep 20, 2010.

Lectured for class XI students at PS Senior Secondary School in Mylapore on Oct 14, 2010. Gave an expository talk on some of the deep mathematical ideas that arise from our attempts to compute the decimal expansion of π.

Raghavan, K. N.

Secretary of Forum D'Analystes

Convener of Local Organising Committee for Advanced Instructional School in Representation Theory held at Indian Statistical Institute, Bangalore Centre during Jun 2 – Jun 24, 2010.

Convener of Local Organising Committee for Algebraic and Combinatorial approaches to Representation Theory held at National Institute for Advanced Studies, Bangalore during Aug 12 – Aug 16, 2010.

Appreciation Course in Mathematics at IMSc on Sep 20, 2010. Helped in organization of the week long program and acted as a resource person

Member of (Mathematics) Curriculum Development Committee of the School of Basic Sciences, Central University of Orissa during Jan – Mar, 2011.

Rajasekaran, G.

Member of Academic Council,CMI

Member of Scientific Steering Committee of INO

Chairman of Board of Studies in Physics, CMI

Popular Science Talk at The American College on Apr 10, 2010. As one of the chief guests on the College Day, talked on the importance of Science Education

Prof A C Banerji Memorial Lecture of the National Academy of Sc at IMSc on Apr 12, 2010. The title of the Lecture was "The elusive neutrinos and their importance"

Popular Science Talk at Madras Press Club on May 8, 2010. Talked on "The Cultural Values of Science"

Popular Science Talk at IITM on May 12, 2010. Gave a talk "Is there a Final Theory?" to students selected for the Summer Programme on Research Science Initiative

Popular Science Talk at Vel's Institute, Chennai on Dec 29, 2010. Talked on "Chandrasekhar and the Stars" to Science Teachers attending Children's Science Congress

General Institute Colloquium at IMSc on Dec 21, 2010. Title: "Chandrasekhar and the Stars"

Ramanujam, R.

Co-chair of Organizing committee of ICLA 2011, the Indian Conference on Logic and Applications during Feb 2010 – Jan 2011.

Co-chaired the Indo-Swedish working group on Mathematics Educati at Góteborg, Sweden on Jun 6, 2010. The first meeting was from June 6 to June 9, 2010 at Góteborg. Co-organized the second meeting of the working group at Homi Bhabha Centre for Science Education, Mumbai, from Feb 21-26, 2011.

Convener of International Organising Committee for ICM Satellite Conference on Logic and Set Theory held at Chennai Mathematical Institute during Aug 11 – Aug 13, 2010.

Panelist on Mathematics Education at the International Congress at Hyderabad on Aug 21, 2010. Spoke in the ICM panel on "School mathematics and the discipline of mathematics".

Co-organized a workshop on "Mathematics in Kolams" for school te at IMSc, Chennai on Jan 17, 2011. The workshop was on 17 and 18 Jan 2011.

Ray, Purusattam

Convener of National Organising Committee for Mechanics and physics of fracture held at IMSc during Feb 28 – Mar 2, 2011.

Member of the International Scientific Advisory Committee, CCP 2010 conference on Computational Physics, held at Trondheim, Norway during 23-26 June, 2010.

Sankaran, Parameswaran

Member of Technical Advisory Committee, Indian Statistical Institute, Kolkata during Oct 2010 – Mar 2011.

Saurabh, Saket

Co-Chair of Program Committee of 5th IPEC Symposium during Jan – Dec, 2010.

Member of Program committee of 36th WG workshop during Jan – Jun, 2010.

Member of Local Organising Committee for International Symposium on Parameterized and Exact Computation (IPEC) held at IMSc during Dec 13 – Dec 15, 2010.

Member of Local Organising Committee for IMPECS School on Parameterized and Exact Computation held at IMSc during Dec 11 – Dec 12, 2010.

Sinha, Rahul

Member of Expert Panel on Fast Track Proposals for Young Scientists in Physical and Mathematical Sciences during Jan 2010 – Jan 2011.

Sinha, Sitabhra

Convener of Local Organising Committee for Discussion Meeting on "Complex Networks of Trade and Credit" held at IMSc during Apr 10 – Apr 11, 2010.

Convener of Local Organising Committee for 2nd IMSc Workshop on "Modeling Infectious Diseases" held at IMSc during Sep 13 – Sep 18, 2010.

Convener of Local Organising Committee for Conference on "Modeling Infectious Diseases" held at Temple Bay Resort, Mamallapuram during Sep 20 – Sep 22, 2010.

Convener of Local Organising Committee for Discussion-Meeting on "The Economy as a Complex System II: Economic Dynamics" held at IMSc during Dec 27 – Dec 29, 2010.

Member of Review Committee for TIFR Programme on Archaeoastronomy during Feb – Feb, 2011.

Srinivas, K.

Treasurer of Executive Committee of Ramanujan Mathematical Society

External member of Faculty Recruitment Board, Revenshaw University, Cuttack, Orissa during Apr – Apr, 2010.

Speaker at IMSc, Chennai on Jun 19, 2010. PKS Math Education and Research and IMSc jointly organized a meeting in Ramanujan Auditorium,IMSc on the eve of 5th remembrance year of the legendary math educator Shri P. K. Srinivasan. Delivered a talk 'PKS and Math Education'.

Convener of Local Organising Committee for ICMzeta 2010 held at IMSc during Aug 29 – Sep 3, 2010.

Resource faculty at Madras Diabetic Research Foundation, Chennai on Dec 28, 2010. The DST-INSPIRE Internship camp 2010 for 11th and 12th standard students was organized by MDRF, Chennai. The objective of the programme is to attract talented students to take up Science as a career. Delivered a talk on what is Public Key Cryptography.

Speaker at Nanganallur, Chennai on Jan 2, 2011. PKS Math Education and Research Trust organized a programme on the eve of Ramanujan's 124th Birth Day. Delivered a talk entitled Popularizing Ramanujan and Contributions of PKS.

Invited Speaker at Ethiraj College, Chennai on Feb 24, 2011. Delivered a talk on *Srinivasa Ramanujan's contributions to modern mathematics.*

Subramanian, C.R.

Co-organizer of the ICM-2010 Satellite International Conference on Algebraic and Probabilistic Aspects of Combinatorics and Computing held at Indian Institute of Science, Bangalore during 29th August – 3rd September, 2010.

Programme Committee member of the IPEC-2010 (International Symposium on Parameterized and Exact Computation) held at IMSc during Dec 13 – Dec 15, 2010.

Sunder, V. S.

Member of Board of Sciences, Math. Sciences, HBNI during Aug 2005 – Jun 2010.

Chair of Regional Committee for Southern scr eening applications for financial aid for participating in ICM 2010 at Hyderabad. during Aug 2009 – Aug 2010.

Chair of Regional Committee to screen applications from the Southern Zone for financial support for attending ICM 2010 in Hyderabad during Aug 2009 – Aug 2010.

Gave special lecture, titled *Transfinite considerations* at IIT, Madras on May 31, 2010. This was addressed to school students of Padma Seshadri Bala Bhavan.

Convener of Local Organising Committee for Instructional Workshop in Free Probability held at IMSc during Jul 26 – Aug 6, 2010.

Convener of Local Organising Committee for Satellite Conference on Operator Algebras held at IMSc during Aug 9 – Aug 13, 2010.

Viswanath, Sankaran

External thesis examiner of Ph.D thesis committee of Tanusree Khandai, HRI, Allahabad.

during Jun – Jun, 2010.

Convener of Local Organising Committee for ICM Satellite conference on "Algebraic and Combinatorial approaches to representation theory" held at NIAS, Bangalore. during Aug 12 – Aug 16, 2010.

Appreciation Course in Mathematics at IMSc. on Sep 20, 2010. A week long programme for under-graduate students from colleges in and around Chennai City

Chapter 4

Colloquia

4.1 Conferences/Workshops Held at IMSc

4.1.1 Discussion Meeting on "Complex Networks of Trade and Credit"

This two day meeting, held during April 10-11, 2010, and supported by the IMSc Complex Systems project, brought together participants from physics and economic history in order to come up with a concrete proposal for collaborative research in the area of trade and credit networks. The meeting had several presentations by key researchers in this area, but the emphasis was on having informal and detailed discussions on potential research problems. There were 12 participants from multiple disciplines. The following researchers gave presentations at the meeting :

- Raman Mahadevan (Chennai): *Credit and Trade networks in colonial India - an exploratory overview.*
- S S Manna (SNBNCBS, Kolkata): *The International Trade Network.*
- Goutam Mukherjee (Bidhan Chandra College, Asansol): *Aspects of complex networks.*
- S Raghavendra (NUI Galway, Ireland): *Studying the Inter-Bank Credit Transfer Network.*
- Sitabhra Sinha (IMSc, Chennai): *Complex Networks - A new paradigm for understanding patterns in economic history.*
- Lakshmi Subramanian (Jamia Milia, Delhi): *Studying Networks in History.*

4.1.2 Functional Analysis Workshop-I

This was the first of a series of workshops we are planning to organize, covering verious aspects of functional analysis. The goal is presenting a panoramic view of the subject to

(prospective) students. This one was at level one and we covered the following topics: Geometric aspects of Banach Spaces, Spectral analysis of self adjoint operators, Distribution Theory, Harmonic Analysis, Banach Algebras, C*-algebras.

4.1.3 Instructional Workshop in Free Probability

This workshop was a fairly intense two-week workshop held from July 26th to August 6th, when:

- two courses of 10 ninety minute lectures each were delivered by **Professors Roland Speicher** (from Queens University, Canada) and **Ken Dykema** (from Texas A&M University, USA);
- the audience consisted of about 30 mathematicians ranging from senior Professors like Huzihiro Araki and K.R. Parthasarathy to post-docs and graduate students from Texas, Tokyo, Paris, Leuven, Bangalore, Kolkata and Chennai; and
- topics covered both combinatorial (non-crossing partitions, mixed cumulants, ...) and analytic (random matrices, R- and S- transforms, free group factors, ...) approaches to the subject.

4.1.4 ICM Satellite Conference on Quantum Systems

The satellite conference was held in the area of quantum systems covering disordered systems approach to symmetry and a bit of quantum information theory. It was represented by mathematical physicists from all over the world.

4.1.5 ICM Satellite Conference on Operator Algebras

This meeting was 'satellite' to the ICM 2010 (*) which was held in Hyderabad in mid-August. This Satelllite Conference on Operator Algebras was held at IMSc from August 9th to 13th, and was attended by about 65-70 participants from such countries as: Kuwait, Turkey, Iran, England, Ireland, Wales, Italy, Poland, Spain, France, Belgium, Germany, Japan, Korea, and USA.

The invited speakers were: Partha Sarathi Chakraborty, Stephen Curran, Ken Dykema, Siegfried Echterhoff, Fred Goodman, Rolf Gohm, Debasish Goswami, Alice Guionnet, Cyril Houdayer, Masaki Izumi, Yasu Kawahigashi, Claus Koestler, Vijay Kodiyalam, Javier Parcet, Florin Radulescu, Eric Ricard, Thomas Schick, Roland Speicher, and S. Sundar.

(*) The International Congress of Mathematicians is held once every four years at different parts of the globe; the 2010 edition was the first instance of an ICM having ever been held in India.

4.1.6 ICMzeta 2010

A satellite Conference to ICM 2010 on "Analytic and Combinatorial Number Theory" was organized at IMSc during the period 29th August to 3rd September 2010. This conference was funded by ICM, Harish-Chandra Research Institute, Allahabad and IMSc, Chennai. About 40 leading experts in Analytic and Combinatorial Number theory from Europe (mainly, France, Italy, UK, Spain, Russia etc) and American continent (US, Canada and Mexico) and India delivered lectures on their current research work. Apart from the speakers, there were about 20 participants including students and post-doctoral fellows from various institutions. The details about the conference can be viewed at http://www.imsc.res.in/∼icmzeta

4.1.7 School on Loop Quantum Gravity

It was felt for some time that although Loop Quantum Gravity has emerged as a serious candidate theory of quantum gravity, there has been no school of sufficient duration to provide an opportunity for graduate students to learn the basics of the theory. With this in mind a *School on Loop Quantum Gravity* was organized last year at IMSc during Sept 8 - 18, 2009. The goal set was to introduce the basic formalism of loop quantum gravity and to illustrate its main achievements so far, namely illustration of resolution of the big bang singularity and explanation of black hole entropy. The school organised during Sept 22 - 30, 2010 was a sequel to the previous school.

The 8 days program focused on the basics of LQG and applications to black hole entropy. In addition, a couple of lectures were devoted to a 'comparison' of the more familiar quantization and the loop quantization. The black hole application part discussed the relevant classical formulation of isolated horizons, discussed how a Chern-Simons theory on an isolated horizon can be gauge-fixed to a U(1) Chern-Simons theory starting from an SU(2) or ISO(2,1) or even an SO(3,1) theory. The comparison of inequivalent quantizations was carried out for Schrodinger vs Polymer quantization (point particle) and for Fock quantization vs loop quantization (free scalar field).

The lectures were given by Ghanashyam Date, Romesh Kaul, Ayan Chatterjee and Rakesh Tibrewala, all from IMSc while Sandipan Sengupta helped with a tutorial on constrained systems.

In all there were 28 participants registered for the school – 12 out-station and remaining local. A total of 24 sessions of 90 minutes each were held.

The funding for the school came from the XI$^{\text{th}}$ Plan project entitled *Numerical Quantum Gravity and Cosmology.*

4.1.8 2nd IMSc Workshop on "Modeling Infectious Diseases"

This intensive one week workshop (September 13-18, 2010) was held as part of the IMI Special Year on Mathematical Biology (August 2010-July 2011) in collaboration with the IISc Mathematics Initiative (IMI) and with funding from IMSc PRISM and the DST Centre for Mathematical Biology. It aimed at providing hands-on training to researchers from different quantitative sciences in the modeling of several aspects of infectious diseases, including, (a)

the genomics & evolutionary biology of pathogens, (b) systems biology of host-pathogen interactions, and, (c) epidemiology: data analysis and mathematical modeling. It was a follow-up of the first workshop on epidemic modeling held at IMSc in September 2006. In each day of the workshop there were six one-hour lectures by distinguished scientists working in the area of infectious disease biology and its modeling. In the evenings there were tutorials and computer sessions to give the participants hands-on experience on working with epidemic models. There were 45 participants from different parts of the country, who came from diverse disciplines of physics, mathematics, biosciences and engineering. The list of speakers at the School were as follows:

- Indrani Bose (Bose Institute, Kolkata): *Bacterial persistence - A search for physical principles.*
- Nagasuma Chandra (IISc, Bangalore): *Modeling host-pathogen interactions.*
- Narendra Dixit (IISc, Bangalore): *Dynamics of molecular evolution.*
- Gautam Menon (IMSc, Chennai): *Agent-based models for infectious diseases.*
- Aditya Rao (TCS, Hyderabad): *Studying host-parasite protein-protein interactions in cerebral malaria.*
- Chandrika Rao (Piramal Life Sciences, Mumbai): *Inverse analysis of idiotypic network interactions.*
- Satyajit Rath (NII, Delhi): *1. Immune system design: phylogeny and ontogeny, 2. The functional anatomy of immune response, 3. Infections, immunity and disease.*
- Ramrup Sarkar (CCMB, Hyderabad): *1-2. Population-based models in epidemiology; 3. Data-based models in epidemiology; 4. Eco-epidemiological models.*
- Rahul Siddharthan (IMSc, Chennai): *Gene regulation, pathogenesis and immune response.*
- Sitabhra Sinha (IMSc, Chennai): *Complex networks and the contact structure of epidemics.*
- Somdatta Sinha (CCMB, Hyderabad): *1. Modeling infectious diseases: an overview; 2. Quantitative analysis of genomes; 3. Host-parasite interactions: discrete models.*
- Sudeshna Sinha (IISER, Mohali): *Cellular automata models of disease spreading.*
- Tushar Vaidya (CCMB, Hyderabad): *The Yang of host-pathogen interactions.*

4.1.9 National level workshop on Quantum Information Science

This workshop was aimed at having a comprehensive course of lectures on quantum information theory which would firmly lead the participants to enter into the front-line research areas in quantum information. In this direction, this workshop had a list of five main speakers and one extra speaker (Dr. Anil Shaji of IISER, Thiruvananthapuram, who gave two

talks on some of the applications of the knowledge gathered in the lectures by the five main speakers). On an average, there were four lectures per day. Each talk was of one and half hour duration.

Prof.R. Simon of IMSc gave a set of twelve lectures on States and Maps in Quantum Information Theory. Prof. Subhash Chaturvedi of Hyderabad University and Dr. J. Ivan Solomon of RRI, Bangalore together gave a set of elevel lectures entitled, "From phasespace description of Quantum Theory to Bosonic Gaussian Channels". Dr. Guruprasad Kar of I.S.I., Kolkata gave a set of sevel lectures entitled, "Quantum Information: Some counterintuitive features of Quantum Theory". Sibasish Ghosh gave a set of nine lectures on "Quantum Channels and their Capacities". At the end of all the lectures on each day, there was a group discussion / problem solving session. Each speaker started the lectures from quite a basic level and tried to take the subject gradually to a level where the participants could get the essence of the some of the front-line research topics of the subject.

There were thirty two outstation participants (which included few advanced-level master's students, Ph.D. students, post-docs and college/university teachers). There were twenty four local participants (which included some IMSc members, members from IIT-Madras and from local colleges). The participants were quite enthusiastic about the workshop, tried to participate actively in it and most of them showed interest to pursue their future research works in the topics presented in the workshop.

Profs. R. Simon, G. Baskaran and R. Shankar and Dr.Sibashish Ghosh were the members of the organizing committee.

The workshop was a part of the activity of the Centre for Quantum Sciences, IMSc.

4.1.10 Foundations of Software Technology and Theoretical Computer Science

The International Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS) is a forum for presenting original results in foundational aspects of Computer Science and Software Technology, and is the annual conference of the Indian Association for Research in Computing Science (IARCS). The 30th edition of this conference, FSTTCS 2010, took place in IMSc during 15–18 Dec 2010.

The program of the conference included five invited talks by the following experts:

1. **Rajeev Alur**, University of Pennsylvania, USA
2. **Bruno Courcelle**, LaBRI, Bordeaux, France
3. **Pavel Pudlák**, Math. Institute, Academy of Sciences, Czech Republic
4. **Santosh Vempala**, Georgia Tech. Univ., USA
5. **Wiesław Zielonka**, LIAFA, Paris 7, France

In addition, there were 38 contributed talks by researchers. The contributed talks (and corresponding papers for the proceedings) were selected by the conference programme committee

from 128 received submissions after a rigorous peer-review process. The proceedings of the conference were published in the Leibniz International Proceedings in Informatics (LIPIcs) series.

The programme this year also featured a special session on undergraduate and graduate curricula in theoretical computer science.

4.1.11 Discussion-Meeting on "The Economy as a Complex System II: Economic Dynamics"

This three day meeting (Dec 27-29, 2010), organized with support from the IMSc Complex Systems Project, was aimed at bringing together economists with physicists and mathematicians to foster a cross-disciplinary approach to understand certain key problems in economics, in particular, in the area of economic dynamics. It was a follow-up of a similar meeting held at IMSc in December 2004. It was intended to be informal with the emphasis on discussions between the participants and breakout sessions where certain ideas were analyzed in great detail. There were brief presentations on the first day of the meeting to introduce the work of each participant to the others. The concluding session had another series of brief presentations on the new ideas and proposals that were generated through interactions during the meeting. The key participants in the meeting were :

- Amit Bhaduri (JNU, Delhi)
- Bikas K Chakrabarti (SINP, Kolkata)
- Deepak Dhar (TIFR, Mumbai)
- Sanjay Jain (Delhi University)
- K Karmeshu (JNU, Delhi)
- M Krishna (IMSc, Chennai)
- Raman Mahadevan (Chennai)
- S S Manna (SNBNCBS, Kolkata)
- Sripad Motiram (IGIDR, Mumbai)
- S Raghavendra (NUI Galway, Ireland)
- S K Shanthi (GLIM, Chennai)
- Sitabhra Sinha (IMSc, Chennai)
- Vamsicharan Vakulabharanam (University of Hyderabad)

4.1.12 Special year in Number Theory

The goal of this program is to acquaint researchers with some of the recent major developments in number theory.

4.1.13 Mechanics and Physics of Fracture

The subject of fracture and breakdown processes has been actively investigated over the years, with researchers of different disciplines focusing on different aspects of the fracture process. The objective of the meeting was to summarise and integrate the current understanding of fracture and conclude with discussions on future directions of the field. There were 10 speakers out of which 3 were from abroad.

4.1.14 IMPECS School on Parameterized and Exact Computation

IMPECS School on Parameterized and Exact Computation was a satellite event of International Symposium on Parameterized and Exact Computation (IPEC) held at IMSc during December 11th and 12th, 2011. This was primarily targeted at graduate students and new researchers in this area.

This event was sponsored by Indo-German Max Planck center for computer science, based at the Department of Computer Science and Engineering, IIT Delhi.

This event had 94 participants from all over the world, and the program consisted of a series of survey talks in the area of parameterized complexity and exact algorithms

4.1.15 5th International Symposium on Parameterized and Exact Computation (IPEC 2010)

This is an annual international symposium on parameterized and exactly algorithms, and this is the fifth in the series. Venkatesh Raman and Saket Saurabh chaired the program committee of this symposium.

32 papers were submitted for the call for papers and after an extensive refereeing process, 19 papers were selected for the proceedings which was published by Springer Verlag Lecture Notes series (LNCS number 6478).

The three day program of the symposium also included three invited speakers: Anuj Dawar (University of Cambridge, UK), Fedor Fomin (University of Bergen, Norway) and Toby Walsh (NICTA and University of New South Wales, Australia).

This year also saw the introduction of the best student paper award which was shared by two papers.

IPEC 2010 had 103 registrants from 15 countries.

4.2 Other Conferences/Workshops Organized by IMSc

4.2.1 Advanced Instructional School in Representation Theory

The school was one of the "Advanced Training in Mathematics Schools" of the NBHM. About thirty five participants were exposed to the basics of linear representations, both ordinary and modular, of finite groups.

K.N. Raghavan was an organizer and resource person of the school.

4.2.2 Workshop on Quantum Chaos and Quantum Information

This workshop was a part of the ICTS funded activity: "Nonlinear Sciences Perspectives 2010", Ram Ramaswamy, Arul Lakshminarayan and Neelima Gupte were the organizers. This workshop was followed by the conference "Perspectives in Nonlinear Dynamics PNLD 2010", held at IISc, Bangalore from 26 July to 29 July, 2010.

The workshop on Quantum chaos and quantum information was on one of the themes of the PNLD conference. There were pedagogic reviews on quantum chaos, complex and open quantum systems, quantum information and decoherence. This workshop brought together experts from diverse fields, ranging from quantum chaos to quantum information to explore these frontier areas, as well as to serve as a focal point for young researchers in these emerging areas.

About 25 speakers and about 44 participants were there in the workshop.

Together with Sibasish Ghosh from IMSc, Dr. Rajesh Narayanan and Prof. Laxmibala, both from the physics department of IIT-Madras, were in the local organizing committee for the workshop.

4.2.3 Aarhus-Chennai Computational Complexity Workshop

This workshop was planned to bring together researchers from The Institute of Mathematical Sciences, Chennai and from Aarhus University. Both institutions have strong traditions of research in Theoretical Computer Science, in particular in the topic of the workshop, computational complexity theory. The aim of this workshop was to build a strong foundation for future collaboration and exchange of ideas. The academic programme was organised by Meena Mahajan from IMSc, and Peter Bro Miltersen and Kristoffer Hansen from Aarhus.

Ten scientists from India participated in the workshop: 7 from IMSc, and 3 from the Chennai Mathematical Institute.

4.2.4 ICM Satellite Conference on Logic and Set Theory

In the successful tradition of logic satellite meetings at ICMs, we held a satellite conference on mathematical logic and set theory in India to provide a specialized venue for logicians and

set theorists connected with ICM 2010 in Hyderabad. The conference was co-hosted by the Institute of Mathematical Sciences and the Chennai Mathematical Institute on behalf of the Association for Logic in India, and supported by the Department of Science and Technology (Govt of India) as well as the European Science Foundation. The conference had keynote lectures by excellent set theorists and model theorists such as Joan Bagaria (Barcelona, Spain), Rob Goldblatt (Wellington, New Zealand), Menachem Magidor (Jerusalem, Israel), Justin T. Moore (Cornell, USA), Andre Nies (Auckland, New Zealand), Kobi Peterzil (Haifa, Israel), Anand Pillay (Leeds, United Kingdom), Theodore A. Slaman (Berkeley, USA) and Wolfgang Thomas (Aachen, Germany). There were also 8 contributed talks.

4.2.5 ICM Satellite conference on "Algebraic and Combinatorial approaches to representation theory"

This was a satellite conference of the International Congress of Mathematicians (ICM) 2010. K.N. Raghavan was a member of the organizing committee.

4.2.6 Conference on "Modeling Infectious Diseases"

This national conference (September 20-22, 2010) was organized at the Temple Bay Resort in Mamallapuram by IMSc in collaboration with the IISc Mathematics Initiative and was sponsored by IMSc PRISM and the DST Centre for Mathematical Biology. It intended to bring together biologists, clinicians and public health specialists working on infectious diseases with scientists from a modeling background, to foster cross-disciplinary interactions. One of the primary aims was to give participants an overview of the research frontier in epidemic modeling in India. Apart from attending the sessions where distinguished scientists in the field gave invited talks, participants were encouraged to give brief presentations on their current research. Discussion sessions between talks and during the evening were arranged to foster potential future collaborations. There were 35 participants from different parts of India, and 13 invited speakers.

The invited speakers at the Conference were:

- B M Jaffar Ali (Pondicherry Univ): *Simulation of Nitric Oxide signaling network - Implications in host-pathogen interactions.*
- Narendra Dixit (IISc, Bangalore): *Optimizing the treatment of hepatitis C virus infection by rational management.*
- Sunita Gakkhar (IIT, Roorkee): *Mathematical models in eco-epidemiology.*
- Niloy Ganguly (IIT, Kharagpur): *Coverage maximization in networks under resource constraints.*
- Anna George (NII, Delhi): *Recruitment of immune memory.*
- Manish Kakkar (PHFI, Delhi): *Mathematical modeling in aid of public health interventions.*

- V Kumaraswami (NIE, Chennai): *Lymphatic filariasis - New challenges and new solutions.*
- Sarika Mehra (IIT, Bombay): *Study of mycobacterium pathogenesis using comparative genomics.*
- B Ravindran (ILS, Bhubaneswar): *Inflammation: TLR-2 in monkeys, chimps and humans.*
- RamRup Sarkar (CCMB, Hyderabad): *Multi-step polynomial regression method to model and forecast malaria incidence.*
- Somdatta Sinha (CCMB, Hyderabad): Analyzing host-pathogen co-evolution in HIV-1.
- Sudeshna Sinha (IISER, Mohali): *Dynamic transitions in a model of infection spreading.*
- Tushar Vaidya (CCMB, Hyderabad): Modeling in infectious diseases

4.2.7 Lorentz Workshop on Kernelization (WorKer 2010)

Kernelization is a vibrant and rapidly developing area. The update meeting on kernelization was aimed at consolidate the results achieved in the recent years, discuss future research directions, and explore further the applications potential of kernelization algorithms, and give excellent oppontunities for the participants to engage in joint research and discussions on open problems and future directions.

4.2.8 Functional Analysis Workshop-II

This was the second of a series of workshops we are planning to organize, covering verious aspects of functional analysis. The goal is presenting a panoramic view of the subject to (prospective) students. This one was at level two and we covered the following topics: Completely bounded (cb) maps on L_p, Pisier's characterization of bounded maps which are cb, cb multipliers (Fourier and Schur' multipliers), existence of a bounded multiplier which is not cb, Group C*-Algebras, Hilbert C*-modules, Basic von Neumann Algebras, Fourier analysis on SU(1,1)/SO(2), Quantum spin chain in the algebraic and the C*-algebraic formulation.

4.3 Seminars

Date	Speaker Affiliation	Title
6-4-2010	Krishnan Rajkumar IMSc	The Gamma Function
7-4-2010	Sanjeev Kumar IFW Dresden	Spin-orbital frustrations in undoped iron-pnictides
8-4-2010	Simone Borghesi University of Milano-Bicocca	Brody hyperbolicity and homotopy
9-4-2010	Surya K. Ghosh IIT Bombay, Mumbai, INDIA	Effect of Intrinsic Curvature on Semiflexible Polymers
12-4-2010	G. Rajasekaran IMSc	The elusive neutrinos and their importance
13-4-2010	Driti Ranjan Dolai IMSc	Probability measures on Hilbert spaces of large dimensions –Gleason's Theorem
20-4-2010	Prateep Chakraborty IMSc	Postnikov Tower
26-4-2010	Prahladh Harsha TIFR	PCPs and Unique Games
28-4-2010	Prahladh Harsha TIFR	PCPs and Unique Games
30-4-2010	Prahladh Harsha TIFR	PCPs and Unique Games
3-5-2010	Prahladh Harsha TIFR	PCPs and Unique Games
4-5-2010	Anjan Kundu SINP, Kolkata	Integrable 1D Anyon models: Construction through braided Yang-Baxter equation

5-5-2010	Shiraz Minwalla TIFR, Mumbai	Small Hairy Black Holes in $AdS_5 \times S^5$
11-5-2010	Naveen Surendran ICTP	Topological order in three dimensions
13-5-2010	Marcus Du Sautoy University of Oxford	The Music of the Primes
14-5-2010	Marcus Du Sautoy University of Oxford	Through the looking glass: groups from a number theoretic perspective
24-5-2010	Prahladh Harsha TIFR	PCP and Unique Games Conjecture
26-5-2010	Ayan Chatterjee IMSc	Isolated black hole horizons: formalism and applications
26-5-2010	Prahladh Harsha TIFR	PCP and Unique Games
28-5-2010	Prahladh Harsha TIFR	PCP and Unique Games
31-5-2010	Mario Martone Syracuse University	Noncommutative Geometry and Hopf Algebras
31-5-2010	Arun Maiti CMI	A short proof of The Atiyah-Singer Index Theorem
2-6-2010	Anshuman Maharana DAMTP, University of Cambridge, UK	Model Building from IIB Branes at Singularities
3-6-2010	Samir Kunkri Mahadevananda Mahavidyalaya, West Bengal	Bound on Hardy's non-locality from the principle of information causality
4-6-2010	Rizwan Khan UCLA	Weak subconvexity of L-functions-exposition of Soundararajan's work
7-6-2010	Pooja Singla Ben Gurion University of the Negev	Representations and conjugacy classes of general linear groups over principal ideal local rings of length two

9-6-2010	K. Narayan CMI, Chennai	Lifshitz spacetimes from AdS null and cosmological solutions
10-6-2010	Raghu Raghavan Therataxix Biomedical Lab, Maryland, USA	Acoustic shepherding in porous media
11-6-2010	Rizwan Khan UCLA	Weak subconvexity of L-functions-exposition of Soundararajan's work
16-6-2010	Auditya Sharma Department of Physics, University of California, Santa Cruz	Almeida Thouless Line in Vector Spin Glasses
16-6-2010	Bobby Ezhuthachan HRI	Review of M2-D2 connection
17-6-2010	Rizwan Khan UCLA	Weak subconvexity of L-functions-exposition of Soundararajan's work
18-6-2010	Krishnan Raghunathan University of Michigan, Ann Arbor, USA	Sequence Dependent Elasticity of DNA
21-6-2010	Karteek Sreenivasaiah IMSc	Lower bound techniques for Formula Size and monotone Circuit Depth
23-6-2010	Bobby Ezhuthachan HRI, Allahabad	Higher derivative M2 brane Lagrangian
23-6-2010	Rizwan Khan UCLA	Weak subconvexity of L-functions-exposition of Soundararajan's work
24-6-2010	S. Ramakrishna Northwestern University, Evanston, USA	High Harmonic Generation as a Probe of Rotational Dynamics
24-6-2010	B. P. Purnaprjna University of Kansas, USA	On Varieties of General type
30-6-2010	Sandeep Goyal IMSc	Spatial entanglement in Quantum Walk

6-7-2010	Kasturi Varadarajan University of Iowa, USA	Weighted Geometric Set Cover via Quasi-Uniform Sampling
13-7-2010	Andreas Krebs University of Tubingen, Germany	Counting paths in VPA is complete for #NC1
15-7-2010	Venkat Venkatasubramanian Laboratory for Intelligent Process Systems, School of Chemical Engineering, Purdue University, USA	What is Fair Pay for CEOs?: A Statistical Teleodynamics Perspective
16-7-2010	Venkat Venkatasubramanian Laboratory for Intelligent Process Systems, School of Chemical Engineering, Purdue University, USA	Spontaneous emergence of complex optimal networks through evolutionary adaptation
19-7-2010	Jayendra N. Bandyopadhyay Centre for Quantum Technologies, National University of Singapore	Quantum chaotic systems with unusual spectrum
21-7-2010	Udit Raha University of Taiwan, Taipei	Space- and Time-like Electromagnetic Pion and Kaon Form Factors in Light-cone pQCD
22-7-2010	Manoj Kummini Purdue University	Arithmetic rank of Ideals
23-7-2010	Pratyusha Chattopadhyay IMSc	Orbit spaces of unimodular rows
23-7-2010	Huzihiro Araki Kyoto University	Dynamics and Potential
28-7-2010	N D Haridass CHEP, IISc, Bangalore	Magnetars: Strong Interactions in the Sky
29-7-2010	Jainendra Jain Penn State University	From fermions to composite fermions to majorana composite fermions

30-7-2010	V. S. Lakshmanan University of British Columbia, Canada	Breaking out of the Box of Recommendations: From Items to Packages
2-8-2010	Jnanadeva Maharana IOP, Bhubaneshwar	Duality and Local Symmetries in String Theory
4-8-2010	Patrick Huber Virginia Tech USA	Submarine neutrino communication
5-8-2010	Murali Sukumaran Dutch Separation Technology Institute (DSTI) and Wageningen University, The Netherlands	Designing Extractants for Lactic Acid and Diaminobutane Using Molecular Modeling
5-8-2010	L. Brambila-Paz (CIMAT, Mexico), CMI Chennai	Augmented bundles
10-8-2010	Yasir Iqbal Laboratoire de Physique Theorique, University Paul Sabatier Toulouse, FRANCE	Competing phases of the J1 and J1-J2 spin-1/2 quantum Heisenberg Anti-ferromagnet on the Kagome lattice : A Variational Monte Carlo approach
12-8-2010	Sir Michael Berry Bristol University	Optical superoscillations
13-8-2010	Sir Michael Berry Bristol University, UK	Boundary conditions that vary
24-8-2010	M. Ram Murty Queen's University	Special values of L-Series
25-8-2010	Samrat Bhowmick IMSc	10 + 1 to 3 + 1 in an Early Universe with mutually BPS Intersecting Branes
26-8-2010	Subhendu Panda SINP, Kolkata	Discrete Breathers in Nonlinear Lattices

26-8-2010	David Mumford Professor Emeritus Brown University, Chern Visiting Professor UC Berkeley, Spring 2010	The Origin of Algebra as Reification
26-8-2010	Sunil Simon ILLC, Amsterdam	Public communication in games of imperfect information
26-8-2010	Dilip Raghavan University of Toronto, Canada	P-ideal dichotomy and lattices (Part 1)
27-8-2010	Raman Sundrum University of Maryland	SUSY Splits, But Then Returns
27-8-2010	Dilip Raghavan University of Toronto, Canada	P-ideal dichotomy and lattices (Part 2)
31-8-2010	Fred Goodman University of Iowa	Cellularity and the Jones Basic Construction
3-9-2010	A. B. Belliappa IMSc	Histogram Methods in Monte Carlo Simulations
3-9-2010	Vijayamohanan K Pillai NCL, Pune	Impact of Molecular Nanotechnology on Materials Reasearch
13-9-2010	Jeanne Scott IMSc	Unipotent matrices, total positivity, and the origins of cluster theory
16-9-2010	John Plaice University of New South Wales, Sydney, Australia	Cartesian Programming
22-9-2010	Prafulla Behera University of Iowa and CERN	First Physics results from LHC: ATLAS Measurements at sqrt(s)=0.9 and 7 TeV
22-9-2010	Jeanne Scott IMSc	Factorization and positivity in unipotent groups
24-9-2010	Sonali DeSouza Wolfram	MATHEMATICA Software

28-9-2010	Krishnan Rajkumar IMSc	A classical result of Hardy-Ramanujan and the Turan-Kubilius inequality
29-9-2010	Alexander V. Panfilov Department of Theoretical Biology, Utrecht University, The Netherlands	Anatomical modeling of electrical and mechanical function of the heart
29-9-2010	Jeanne Scott IMSc	Positivity and factorization in unipotent groups
1-10-2010	S. M. Bhattacharjee IOP, Bhubaneswar	When a DNA Triple helix melts: An analog of the Efimov state
1-10-2010	Kunal Mukherjee IMSc	Maximal abelian subalgebras in finite factors - II
5-10-2010	Abhisekh Sankaran IIT Bombay	On Semantic Generalizations of the Bernays-Schönfinkel-Ramsey Class with Finite or Co-finite Spectr
5-10-2010	T. Srikanth IMSc	The Stone-Weierstrass theorem for a compact Hausdorff topological space
6-10-2010	Kiran Kolwankar Dept of Physics, R J College, Mumbai and Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany	Evolution of Network Structure by Temporal Learning
7-10-2010	Jeanne Scott IMSc	Kac-Moody groups and generalised minors
8-10-2010	Anil Ananthaswamy New Scientist	The Edge of Physics: Dispatches from the Frontiers of Cosmology
8-10-2010	Madhushree Basu IMSc	CP maps on non-commutative probability spaces and non-commutative semicircular distributions.
11-10-2010	Mainak Poddar ISI Kolkata	Blowdowns in quasitoric spaces.

12-10-2010	Prem Prakash Pandey IMSc	Multiquadratic fields and simultaneous quadratic residues
14-10-2010	Prasad Naldurg Microsoft Research India	Logic for Authorization: Issues and Algorithms
14-10-2010	S.P. Sudeep IMSc	On the u-invariant of hermitian forms
20-10-2010	R. Balasubramanian IMSc	Selberg sieve and its applications
20-10-2010	Jeanne Scott IMSc	Generalized flag minors for Kac-Moody groups
21-10-2010	Arati Khedekar. IMSc	Extensions of locally compact groups.
22-10-2010	R. Balasubramanian	Selberg sieve and its applications
22-10-2010	T. Srikanth	A note on generators for finite depth subfactor planar algebras
26-10-2010	Prajakta Nimbhorkar IMSc	Complexity analysis of some problems in planar graphs, bounded tree-width graphs and planar point sets. (HBNI PhD defense)
27-10-2010	Umesh Waghmare Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore	Soft modes, Hyperelasticity and Cracks: How does a crystal break?
27-10-2010	R. Balasubramanian IMSc	Selberg Sieve and its application
27-10-2010	Jeanne Scott IMSc	Unipotent cells and cluster algebras
28-10-2010	Colas Bardavid IMSc	Leaves and trajectories for schemes. Application.
29-10-2010	Kunal Mukherjee	Maximal abelian subalgebras in finite factors - III

1-11-2010	Siva Athreya ISI, Bangalore	Brownian Motion on R trees
3-11-2010	Vishwesha Guttal Princeton University	The evolution of collective animal behavior
4-11-2010	Krishna Maddaly IMSc	Some new theorems in spectral theory
4-11-2010	Sampath Kannan University of Pennsylvania	Data Streams
8-11-2010	N D Haridass CTS, IISc, Bangalore	Statistical Significance of Single Harmonic Oscillator Coherent States
11-11-2010	Jung Hun Han IMSc	On the Levy density function
11-11-2010	Sampath Kannan University of Pennsylvania	Data Streams
12-11-2010	Varsha Banerjee	Mass-Transport Models with Multiple-Chipping Processes
12-11-2010	Eknath Ghate TIFR	Weight 1 forms in p-adic families
12-11-2010	Jeanne Scott IMSc	Unipotent cells and their cluster algebra structure
12-11-2010	N. S. Narayanaswamy IIT Chennai	Better kernels for vertex cover
12-11-2010	Kunal Mukherjee	Maximal abelian subalgebras in finite factors - IV
13-11-2010	Madhavan Mukund Chennai Math Institute, Chennai	Who's afraid of concurrent programming?
16-11-2010	Chee Yap Courant Institute, NY, USA	Pi is in Log Space
16-11-2010	Pampa Paul IMSc	"Bergman metric on a bounded domain of C^n

5-8-2010	Murali Sukumaran Dutch Separation Technology Institute (DSTI) and Wageningen University, The Netherlands	Designing Extractants for Lactic Acid and Diaminobutane Using Molecular Modeling
5-8-2010	L. Brambila-Paz (CIMAT, Mexico), CMI, Chennai	Augmented bundles
18-11-2010	Amritanshu Prasad IMSc	Combinatorics of the oscillator representation
19-11-2010	G Gnanasangeetha	Quantum Zeno suppression of three-body losses in Bose-Einstein condensates
19-11-2010	Olaf Beyersdorff Leibniz University, Hannover	Parameterized Proof Complexity
18-11-2010	Sampath Kannan University of Pennsylvania	Data Streams
21-12-2010	G. Rajasekaran IMSc & CMI	Chandrasekhar and the Stars
22-12-2010	Rama Ratnam Department of Biology, University of Texas at San Antonio San Antonio, Texas, USA	The role of noise in stochastic neural spike trains
22-12-2010	S.Ramanan IMSc & CMI, Disitinguished Professor (Retd.) TIFR	"Mathematics - Her Infinite Variety"
24-12-2010	Subir Sarkar Oxford University	Asymmetric dark matter
24-12-2010	M. Ram Murty Queen's University, Canada	Buddha And His Message
30-12-2010	Raja Sridharan TIFR, Mumbai	On the Representation of Numbers

30-12-2010	M. Ram Murty Queen's University, Canada	Ellipses and Elliptic Curves
30-12-2010	R. Tubbs	Hilbert's seventh problem
3-1-2011	Geetha Thangavelu Periyar University, Salem	Cellular Algebras
4-1-2011	David Gross The Kavli Institute for Theoretical Physics, USA	The Coming Revolutions in Fundamental Physics
6-1-2011	Victor Anadam IMSc	Harmonic functions and potentials on finite networks
7-1-2011	Indu Satija George Mason University	Chern Numbers Hiding in Time of Flight Images
7-1-2011	C. Gasbarri University of Strasbourg	Geometric transcendence theory
13-1-2011	Y. V Nesterenco	Transcendental Number Theory
13-1-2011	Michel Brion Institut Fourier, Grenoble	Geometry of algebraic groups and of homogeneous spaces
17-1-2011	Mikhail Kiselev Abdus Salam ICTP, Trieste, Italy	Haldane gap in spiral staircase model
18-1-2011	Y. V. Nesterenko	Transcendental number theory
18-1-2011	Madhusudan Manjunath Max Planck Institute for Informatics, Saarbruecken, Germany	The Laplacian lattice of a graph under a simplicial distance function
18-1-2011	Antony Leggett University of Illinois, Urbana-Champaign, USA	Why can't time run backwards?
19-1-2011	Suvankar Dutta University of Swansea	Holographic Hydrodynamics

20-1-2011	David Claman Lehman College, CUNY, New York	On composing music
20-1-2011	Y. V. Nesterenko	Transcendental number theory
21-1-2011	Anthony Sudbery The University of York, U.K.	The geometric measure of entanglement
21-1-2011	Y. V. Nesterenko	Transcendental Number Theory
21-1-2011	Arnab Bhattacharyya MIT, USA	A Unified Framework for Testing Linear-Invariant Properties
21-1-2011	Sunil Mukhi TIFR, Mumbai	Beyond the Gauge Principle
22-1-2011	Venkatesh Raman IMSc, Chennai	NP-complete problems and approaches to deal with them
24-1-2011	Sunil Mukhi TIFR, Mumbai	3-algebra gauge symmetry in 2+1 dimensions (Part- I)
24-1-2011	Y. V. Nesternko	Transcendental Number Theory
24-1-2011	Thomas Konrad University of KwaZulu-Natal, Durban, South Africa	Entanglement in a noisy environment.
25-1-2011	Sunil Mukhi TIFR, Mumbai	3-algebra gauge symmetry in 2+1 dimensions (continued)
25-1-2011	Y. V. Nesterenko	Transcendental number theory
25-1-2011	T. Mubeena IMSc	CAT(0) spaces and groups
25-1-2011	Yanjing Wang Peking University, Beijing, China	Counting Models modulo Bisimulation
25-1-2011	Hans van Ditmarsch University of Sevilla, Spain	The Art of Lying

28-1-2011	V Parameswaran Nair CUNY, Newyork, USA	On Casimir effect and edges and diffraction
28-1-2011	Srikanth Srinivasan IAS, Princeton	New Directions in Arithmetic and Boolean Circuit Complexity
31-1-2011	Anjan Kundu SINP, Kolkata	Topological Magnetic Pattern: Modeling the Recent Observation
1-2-2011	Sanjay Puri JNU, Delhi	Pattern Formation in Granular Materials
1-2-2011	Y. V. Nesterenko	Transcendental Number Theory
1-2-2011	Panchugopal Bikram IMSc	Hilbert von Nuemann modules
2-2-2011	Chinmay Das Polymers and Complex Fluids Group, School of Physics and Astronomy, University of Leeds, Leeds, UK	Simulations of Stratum Corneum lipids
2-2-2011	Borun D Chowdhury University of Amsterdam, The Netherlands	Moving of the orbifold point in the D1-D5 CFT
2-2-2011	Jerry Fernandes, Hans van Ditmarsch and others Madras Chamber Orchestra	String Quartet
3-2-2011	Professor Anatoly Yagola Department of Mathematics, Physical Faculty, Moscow State University, Moscow, 119991, Russia	Error estimation for ill-posed problems with a priori information
3-2-2011	Y. V. Nesterenko	Transcendeltal Number Theory
3-2-2011	Aldo Conca University of Genova	Koszul algebras and Koszul homology
3-2-2011	Raghavendra Singh IBM Research India, Delhi	Network architecture of the long-distance pathways in the macaque brain

4-2-2011	Y. V. Nesterenko	Transcendeltal Number Theory
4-2-2011	Matthias Brack Institute for Theoretical Physics, University of Regensburg, Germany	Spacial density oscillations in Fermionic Systems
4-2-2011	Abhishek Agarwal American Physical Society, NY	From Quarks to Strings via Magnets: Recent progress in Gauge and String Theories
8-2-2011	Driti Ranjan Dolai IMSc	Representation of analytic functions from the upper half plane to the upper half plane.
8-2-2011	Simon Kramer University of Luxembourg	Formal Definitions and Complexity Results for Trust Relations and Trust Domains with Applications to Cryptographic-Key Management
9-2-2011	Alan Drew Queen Mary University of London, London	Local probe investigation of spin transport and dynamics in organic semiconductors
10-2-2011	Masahiro Kaminaga IMSc	"Analyticity of density of states"
11-2-2011	P. Philippon University of Paris VI	Some aspects of Mahler's method in transcendence theory
11-2-2011	R. Ganesh University of Toronto, Toronto	Quantum paramagnetism on the honeycomb lattice
14-2-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
15-2-2011	Rajat K. Bhaduri Department of Physics and Astronomy, McMaster University, Canada	Efimov effect in Ultra-Cold Atoms
16-2-2011	Josep M Pons DECM and ICC, Dept of Physics, University of Barcelona, Spain	The issue of observables in General Relativity

17-2-2011	Ved Prakash Gupta IMSc	Bimodules, Subfactors, Planar Algebras and Perturbations.
17-2-2011	Anupama Bhagwat	Sitar concert
18-2-2011	Pankaj Mishra IIT Kanpur	Dynamics of reorientations and reversals of large-scale flow in Rayleigh-Benard convection.
18-2-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
21-2-2011	Lis Brack History of Science Unit, University of Regensburg	Babylonian astronomy: Methods for understanding empirical rules found on cuneiform tablets
21-2-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
22-2-2011	Kristoffer Arnsfelt Hansen Aarhus University, Denmark	Learning Read-constant Polynomials of Constant Degree modulo Composites
22-2-2011	Umesh Dubey IMSc	Spectrum of tensor triangulated category
23-2-2011	Sudipto Paul Chowdhury IACS, Kolkata	Bagger-Lambert-Gustavsson (BLG) theory: A general study
23-2-2011	Sambhunath Biswas Machine Intelligence Unit, ISI, Kolkata	Machine Vision:A Brief Overview and Some of its Challenges
24-2-2011	Abhay Parvate TIFR, Mumbai	Calculus on Fractal Subsets of Real Line: Formulation, Techniques and Application
24-2-2011	Narasimha Kumar IMSc	"On Local Galois Representations attached to Automorphic Forms"
25-2-2011	Suman K Banik Bose Institute, Kolkata	To luminesce or not: Story of light emitting marine bacteria

25-2-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
28-2-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
1-3-2011	Sujit Sarkar Poorna Prajna Institute, Bangalore	Perfect Entanglement Transport in Quantum Spin Chain Systems
2-3-2011	D.P. Roy	Using Tau polarization for Charged Higgs boson & SUSY searches
2-3-2011	P. Philippon University of Paris VI	Mahler's method in transcendence theory
3-3-2011	D. P. Roy Homi Bhabha Centre for Science Education	Why LHC?
4-3-2011	C. K. Chan Institute of Physics, Academia Sinica, Taipei, Taiwan	Effect of Temperature on the Synchronization of the Sino-atrial Node
8-3-2011	Ram Murty, K. Soundararajan, K. Srinivas and R. Balasubramanian	Ramachandra, some professional and personal reminiscences
8-3-2011	Kajal Das IMSc	Bipartite graph planar algebras
9-3-2011	Anil R. Kulkarni Divecha Center for Climate Change, IISc.	Understanding Changes in Himalayan Glaciers
9-3-2011	C. S. Rajan TIFR	Prime valuations for spectra?
10-3-2011	K. Soundararajan Stanford University	Zeta and L-functions
10-3-2011	S. D. Adhikari HRI	Classical Ramsey type theorems: Interrelations and applications

11-3-2011	K. Soundararajan Stanford University	Zeta and L-functions
14-3-2011	B. Ramakrishnan HRI	Correspondences between modular forms and Jacobi forms
14-3-2011	Romesh Kaul IMSc	Lecture Series on Naturalness and Electroweak Symmetry Breaking
16-3-2011	S. Sundar	The geometry of some quantum homogeneous spaces and the weak heat kernel expansion
16-3-2011	K. Soundararajan Stanford University	Zeta and L-functions
16-3-2011	Romesh Kaul IMSc	Lecture Series on Naturalness and Electroweak Symmetry Breaking
16-3-2011	S. David University of Paris VI	Introduction to Lehmer's problem
17-3-2011	D. Prasad TIFR	Effective Chebotarev density theorem
17-3-2011	W. Kohnen University of Heidelberg	Generalized modular functions
17-3-2011	Romesh Kaul IMSc	Lecture Series on Naturalness and Electroweak Symmetry Breaking
18-3-2011	D. Prasad TIFR	Effective Chebotarev density theorem
18-3-2011	Anjan Joshipura Physical Research Laboratory, Ahmedabad	Pathways to quark lepton unification
18-3-2011	W. Kohnen University of Heidelberg	Generalized modular functions
19-3-2011	Anjaneyulu Pasala Infosys Technologies	Challenges in preventive maintenance of software

21-3-2011	W. Kohnen University of Heidelberg	Generalized modular forms
21-3-2011	Anandamohan Ghosh IISER, Kolkata	Analysis of retinal ganglion cell response to non-Gaussian stimuli
21-3-2011	S. David University of Paris VI	Introduction to Lehmer's problem
22-3-2011	W. Kohnen University of Heidelberg	L-functions
22-3-2011	Roman Sverdlov RRI	Entanglement without configuration space
22-3-2011	Issan Patri IMSc	Operator spaces and Ruan's theorem
23-3-2011	Gaurav Narain IMSc	Asymptotic Safety
23-3-2011	P. Chellapandi Director, Nuclear and Safety Engineering Group, IGCAR, Kalpakkam	Design of Nuclear Reactors against Earth Quake and Tsunami
23-3-2011	S. David University of Pierre et Marie Curie, Jussieu, France	Elliptic curves, a brief introduction
24-3-2011	Mattias Stemmler TIFR, Mumbai	Stability and Hermitian-Einstein metrics for vector bundles on framed manifolds
24-3-2011	Eleonora Dell'Aquila Perimeter Institute	Scattering Amplitudes in N=4 Super Yang-Mills
29-3-2011	S. David University of Paris VI	Lehmer's Problem
30-3-2011	S. David University of Paris VI	Lehmer's Problem

31-3-2011	V. Lakshmibai Northeastern University	Cotangent bundles and affine Schubert varieties
31-3-2011	S. David University of Paris VI	Introduction to Lehmer's problem

Chapter 5

External Interactions

5.1 Collaborative Projects with Other Institutions

5.1.1 Arithmetic vs Boolean complexity: the case of small-depth circuits

Boolean and arithmetic circuits provide complementary views on important algorithmic problems. This applies both for the design of efficient algorithms within these models as well as for the search for lower bounds. Both directions have seen remarkable progress during recent years. This project, funded by the DST, Government of India, and the DAAD, Germany, aims to clarify the relationship between these two computation models. In particular, research activity is centred on the connections between arithmetic circuits and small counting complexity classes. Resolving relations between these classes will also affect practical questions, as a number of algorithmic problems like testing for perfect matchings are intimately linked to such tractable complexity classes within P.

Participants in this project are Meena Mahajan (IMSc, principal investigator, Indian side), Heribert Vollmer (Leibniz University, Hannover, principal investigator, German side), Samir Datta (CMI, Chennai), B V Raghavendra Rao (formerly IMSc, now University of Saarlandes, Germany) and Michael Thomas (Hannover). The project is for 2 years, June 2009 to May 2011.

5.1.2 Belle Collaboration

Rahul Sinha is an invited memeber of the "Belle Collaboration" which is an experimental collaboration based in Japan. The Belle collaboration is an international team of 437 scientists from 71 institutions located in 15 different countries.

5.1.3 Developing tools for dynamical modeling of C. elegans neuronal network activity

Caenorhabditis elegans is the only organism with its nervous system completely mapped. In addition to being small and well-characterized, its genetic amenability has made it an ideal system to study a whole animals behavior at the molecular and cellular levels. While the complete mapping of neuronal connections allows one to know the structural aspects of connectivity among neurons, there exists little information as to how the activities of individual neurons might correlate with particular behavioral patterns. This project intends to construct a dynamical neural network simulator for the entire C. elegans somatic nervous system using physiologically realistic single-compartment models of individual neurons. This will allow connecting electrical activity at the level of individual neurons to the behavior of the organism in response to specific stimuli, something which is experimentally still challenging. This will also permit prediction of hitherto unidentified neuronal members of specific behavioral circuits from activity patterns of the network. To verify the predictions obtained from the results of the model simulations, C.elegans strains with cameleon-labeled dopaminergic neurons for dynamical calcium imaging will be developed. The further aim of this proposal is to image and investigate activity-induced calcium changes in core cells of specific behavioral circuits.

5.1.4 India-based Neutrino Observatory (INO)

The INO group at IMSc consists of D. Indumathi, M.V.N. Murthy, G. Rajasekaran and Nita Sinha in addition to N.S. Sreenivasan and R. Sundarasrinivasan who are INO project consultants at IMSc. IMSc members are actively involved in many aspects of this ambitious project such as physics and simulations studies, and site related activities.

Underground Science in India has a long history. The underground laboratory at Kolar Gold Fields (KGF) where Indian scientists conducted many front-ranking experiments in the field of cosmic rays and neutrinos, and where cosmic ray neutrinos were detected for the first time, were closed down in early 1990. It was in this background that the idea for a new underground neutrino observatory, with unique advantages to carry out internationally front-ranking experiments in India, was initially discussed in a Workshop on High Energy Physics and Phenomenology (WHEPP), held in Chennai in January 2000, nearly a decade ago.

Over the next few years, the physics goals and reach of the project were discussed, finalised, and the case for such a laboratory was strengthened by detailed calculations and initial proof-of-principle of the proposed detector technology. Presently there are nearly a hundred scientists, students and engineers from nearly 26 institutions in India are part of the collaboration. IMSc group has significantly contributed to defining the goals of the project through physics analysis and simulations. In addition IMSc group is also involved in human resource generation for the project by training students in many tasks.

The immediate goal of INO is the creation of an underground laboratory which will house a large magnetised iron calorimeter detector that will study the naturally produced neutrinos in Earth's atmosphere. The INO underground laboratory is expected to come up in the Bodi West Hills near Pottipuram village in the Theni district of Tamil Nadu. The decision on

the location of the site was taken after detailed studies on geology, topography, environment and other parameters. Through IMSc, a detailed project on the site (DPR) was prepared by TNEB. The INO Centre is to be located in Madurai near the MK Univerisity. BARC is now likely to take up the construction of the project.

IMSc group was also involved in obtaining statutory forest and environmental clearances. The Environmental Impact Assessment (EIA) was done by Salim Ali Centre for Ornithology and Natural History(SACON) through IMSc. The INO project has now been given forest and environmental clearance by the Ministry of Environment and Forests (GOI). The government of Tamil Nadu has offered land at Bodi West Hills for locating the INO underground laboratory as also land for locating the INO Centre at Madurai.

These clearances came after a concerted effort by the IMSc group which involved negotiating with the officials, many outreach activities to educate public, students and others on many aspects of the project while removing their apprehensions and fears. An INO cell has been formed at American College, Madurai to aid the outreach activities of INO members.

5.1.5 Preserving species and genetic diversity through spatial heterogeneity and temporal fluctuations

This is a project funded by the Indo-US Science and Technology Forum under their Frontiers of Science program. A joint collaboration between IMSc and the group of Prof Adam P. Arkin at UC Berkeley, the project is investigating the role played by spatiotemporal inhomogeneity of species fitness in maintaining species and genetic diversity (thereby increasing robustness) of a biological system.

5.1.6 The Debian Project

The Debian project was established in 1993 to provide an operating system that is composed of entirely free software.

The IMSc is one of the few academic institutions in India that runs all its services on free software; indeed it has been a pioneer in this area. In earlier years our contribution has been restricted to reporting bugs and patches for those bugs.

Since November 2004 we have been maintaining some packages that are used by the wide community of Debian users. These include:

tex4ht A system for developing hypertext documents using TEX and LATEX.

elvis An editor that is similar to `vi` but has many more features.

par An intelligent paragraph formatter.

pngcrush A program that reduces the size of `png` graphics files without losing graphic information.

swish++ A file indexing and searching system.

5.2 Institute Associateships

The Institute has established short-term associateships in **Mathematics, Theoretical Physics and Theoretical Computer Science** to enable teachers from colleges and universities to work at the Institute. The programme is envisaged to develop interaction between the members of the faculty of the institute and scientists in the university system. Under this programme, an associate can visit the institute once or twice a year, up to a total of 90 days per year, each visit lasting a minimum of three weeks. The tenure of an associate will be for a period of three years and (s)he is expected to visit the institute at least twice during this period.

The institute will bear the expenses of round-trip travel (by rail) from the Associate's normal place of work to Chennai and will also pay a daily allowance to cover local expenses at Chennai. During their stay at Chennai, Associates will be accommodated in the institute Guest House.

Associates who visited the institute during the period 01.04.10 to 31.03.11 are :

L K Saini
S.V. National Institute of Technology, Surat
29.03.10 to 15.06.10

Anirudh Pradhan
Hindu PG. College, Zaminia, Ghazipur, Uttar Pradesh
31.03.10 to 10.05.10

Anil Kumar Yadav
Anand Engineering College, Agra, Uttar Pradesh
16.06.10 to 30.07.10

R. Rajdeep Niyogi
Indian Institute of Technology, Roorkee, Uttarakhand
06.07.10 to 16.07.10

Hans Van Ditmarsch
Department of Logic, University of Sevilla, Spain
12.01.11 to 04.02.11

Subinay Dasgupta
Department of Physics, University of Calcutta
27.03.11 to 09.04.11

5.3 Conference Participation and Visits to Other Institutions

Balakrishnan, Radha

Participated in *Seminar organized by the Centre for Empowerment of Women, Anna University and the WIS programme of the Indian Academy of Sciences, Bangalore* held at Anna University, Chennai during May 15 – May 16, 2010. Gave an invited talk on Solitons in Bose-Einstein Condensates

Participated in *Perspectives in Nonlinear Dynamics 2010 (A satellite meetingto STATPHYS 24)* held at Indian Institute of Science, Bangalore during Jul 26 – Jul 29, 2010. Gave an invited talk on Immortal solitons in a hard-core Bose-Einstein condensate. Chaired a session.

Visited George Mason University, Fairfax, USA during Nov 1 – Nov 30, 2010. For collaborative research.

Participated in *DST-SERC School on Nonlinear Dynamics* held at Bharathidasan University, Tiruchirapalli during Jan 20 – Jan 25, 2011. Gave a set of lectures on Solitons in magnetic systems.

Participated in *Sixth National Conference on Nonlinear Systems and Dynamics* held at Bharathidasan University, Tiruchirapalli during Jan 27 – Jan 30, 2011. Gave an invited talk on Bright and dark solitons in a strongly repulsive Bose-Einstein condensate.

Balasubramanian, R.

Participated in *ICM Satellite Conference on Modular Forms* held at Mahabalipuram during Aug 1 - Aug 9, 2010. Gave a lecture on Omega Results for Tau functions.

Participated in *International Congress for Mathematicians* held at Hyderabad during Aug 19 - Aug 27, 2010. Gave Plenary Lecture.

Visited Chennai Mathematical Institute on Feb 9, 2011. Gave the K. Lakshmanan Memorial Distinguished Lecture.

Visited TIFR CAM on Mar 3, 2011. Gave Lecture on the Work of K. Ramachandra.

Basu, Madhushree

Participated in *Non Commutative Geometry and Operator Algebras Eighth Spring Institute 2010* held at Vanderbilt University, Nashville, Tenessee during May 10 – May 19, 2010.

Participated in *Instructional Workshop on Free Probabiity* held at Institute of Mathematical

Sciences, Chennai during Jul 26 – Aug 6, 2010.

Participated in *Satellite Conference on Operator Algebras* held at Institute of Mathematical Sciences, Chennai during Aug 9 – Aug 13, 2010.

Basu, Rahul

Participated in *SERC Main School in High Energy Physics* held at Physics Department, Panjab University, Chandigarh during Apr 2 – Apr 12, 2010. Delivered a 9 lecture course on perturbative QCD

Chakraborty, Partha S.

Participated in *Conference on Geometry and Quantum Field Theory* held at Max-Planck Institute, Bonn, Germany during Jun 21 – Jun 25, 2010. Invited Speaker

Visited Indian Statistical Institute, Delhi during Nov 30 – Dec 6, 2010. Collaborative research with Prof. Arup Pal.

Chatterjee, Chandrasekhar

Visited S.N.Bose National Centre for Basic sciences during Nov 9 – Nov 12, 2010. For collaborative work with Amitabha Lahiri.

Visited Indian Association for the Cultivation of Science, Jadavpur, Kolkata during Dec 20 – Dec 29, 2010. Collaborative work

Participated in *One Day Workshop on Non-Perturbative Aspects of Quantum Field Theory* held at Indian Association for the Cultivation of Science, Jadavpur, Kolkata on Dec 20, 2010. I was invited to talk on "Systematic techniques for computations with monopole plasma".

Participated in *International conference on New trends in Field Theories* held at Banaras Hindu University during Feb 7 – Feb 12, 2011.

Chatterjee, Tapas

Participated in *ICM Satellite Conference on "Modular Forms"* held at TTDC Ltd. Resort, Mamallapuram during Aug 1 – Aug 9, 2010.

Participated in *ICM 2010* held at HICC , Hyderabad during Aug 19 – Aug 27, 2010.

Participated in *ICM Zeta* held at IMSc, Chennai during Aug 29 – Sep 3, 2010.

Date, G.

Participated in *XIX DAE-BRNS High Energy Physics Symposium* held at LNM Institute of Information Technology, Jaipur during Dec 16 – Dec 18, 2010. Delivered an invited talk on *Loop Quantum Gravity.*

Participated in *New Trends in Field Theories* held at Swatantrata Bhawan, Banaras Hindu University, Varanasi during Feb 9 – Feb 12, 2011. Delivered an invited talk on *Loop Quantum Gravity.*

Visited Centre for Theoretical studies, Indian Institute of Technology, Kharagpur during Mar 1 – Mar 6, 2011. Gave a seminar on *Why a Quantum Theory of Gravity?*

Ghosh, Sibasish

Visited Homi Bhabha National Centre for Science Education during Jun 15 – Jun 20, 2010. Visited the Centre to give a series of lectures on quantum information theory at NIUS camp and also interacted with Prof. S. M. Roy there at the Centre towards completing our work on chain of Hardy-type nolocality arguments.

Participated in *Quantum Chaos and Quantum Information* held at IIT - Madras during Jul 21 – Jul 25, 2010. This was a workshop. Gave a talk there entitled, "Dynamics of entanglement under the influence of local heat baths".

Participated in *ICM Satellite Conference on Quantum Systems* held at IMSc, Chennai during Aug 14 – Aug 18, 2010. Attended this conference as a participant.

Participated in *Indo-Brazil Workshop on Cold Atoms, Mesoscopic Systems and Quantum Information* held at Hyderabad during Oct 16 – Oct 18, 2010. Attended this workshop as a participant.

Participated in *National level workshop on quantum information* held at IMSc, Chennai during Nov 22 – Dec 4, 2010. One of the organizers of this workshop and gave a series of lectures on classical and quantum information theory.

Participated in *75 Years of Quantum Entanglement: Foundations and Information Theoretic Applications* held at S. N. Bose National Centre for Basic Sciences, Kolkata during Jan 6 – Jan 10, 2011. Gave an invited talk entitled, "Quantum to classical transition and entanglement sudden death in Gaussian states under local heat bath dynamics".

Visited S. N. Bose National Centre for Basic Science during Jan 11 – Jan 15, 2011. Interacted with the people (Dr. Archan S. Mazumdar and his students) working on quantum information theory at S. N. Bose Centre, Dr. Somshubhro Bandyopadhyay of Bose Institute and Dr. Guruprasad Kar at I. S. I. Kolkata.

Participated in *National Level Seminar on Mathematics and Applications* held at Burdwan

University, Burdwan, West Bengal during Feb 24 – Feb 25, 2011. Gave an invited talk entitled, "Constancy of Maximal Non-local Probability in Hardy's Non- locality Test for Bipartite Quantum Systems".

Participated in *International Conference on Frontiers in Applied Mathematics and its Computational Aspects* held at Applied Mathematics Department, University of Calcutta during Mar 15 – Mar 17, 2011. Gave an invited talk entitled, "Analytical proof of Gisin's theorem for three qubits".

Participated in *International Conference on Quantum Optics and Quantum Computing (ICQOQC - 11)* held at Jaypee Institute of Information Technology, Noida during Mar 24 – Mar 26, 2011. Gave an invited talk entitled, "Approximate joint measurement of qubit observables through an Arthur-Kelly type model".

Gun, S.

Visited Harish-Chandra Research Institute during Apr 1 – May 30, 2010. Academic collaboration

Participated in *The ICM Sattellite conference on Modular forms* held at Maamallapuram, Chennai during Aug 1 – Aug 14, 2010. Gave an invited talk on "Transcendental values of modular forms and quasi-modular forms"

Participated in *The International congress of Mathematicians* held at Hyderabad during Aug 19 – Aug 25, 2010.

Participated in *The ICM Satellite Conference on Number theory* held at IMSc during Aug 29 – Sep 3, 2010.

Gupta, Ved Prakash

Participated in *Satellite Conference on Operator Algebras* held at IMSc, Chennai during Aug 10 – Aug 13, 2010.

Participated in *International Congress of Mathematicians* held at Hyderabad during Aug 18 – Aug 27, 2010.

Visited IISER Mohali, Chandigarh. on Nov 16, 2010. Gave a talk on "Bimodules, Subfactors, Planar Algebras and Perturbations".

Participated in *Winter School on Functional Analysis* held at ISI Delhi, New Delhi during Dec 6 – Dec 10, 2010. Gave a mini course on "Introdution to von Neumann Algebras".

Karthick, T.

Participated in *International Workshop on Graph Coloring and its Applications (IWGC-2010)* held at Bharathidasan University, Tiruchirappalli during Aug 7 – Aug 9, 2010. Gave an invited talk and presented a paper titled "On b-perfect graph conjecture and forbidden subgraphs".

Participated in *International Conference on Recent trends in Graph Theory and Combinatorics (ICRTGC-2010)* held at CUSAT, Cochin during Aug 12 – Aug 15, 2010.

Participated in *IMPECS, IPEC, FSTTCS (2010)* held at IMSc., Chennai during Dec 11 – Dec 18, 2010.

Participated in *National Worshop on Recent Trends in Graph Theory and its Applications* held at Pondicherry University, Puducherry during Feb 15 – Feb 17, 2011. Gave an invited talk on "Forbidden subgraph colorings and its applications".

Kesavan, S.

Participated in *ATMLDU-2010* held at Delhi University during Mar 22 – Apr 2, 2010. Delivered a series of two lectures

Participated in *International Congress of Mathematicians (ICM,2010)* held at Hyderabad during Aug 19 – Aug 27, 2010. Member, Executive Organizing Committee and Chair, Local Programme Committee

Participated in *Recent Trends in Nonlinear Elliptic Partial Differential Equations* held at TIFR-CAM, Bangalore during Jan 6 – Jan 8, 2011. Delivered an invited talk

Kodiyalam, Vijay

Participated in *Noncommutative Geometry and Operator Algebras 2010* held at Vanderbilt University, Nashville, USA during May 9 – May 19, 2010. Gave a talk on "The GJS construction for graphs"

Participated in *Satellite conference to ICM 2010 on Operator Algebras* held at IMSc. Chennai during Aug 9 – Sep 13, 2010. Gave a talk on "Universal skein theory for finite depth subfactor planar algebras"

Krishna, M.

Visited Department of Mathematics, Fern University Hagen, Germany during May 17 – May 25, 2010. Gave talk on "Interband Light Absorption Coefficient"

Visited Departments of Mathematics, University of Alborg and University of Arhus, Denmark during May 26 – May 30, 2010. Gave a joint seminar on "Detecting components of

measures and some application to random operators"

Participated in *Random Schrodinger Operators* held at Ecole Polytechnique Federale de Lausanne - Centre Interfacultaire Bernoulli during May 31 – Jun 4, 2010.

Visited Tata Institute of Fundamental Research Centre for Applicable Mathematics on Oct 26, 2010. Colloquium Talk on "Spectral Theory of Random Operators"

Participated in *Discussion meeting on operator theory* held at Orange County Resorts during Feb 23 – Feb 26, 2011. This is a meeting organized by the Indian Academy of Sciences

Ramanujan, M.S.

Visited RWTH Aachen during Oct 30 – Nov 7, 2010. Research Visit

Participated in *Workshop on Kernelization* held at Lorentz Center, Leiden during Nov 8 – Nov 12, 2010.

Participated in *2011 School on Approximability* held at IISc during Jan 5 – Jan 9, 2011.

Mahajan, Meena B.

Participated in *ACM Symposium on Theoretical Aspects of Computing* held at Cambridge, MA, USA during Jun 5 – Jun 8, 2010.

Participated in *IEEE Conference on Computational Complexity* held at Harvard University, Cambridge MA, USA during Jun 9 – Jun 11, 2010. Chaired the afternoon sessions on 10th June.

Participated in *Aarhus-Chennai Computational Complexity Workshop* held at Dept of Computer Science, Aarhus University, Denmark during Aug 2 – Aug 6, 2010. Gave a talk titled "Logarithmic depth arithmetic-boolean circuits"

Participated in *ICM 2010 Satellite Conference On Algebraic and Probabilistic Aspects of Combinatorics and Computing* held at IISc, Bengaluru during Aug 29 – Sep 3, 2010.

Participated in *Mysore Park Series Workshop on Algorithms and Complexity* held at Infosys Campus, Mysore. during Oct 21 – Oct 24, 2010.

Participated in *Dagstuhl Seminar on Computational Counting* held at Leibniz-Zentrum fur Informatik, Schloss Dagstuhl, Germany during Nov 28 – Dec 3, 2010. Gave a talk titled "Counting problems in the low-complexity world around NC^1 and logspace".

Participated in *MSR-IMPECS School on Approximability* held at IISc Bangalore during Jan 5 – Jan 9, 2011.

Visited Leibniz University, Hannover, Germany during Mar 13 – Mar 20, 2011. Research collaboration under a DST-DAAD sponsored project. Gave a talk titled "Counting paths in VPA is complete for $\#NC^1$".

Participated in *Dagstuhl Seminar on Computational Complexity of Discrete Problems* held at Leibniz-Zentrum fur Informatik, Schloss Dagstuhl, Germany during Mar 21 – Mar 25, 2011. Gave a talk titled "Counting Classes and the Fine Structure between NC^1 and DLOG".

Maiti, Moitri

Participated in *Indian Condensed Matter Workshop* held at The Infosys Campus, Mysore, India during Dec 12 – Dec 23, 2010.

Participated in *Conference on Research Frontiers in Ultra-Cold Atomic and Molecular Gases* held at The International Center, Goa, India during Jan 10 – Jan 14, 2011.

Meena Devi, J.

Participated in *Workshop and Conference on Monte Carlo Simulation* held at School of Physics, Madurai Kamaraj University, Madurai. during Aug 9 – Aug 13, 2010. Presented a paper entitled "Molecular Dynamics Simulation Technique using NAMD"

Participated in *Workshop on Understanding Molecular Simulations: Theory and Applications* held at Indian Institute of Technology, Kanpur during Nov 3 – Nov 13, 2010.

Participated in *98th Indian Science Congress* held at SRM University, Kattankulathur, Kanchipuram district during Jan 3 – Jan 7, 2011.

Participated in *Chennai Chemistry Conference-2011* held at IIT Madras, Chennai. during Feb 11 – Feb 13, 2011. Presented a paper entitled "Molecular Dynamics simulation of functionalized gold particles"

Participated in *Seminar on Computational Materials Science (SCMS -2011)* held at Department of Physics,Pondicherry University, Pondicherry on Mar 26, 2011.

Menon, Gautam I.

Participated in *RRI School on Non-equilibrium Statistical mechanics* held at RRI, Bangalore during Mar 27 – Apr 4, 2010. 5 lectures on "Introduction to Biological Physics"

Visited IIT, Kanpur during Apr 5 – Apr 6, 2010. Visited the Physics Department of IIT Kanpur in connection with a thesis examination

Participated in *Emergent properties and novel behavior at the nanoscale* held at JNCASR,

Bangalore during Apr 19 – Apr 27, 2010. Invited talk on "Emergent Behavior of DNA at the Nano-scale"

Visited Simon Fraser University, Burnaby, Canada during May 17 – May 21, 2010. Visited for a week and presented a talk on "Loop formation in short double-stranded DNA molecules"

Participated in *School on Nucleation, Aggregation and Growth* held at JNCASR, Bangalore during Aug 1 – Aug 6, 2010. Invited Lectures on "Active Matter"

Participated in *Workshop on Physics of DNA* held at Banaras Hindu University, Banaras during Aug 11 – Aug 13, 2010. Invited talk on "Bending and Stretching Fluctuations in short Double-stranded DNA Molecules"

Participated in *Workshop on Modeling Infectious Diseases: from the genome to populations* held at IMSc, Chennai during Sep 13 – Sep 18, 2010. Delivered two lectures and a tutorial on "Agent-based Models for Infecious Diseases"

Participated in *Lecture-Workshop on Biophysics* held at Mysore University on Sep 16, 2010. Invited lectures on "Biophysical Modeling"

Visited NCL, Pune during Oct 20 – Oct 22, 2010. Delivered the CFPE Seminar and interacted with scientists at NCL and IISER

Participated in *Advanced Workshop on Living Mechanics* held at NCBS, Bangalore during Oct 28 – Nov 8, 2010. Invited lectures on "Basic Biophysical Modeling"

Participated in *Current Trends in Condensed Matter Physics* held at NISER, Bhubaneswar during Dec 15 – Dec 19, 2010. Invited talk on "Transport and Patterning in Motor-Microtubule MIxtures"

Visited Stella Maris College on Jan 7, 2011. Delivered a public lecture on "Superconductivity"

Participated in *Mumbai-Pune Soft Matter Meeting* held at IISER, Pune on Jan 22, 2011. Invited external participant

Visited Indian Institute of Science, Bangalore on Jan 30, 2011. Visited the Indian Institute of Science in connection with a thesis examination

Visited Pondicherry University on Feb 4, 2011. Delivered a Physics Colloquium on "The Phases of Vortex Lines in Superconductors"

Visited NCBS, Bangalore during Feb 14 – Feb 15, 2011. Visited the group of Sandhya Koushika for collaborative research. Presented an informal seminar on our joint work on modeling vesicular motion.

Participated in *Academy-sponsored Refresher Course on Condensed Matter and Statistical Physics* held at St. Thomas College, Pala during Feb 28 – Mar 13, 2011. Set of Invited lectures on "Biophysics"

Mitra, Tanmay

Participated in *Chandrayan* held at IMSc,Chennai. during Jan 3 – Jan 7, 2011.

Mukherjee, Kunal K.

Participated in *Instructional Workshop on free probability* held at IMSc, Chennai during Jul 26 – Aug 6, 2010.

Participated in *Satellite Conference on Operator Algebras* held at IMSc, Chennai during Aug 9 – Aug 13, 2010.

Mukhopadhyay, Anirban

Participated in *Analytic questions in arithmetic* held at TIFR, Mumbai during Jul 23 – Aug 7, 2010.

Mukhopadhyay, Partha

Participated in *School on Loop Quantum Gravity* held at IMSc during Sep 22 – Sep 30, 2010.

Participated in *Chandrayana* held at IMSc during Jan 3 – Jan 7, 2011.

Murthy, M.V.N.

Visited BITS, Goa during Feb 5 – Feb 12, 2011 for Research Collaboration. Delivered a lecture on "The Solar Neutrino Puzzle and resolution".

Participated in *7th International Workshop on Neutrino-Nucleus Interaction in few-Gev Region (NuInt 11)* held at HNBG University, Dehradun during Mar 7 – Mar 11, 2011. Invited talk on the "Present status of the India-based Neutrino Observatory Project".

Nagaraj, D. S.

Visited University of Artho's Lance, France during May 1 – May 31, 2010. Gave a talk on "Morphisms to Grassmannians"

Participated in *"Advanced Instructional School on Schemes & Cohomology"* held at KSOM,

Kozhikode, Kerala during Jul 10 – Jul 16, 2010. Gave four lectures on 'Topics in Algebraic Geometry'

Participated in *International conference on'Algebraic Geometry and Algebraic Groups'* held at University of Hyderabad, Hyderabad. during Aug 13 – Aug 16, 2010. Chaired a session.

Visited University of Lille during Sep 5 – Sep 30, 2010. For research under Indo French exchange program.

Participated in *International conference on Commutative Algebra and Algebraic Geometry* held at IISc, Bangalore. during Dec 6 – Dec 10, 2010. Gave a talk on "Secant bundles on Ssecond symmetric power"

Paul, Pampa

Participated in *ATM Workshop on Riemannian Geometry* held at TIFR Centre for Applicable Mathematics, Bangalore during Jul 19 – Jul 30, 2010.

Participated in *An ICM 2010 Sattellite Conference-Geometry, Topology Dynamics in Negative Curvature* held at Raman Research Institute, Bangalore during Aug 2 – Aug 7, 2010.

Philip, Geevarghese

Visited University of Warsaw, Warsaw, Poland during Oct 23 – Oct 31, 2010. Worked on the fixed-parameter tractability of the Dominating Set problem on Claw-free graphs with a group of researchers at the University; the results obtained have been submitted for publication [**Ph6**].

Visited Technical University of Berlin, Berlin, Germany during Oct 31 – Nov 7, 2010. Collaborated with a group of researchers at the university on investigating the fixed-parameter tractability of some variants of the k-Anonymity problem.

Participated in *WorKer 2010 : Workshop on Kernelization* held at Lorentz Center : International Center for workshops in the Sciences, Leiden University, Leiden, The Netherlands during Nov 8 – Nov 12, 2010.

Visited University of Bergen, Bergen, Norway during Nov 13 – Nov 26, 2010. Collaborated with a group of researchers at the university on investigating the kernelization and approximation complexity of the Minimum Fill-In problem when restricted to sparse graph classes.

Visited University of Montpellier, Montpellier, France during Nov 27 – Dec 5, 2010. Collaborated with a group of researchers at the university on the parameterized tractability of the problem of deleting all K_4 minors in a graph.

Participated in *IMPECS School on Parameterized and Exact Computation* held at The Institute of Mathematical Sciences, Chennai, India during Dec 11 – Dec 12, 2010. Gave a talk titled "Subexponential Parameterized Algorithms".

Participated in *5th International Symposium on Parameterized and Exact Computation (IPEC 2010)* held at The Institute of Mathematical Sciences, Chennai, India during Dec 13 – Dec 15, 2010.

Participated in *30th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS 2010)* held at The Institute of Mathematical Sciences, Chennai, India during Dec 15 – Dec 18, 2010. Presented a paper titled "The effect of girth on the kernelization complexity of Connected Dominating Set".

Participated in *The 2011 School on Approximability* held at Indian Institute of Science, Bangalore, India during Jan 5 – Jan 9, 2011.

Ponmurugan, M.

Participated in *Workshop and Conference on Monte Carlo Simulation* held at School of Physics, Madurai Kamaraj University, Madurai, Tamilnadu, India. during Aug 9 – Aug 13, 2010. Conducted tutorials for Monte Carlo basics and delivered lectures on Monte Carlo simulation of growth models of polymers.

Participated in *Statphysics-Kolkatta VII International Conference* held at Saha Institute of Nuclear Physics, Kolkatta, India during Nov 26 – Nov 30, 2010. Presented a poster titled Free energy study of unfolding Contactin-1 protein by Steered Molecular Dynamics in Collaboration with Satyavani Vemparala.

Prasad, Amritanshu

Visited Indian Statistical Institute, New Delhi on Apr 28, 2010. Spoke in the Stat-Math seminar.

Participated in *the ICM satellite conference on Algebraic and Combinatorial Approaches to Representation Theory* held at National Institute of Advanced Study, Bangalore during Aug 12 – Aug 16, 2010.

Participated in *the International Conference on Non-Commutative Rings and Combinatorial Representation Theory* held at Pondicherry University during Sep 2 – Sep 3, 2010.

Participated in *the One day colloquium sponsored by the Dr. R. Vaidyanathaswamy Mathematics Trust* held at Ramanujan Institute for Advanced Study in Mathematics on Mar 18, 2011.

Praveen, M.

Participated in *European Summer School on Logic, Language and Information* held at University Of Copenhagen, Denmark during Aug 9 – Aug 20, 2010.

Participated in *Mathematical Foundations of Computer Science* held at Masaryk University in Brno, Czech Republic during Aug 23 – Aug 27, 2010. Presented the paper [**Pr1**].

Participated in *Parametrized Complexity of Computational Reasoning* held at Masaryk University in Brno, Czech Republic on Aug 28, 2010. Gave a talk on treewidth and parameterized complexity of modal satisfiability.

Participated in *IMPECS School on Parameterized and Exact Computation* held at IMSc, Chennai during Dec 11 – Dec 12, 2010. Gave a tutorial talk on Logic, Courcelles theorem and Applications.

Participated in *International Symposium on Parameterized and Exact Computation* held at IMSc, Chennai during Dec 13 – Dec 15, 2010. Presented the paper [**Pr2**].

Participated in *Automata, Concurrency and Timed Systems* held at Chennai Mathematical Institute, Chennai during Jan 27 – Jan 29, 2011.

Participated in *The Chemistry of Concurrent and Distributed Programming* held at Infosys Campus, Mysore, India during Feb 16 – Feb 19, 2011.

Raghavan, K. N.

Participated in *Special course on algebraic curves* held at Harish-Chandra Research Institute during Apr 19 – Apr 26, 2010 as resource person.

Participated in *Workshop in Cohomology and Schemes* held at Kerala School of Mathematics, Kozhikode during Jul 5 – Jul 16, 2010. The workshop was part of the "Advanced Training in Mathematics Schools" of the NBHM.

Acted as a resource person.

Participated in *International Congress of Mathematicians* held at Hyderabad during Aug 19 – Aug 27, 2010.

Participated in *Indo-German Workshop on Computational Commutative Algebra at IISER Pune* held at IISER, Pune during Dec 13 – Dec 18, 2010. The workshop was partly sponsored by NBHM under its "Advanced Training in Mathematics Schools" programme.

Acted as a resource person.

Visited Central University of Orissa during Jan 7 – Jan 10, 2011. (Mathematics) Curriculum Development Committee meeting

Rajasekaran, G.

Visited University of Madras during Apr 1, 2010 – Mar 31, 2011. Teaching Quantum Mechanics to MSc Students and Teachers from Chennai and its neighborhood every Sunday for three hours

Visited BARC, Mumbai on Apr 24, 2010. Participated in the DAE-DST Meeting for the major projects such as INO, jointly funded by DAE and DST

Visited IIT, Kharagpur during May 3 – May 5, 2010. INO Collaboration Meeting

Participated in *Summer School in Physics and Astrophysics* held at Kodaikanal Observatory during May 17 – May 28, 2010. Gave lectures on Particle Physics

Participated in *SERC Schools in THEP: Review Meeting* held at IIT, Mumbai during May 21 – May 22, 2010. Presented a review of the II Cycle of SERC Schools in THEP (1991-95)

Visited University of California, Riverside during Jun 1 – Jul 25, 2010. Collaborative research with Physics Faculty Members

Visited CMI on Aug 11, 2010. Gave a Colloquium on "The elusive neutrinos and their importance"

Participated in *Workshop on "Loop Quantum Gravity"* held at IMSc during Sep 20 – Sep 28, 2010.

Visited The American College, Madurai during Oct 5 – Oct 6, 2010. INO- Engineering Task Force Meeting

Participated in *International Conference on Neutrino Factories and Beta Beams* held at TIFR, Mumbai during Oct 20 – Oct 25, 2010. Chaired a Plenary Session

Visited CMI on Nov 10, 2010. Gave a Colloquium on "Chandrasekhar and the Stars"

Participated in *Workshop on "Quantum Information Science"* held at IMSc during Nov 22 – Dec 4, 2010.

Participated in *Chandrayana* held at IMSc during Jan 3 – Jan 7, 2011. Chaired the first session

Participated in *Workshop on "Dark Matter"* held at Saha Institute of Nuclear Physics, Kolkata during Jan 4 – Jan 8, 2011. Member of the Panel to discuss the possibility of initiating Dark Matter experiments in India

Participated in *One-day-meeting on LENS (Low Energy Neutrino Spectroscopy)* held at IMSc on Jan 10, 2011. Gave the Opening Remarks emphasizing the importance of starting LENS

in India

Participated in *Synergy between Energy and Luminosity* held at TIFR, Mumbai during Jan 10 – Jan 12, 2011. Presented concluding remarks

Participated in *Interaction between Fermilab and Indian Institutions* held at TIFR, Mumbai during Jan 13 – Jan 14, 2011. Member of the Panel for discussion of the plan of interaction

Visited The American College, Madurai during Jan 24 – Jan 25, 2011. INO-Collaboration Meeting

Participated in *Qunatum Field Theory* held at Banares Hindu University during Feb 7 – Feb 12, 2011. Gave a general talk on "The elusive neutrino and its importance"

Participated in *Astronomy through the ages* held at Dept of Theoretical Physics, University of Madras during Feb 21 – Feb 22, 2011. Gave a talk on "Neutrinos, The Sun and INO".

Participated in *NewHoRIzon (Neutrino Conference)* held at Harishchandra Research Institute, Allahabad during Feb 23 – Feb 25, 2011. Gave a talk on "Dark Energy, Neutrino Condensate and Pseudo-Dirac Neutrinos"

Participated in *Quantum Field Theory* held at IISER, Pune during Feb 23 – Feb 27, 2011. Gave a general talk on "The elusive neutrino and its importance"

Visited IIT, Madras on Mar 31, 2011. Gave a talk on "The elusive neutrinos and their importance"

Raman, Venkatesh

Participated in *International Conference on Advances and Emerging Trends in Computing Technologies* held at SRM University, Chennai during Jun 21 – Jun 24, 2010. Gave a tutorial talk on 21st June on 'Recent Trends in Algorithms'

Participated in *Mysore Park Workshop on Algorithms and Complexity* held at Infosys Campus, Mysore during Oct 21 – Oct 24, 2010. Gave a survey talk on Subexponential parameterized Algorithms.

Participated in *International Symposium on Parameterized and Exact Computation* held at IMSc Chennai during Dec 13 – Dec 15, 2010. Co-chaired the program committee

Participated in *Foundations of Software Technology and Theoretical Computer Science (FSTTCS)* held at IMSc Chennai during Dec 15 – Dec 18, 2010.

Participated in *2011 School on Approximability* held at IISc Bangalore during Jan 5 – Jan 9, 2011.

Participated in *Introduction to Graph and Geometric Algorithms* held at PSG College of Technology, Coimbatore on Jan 7, 2011. Gave a talk on 'Fixed Parameter Algorithms'

Participated in *ACM Chennai Chapter* held at IMSc, Chennai on Jan 22, 2011. Gave a talk on 'NP-complete problems and Approaches to deal with them'

Participated in *Science Day* held at IMSc, Chennai on Feb 27, 2011. Gave a talk on 'Ending Corruption Quickly – dictionaries to priority queues'

Participated in *School on Graph Algorithms* held at Karnataka University, Dharwad during Mar 28 – Mar 31, 2011. organized the academic program and gave a series of talks on "NP-completeness, Approximation and Parameterized Complexity"

Ramanujam, R.

Participated in *Games, Automata, Logic, and Formal Verification* held at Amalfi Coast, Italy during Jun 16 – Jun 18, 2010. Presented paper on "Imitation in large games".

Participated in *Workshop on concurrency* held at TIFR, Mumbai on Nov 12, 2010. Gave a talk on "Reasoning underlying security theory".

Visited Indian Statistical Institute, Kolkata on Nov 13, 2010. Gave a talk on "Logical definability of strategies in infinite games".

Participated in *Calcutta Logic Circle Seminar* held at Kolkata during Nov 14 – Nov 16, 2010. Gave two lectures on "Logics on trees".

Visited PSG College of Technology on Dec 4, 2010. Gave a lecture on "Games for verification and control".

Participated in *Logic and Philosophy today* held at Delhi University during Jan 5 – Jan 6, 2011. Gave a talk on "Memory and communication in logic".

Visited Vellore Institute of Technology on Jan 21, 2011. Gave two lectures on 'Automata theory and logic'.

Participated in *International Conference on Distributed Computing and Internet Technology* held at Bhubaneswar during Feb 9 – Feb 11, 2011.

Participated in *Dagstuhl Seminar on "Rationality and interaction: from logic to game theory and back"* held at Schloss Dagstuhl, Germany during Mar 7 – Mar 11, 2011. Gave a talk on "Neighbourhood structures in large games".

Ray, Purusattam

Visited Jawaharlal Nehru Centre for Advanced Scientific Research during Jun 28 – Jun 30, 2010. Gave a seminar on 'shock propagation un granural media'.

Participated in *Workshop and conference on Monte Carlo simulation* held at Madurai Kamaraj University during Aug 9 – Aug 13, 2010. Invited lecturer

Participated in *STATPHYS-Kolkata VII* held at Saha Institute of Nuclear Physics,Kolkata during Nov 26 – Nov 30, 2010. Presented papers and also a member of the organizing committee.

Visited Physics Department, Universilty of Calcutta during Jan 18 – Jan 22, 2011 for Research collaboration.

Sankaran, Parameswaran

Participated in *Advanced Instructioinal School in Group Theory* held at IIT Bombay during May 10 – May 29, 2010. Gave a series of lectures on CAT(0) spaces.

Participated in *Third Training Programme in Mathematics* held at Ramanujan Institute, Universtiy of Madras, Chennai during Jun 1 – Jun 2, 2010. Resource person for group theory.

Participated in *International Congress of Mathematicians* held at Hyderabad during Aug 19 – Aug 27, 2010.

Participated in *Lie theory and complex geometry* held at Philipps University of Marburg, Marburg, Germany during Nov 4 – Nov 6, 2010. Gave a talk on 'complex structures on product of circle bundles on compact complex manifolds'.

Participated in *National Seminar on Topology and Fractal Geometry* held at Government College, Chittur, Kerala during Nov 19 – Nov 21, 2010. Gave a talk on 'The vector field problem'.

Participated in *National Seminar on Mathematics and Applications* held at IIT Madras, Chennai on Dec 22, 2010. Gave a talk on 'Generalized Calabi-Eckmann manifolds'

Participated in *Annual Meeting of the Indian Mathematical Society* held at S.V. NIT, Surat during Dec 27 – Dec 30, 2010. Gave an invited talk on 'Vector field problem on certain homogeneous spaces'.

Participated in *98th Indian Science Congress* held at SRM University, Chennai during Jan 3 – Jan 7, 2011. Gave an invited talk on 'Complex structures on product of circle bundles over complex manifolds'.

Visited Vivekananda College, Chennai on Feb 12, 2011. Gave the Narayani N. and Kadayam S. Sankaran Endowment Lecture on 'Surfaces'.

Sathiapalan, Balachandran

Participated in *Strongly Co-related Systems and AdS/CFT organized by ICTS, Bangalore* held at IISC, Bangalore during Dec 8 – Dec 10, 2010.

Participated in *International String Meeting (ISM 2011)* held at Puri, Orissa during Jan 4 – Jan 11, 2011.

Participated in *ICTS Subramanium Chandrasekhar Discussion Meeting* held at TIFR, Mumbai during Mar 21 – Mar 23, 2011. Gave a talk on "Strong Coupling BCS"

Saurabh, Saket

Visited Department of Informatics, University of Bergen, Norway during Aug 18 – Nov 7, 2010. Visited Prof. Fedor Fomin

Visited ALgorithms for Graphs and Combinatorics group (AlGco) of the LIRMM during Oct 12 – Oct 17, 2010. Visited Prof. Stéphan Thomassé and Prof. Christophe Paul.

Participated in *2nd Workshop on Graph Decompositions Theoretical, Algorithmic and Logical Aspects* held at CIRM, Luminy, Marseille, France during Oct 18 – Oct 22, 2010.

Participated in *Lorentz Workshop on Kernelization (WorKer 2010)* held at Lorentz Center, Leiden, Netherlands during Nov 8 – Nov 12, 2010. Organizer and gave a talk.

Participated in *National Conference on Theoretical Computer Science and Applications* held at Vandalur,Chennai during Nov 25 – Nov 26, 2010. Invited Speaker.

Participated in *IMPECS School on Parameterized and Exact Computation* held at Chennai, India during Dec 11 – Dec 12, 2010. Organizer as well as gave a talk.

Participated in *Formal Software Technology and Theoretical Computer Science (FSTTCS)* held at Chennai, India during Dec 15 – Dec 18, 2010. Organizer as well as gave a talk.

Visited University of California, San Diego during Jan 10 – Jan 21, 2011. Visited Prof. Ramamohan Paturi and Dr. Daniel Lokshtanov.

Participated in *ACM-SIAM Symposium on Discrete Algorithms (SODA).* held at San Francisco, USA during Jan 23 – Jan 25, 2011. Gave a talk.

Participated in *Research Promotion Workshop on Introduction to Graph and Geometric Algorithms* held at National Institute of Technology, Patna during Mar 25 – Mar 27, 2011. Invited Speaker

Sharatchandra, H.S.

Participated in *One Day Workshop on Non-parturbative Aspects of Quantum Field Theory* held at Indian assiociation for the Cultivation of Science, kolkata during Dec 20 – Dec 22, 2010. Invited Talk

Visited SN Bose National Centre for Basic Sciences, Kolkata during Jan 13 – Jan 18, 2011. Three lectures on Topological degrees and Confinement. Collaborative research.

Participated in *International Conference on New Trends in Field Theories, BHU Varanasi* held at BHU Varanasi during Feb 7 – Feb 12, 2011. Invited Talk Integrating topological degrees of freedom with perturbation theory: YM—3

Visited School of Physics University of Hyderabad during Mar 14 – Mar 20, 2011. Collaborative research and discussions

Singh, Mahender

Visited HRI Allahabad during Jun 20 – Jul 10, 2010. Taught a course in Algberaic Topology in the Summer Programme in Mathematics at HRI Allahabad.

Participated in *International Congress of Mathematicians* held at Hyderabad during Aug 19 – Aug 27, 2010.

Participated in *Groups Actions and Computations* held at HRI Allahabad during Sep 1 – Sep 12, 2010. Gave a contributed talk on "Extension and Lifting of Automorphisms in Group Extensions".

Visited IISER Mohali during Mar 16 – Mar 23, 2011. Gave a talk on my recent work.

Sinha, Nita

Visited IIT Kharagpur during May 3 – May 5, 2010. Participated in the INO Collaboration meeting and presented a talk "Effect of tau neutrino contribution to muon signals at neutrino factories".

Participated in *NuTheme, Neutrino Theory, Models, and Experimental perspectives* held at CERN, Geneva during Sep 13 – Sep 22, 2010.

Participated in *Nufact2010, 12th International workshop on neutrino factories, superbeams and betabeams* held at TIFR, Mumbai during Oct 20 – Oct 25, 2010. Presented an invited talk.

Participated in *XIX DAE-BRNS High Energy Physics SYMPOSIUM* held at LNMIIT, Jaipur during Dec 13 – Dec 18, 2010. Delivered the Invited Plenary talk on B Physics and CP violation (and search for BSM).

Visited The American College, Madurai during Jan 24 – Jan 25, 2011. INO-Collaboration meeting.

Participated in *NUINT11, Seventh International workshop on neutrino-nucleus interactions in few GeV region* held at Dehradun (Hosted by H.N.B. Garhwal University) during Feb 7 – Feb 11, 2011.

Sinha, Rahul

Visited High Energy Accelerator Research Organization, KEK, Japan during May 13 – May 22, 2010. Collaboration and attend the Belle Analysis meeting

Participated in *Workshop on Synergy between High Energy and High Luminosity Frontiers* held at Tata Institute of Fundamental Research during Jan 10 – Jan 12, 2011. Member of National Organizing Committee

Participated in *Interaction Meeting on Project X* held at Tata Institute of Fundamental Research during Jan 13 – Jan 14, 2011. Invited Pleanry Speaker

Sinha, Sitabhra

Visited University of California, Berkeley, USA during Jun 6 – Jul 3, 2010. As part of IUSSTF collaborative project

Participated in *Perspectives of Nonlinear Dynamics (PNLD-2010)* held at Indian Institute of Science, Bangalore during Jul 26 – Jul 29, 2010. Invited talk on "Mind, Memory and Modules: Dynamics of associative recall in complex networks with mesoscopic organization"

Visited Indian Institute of Technology, Bombay during Nov 8 – Nov 10, 2010. Taught a module on networks in a course on nonlinear dynamics for Physics students and gave invited talk on "Chimera order in spin systems"

Participated in *Training Programme on the Indus Script* held at Indus Research Center, Roja Muthiah Research Library, Chennai on Nov 20, 2010. Invited talk on "Using Computers to Read Indus"

Participated in *Dynamics Days Delhi* held at University of Delhi on Nov 27, 2010. Invited talk on "Dynamical consequences of modular organization: Multiple time-scales and novel ordering phenomena in networks with complex mesoscopic features"

Participated in *Workshop on Mathematical Ecology* held at Okakura Bhavan, Kolkata during Dec 7 – Dec 11, 2010. Gave a series of four lectures on "Complex Networks in Ecology"

Participated in *Symposium on Mathematical Ecology* held at IISER Kolkata, Mohanpur Campus during Dec 13 – Dec 14, 2010. Invited talk on "Why large diverse and highly

connected ecosystems should exist?"

Participated in *Workshop on Mathematical Physiology* held at IISER Pune during Jan 15 – Jan 21, 2011. Gave a series of lectures on "Patterns of life and death: Modeling cardiac dynamics"

Participated in *Symposium on Mathemtical Physiology* held at IISER Pune during Jan 22 – Jan 23, 2011. Invited talk on "Complex Networks in the Brain: Relating dynamics, structure and function"

Participated in *VIT Faculty Development Programme on Protein Interactions and Dynamics* held at VIT University, Vellore on Jan 24, 2011. Invited talk on "Proteins as Complex Networks: Using graph theory to investigate protein structure and dynamics"

Participated in *6th National Conference on Nonlinear Systems and Dynamics (NCNSD 2011)* held at Bharathidasan University, Tiruchirapalli during Jan 27 – Jan 30, 2011. Invited talk on "Controlling spatio-temporal chaos by sub-threshold stimulation in excitable media"

Participated in *Meeting for formulating future scientific activities of C-MMACS Bangalore* held at NAL Bangalore on Feb 4, 2011.

Participated in *Indian Academy of Sciences Discussion Meeting on "Computational Biology in India: Status and Prospects"* held at Orange County Resort, Coorg during Feb 27 – Mar 2, 2011. Invited talk on "Computational systems biology: from the cell to the brain and beyond"

Participated in *19th IEEE Workshop on Nonlinear Dynamics of Electronic Systems* held at Indian Institute of Chemical Biology, Kolkata during Mar 9 – Mar 11, 2011. Invited talk on "Chimera order in spin systems"

Sridhar, S.

Participated in *Perspectives in Non-linear Dynamics* held at IISc, Bangalore during Jul 26 – Jul 29, 2010. Presented a poster titled, "Response to sub-threshold stimulus is enhanced by spatially heterogeneous activity".

Participated in *Workshop and Symposium on Mathematical Physiology* held at IISER Pune during Jan 15 – Jan 23, 2011.

Participated in *Non-linear Dynamics of Electronic Systems-2011* held at Cohosted by IICB and SINP Kolkata during Mar 8 – Mar 11, 2011. Presented a poster on, "Obstacle induced transition to scroll wave break in 3-D active media"

Srinivas, K.

Participated in *Annual meeting of RMS* held at N.I.T., Jalandhar, Punjab during May 3 – May 5, 2010. Attended as an EC member of RMS.

Participated in *ICM 2010* held at Hyderabad during Aug 19 – Aug 27, 2010. Chaired a session, attended talks.

Participated in *Refresher Course in Mathematics* held at UGC-Academic Staff College, University of Madras. during Nov 22 – Nov 24, 2010. Delivered a few lectures on Riemann zeta-function.

Participated in *Advanced Training Camp in Mathematics* held at SSNCE, Kalavakkam, Chennai during Dec 17 – Dec 31, 2010. Delivered a short course of 8 lectures on basic number theory.

Visited ANURAG, Hyderabad during Feb 5 – Feb 7, 2011. Delivered lectures on basics of finite fields.

Visited ANURAG, Hyderabad during Feb 12 – Feb 14, 2011. Delivered lectures on arithmetic of finite fields.

Subramanian, C. R.

Participated in the International Workshop on Graph Colorings and its Applications held at Bharathidasan University, Trichy during August 7-9, 2010. Also gave an invited talk on "Constrained Colorings".

Visited Indian Institute of Information Technology (IIT), Hyderabad during Augst 17-19, 2010 and gave a talk on "Forbidden subgraph colorings and Intersection dimensions of graphs".

Participated in the International Congress of Mathematicians (ICM-2010) at Hyderabad during August 2010. Also chaired a parallel session on contributed papers.

Participated and gave a talk on "Random Digraphs : Some Concentration Results" at the ICM-2010 Satellite International Conference on "Algebraic and Probabilistic Aspects of Combinatorics and Computing" held at Indian Institute of Science, Bangalore during 29th August – 3rd September, 2010.

Participated in IMPECS, IPEC-2010 and FSTTCS-2010 held at IMSc during Dec 11-18, 2010.

Participated in the Research Promotion Workshop on Introduction to Graph and Geometric Algorithms held at PSG College of Technology, Coimbatore during January 6-8, 2011. Gave a talk on Randomized Algorithms.

Sunder, V. S.

Participated in *NCGOA 2010 - von Neumann Algebras* held at Vanderbilt University, Nashville, Tennessee, USA during May 10 – May 19, 2010. Participated in the conference and delivered a lecture titled *The GJS construction for graphs I: Presentation of two categories*

Participated in *International Congress of Mathematicians 2010* held at HICC, Hyderabad during Aug 19 – Aug 27, 2010. I chaired a session of 45-minute talks by three invited speakers on August 20th.

Visited Pt. Ravishankar Shukla University on Dec 17, 2010. Gave two lectures on *Catalan numbers* and *Knot theory* at the 'INSPIRE Programme Camp' held there for school children (in the XIth and XIIth classes).

Visited Indian Statistical Institute, Bangalore during Jan 24 – Jan 26, 2011. Gave a lecture on *Hilbert von Neumann modules* on 24/01/2011

Mubeena, T.

Participated in *AIS on Geometric Group theory* held at IIT BOMBAY during May 10 – May 29, 2010.

Participated in *ATM workshop on Riemannian Geometry* held at TIFR CAM Bangalore during Jul 19 – Jul 30, 2010.

Participated in *ICM Satellite conference on Geometry, Topology and Dynamics in Negative Curvature* held at RRI Bangalore during Aug 2 – Aug 7, 2010.

Participated in *ICM Satellite workshop on Geometric Group theory* held at Goa University during Aug 9 – Aug 14, 2010.

Participated in *INTERNATIONAL CONFERENCE OF MATHEMATICIANS* held at Hyderabad Central University, Hyderabad during Aug 19 – Aug 27, 2010.

Viswanath, Sankaran

Participated in *ICM Satellite conference on "Algebraic and Combinatorial approaches to representation theory"* held at NIAS, Bangalore. during Aug 12 – Aug 16, 2010.

5.4 Visitors from Other Institutions

5.5 Visitors

Name	*Date*	*Affiliation*
Vinu Lukose	01/08/10 - 20/11/10	ICTP, Trieste, Italy
P.T. Sumesh	22/03/10 - 03/04/10	JNCASR, Bangalore
Daniel Lokshtanov	24/02/10 - 04/04/10	University of Bergen, Norway
Johannes Koebler	08/03/10 - 09/04/10	Humboldt University, Berlin, Germany
Sebastian Kuhnert	07/03/10 - 09/04/10	Humboldt University, Berlin, Germany
Surya Kanta Ghosh	04/04/10 - 09/04/10	Dept. of Physics, IIT, Bombay
P.T. Sumesh	03/04/10 - 10/04/10	JNCASR, Bangalore
Sanjeev Kumar	07/04/10 - 09/04/10	IFW, Dresden
Anirban Polley	08/04/10 - 17/04/10	RRI, Bangalore
Manu mathur	04/04/10 - 17/04/10	SN Bose National Centre for Basic Sciences, Kolkata
Sunil Mukhi	16/04/10 - 16/04/10	TIFR, Mumbai
Simone Borghesi	28/03/10 - 22/04/10	University of Milan
Masahiro Kaminaga	30/03/10 - 29/03/11	-
K Gopaka Krishna	13/04/10 - 22/04/10	HRI, Allahabad
Anuradha Shrimali	01/08/09 - 01/05/10	BITS Pilani, Goa Campus
A Jayannawar	25/04/10 - 27/04/10	IOP, Bhubaneswar
N Kumar	26/04/10 - 27/04/10	RRI, Bangalore
Prahladh Harsha	25/04/10 - 03/05/10	TIFR Mumbai
Parashuram Ram	20/04/10 - 10/05/10	Hindu P.G. College, Zamania, Ghazipur, UP
Pramod Padmanabhan	18/01/10 - 01/05/10	Syracuse University, New York
J Solomon Ivan	16/04/10 - 05/05/10	RRI, Bangalore
Subinay Dasgupta	02/05/10 - 14/05/10	University of Calcutta, Kolkata
Shiraz Minwalla	02/05/10 - 15/05/10	TIFR, Mumbai
Upendra Kulkarni	13/05/10 - 15/05/10	ISI, Bangalore
Prahladh Harsha	23/05/10 - 01/06/10	TIFR
Awadhesh Kumar Dubey	10/04/10 - 11/05/10	School of Physical Sciences, JNU, New Delhi
Rajesh Karan	28/04/10 - 30/05/10	IISc, Bangalore
Ajay Patwardhan	17/05/10 - 21/05/10	St. Xavier, Mumbai
R Nithyananda	29/05/10 - 01/06/10	NCRA, TIFR, Pune
Naveen Surendran	01/05/10 - 12/05/10	ICTP, Trieste, Italy
Raja Sridharan	12/05/10 - 04/06/10	TIFR, Mumbai
Chandrashekar Madaiah	03/05/10 - 02/06/10	Perimeter Institute, Waterloo, Canada
Anshuman Maharana	31/05/10 - 05/06/10	DAMTP, University of Cambridge, UK
B Sury	07/06/10 - 07/06/10	ISI, Bangalore

Kamalakshya Mahatab	15/05/10 - 11/06/10	Institute of Mathematics and Applications, Bhubaneswar
Pooja Singla	04/06/10 - 10/06/10	BEN Gurion University, Israel
Basudha Misra	04/06/10 - 10/06/10	CHEP, IISc, Bangalore
S Uma Sankar	05/06/10 - 08/06/10	IIT, Bombay
P.S. Joag	06/06/10 - 13/06/10	University of Pune
Rajesh Karan	04/06/10 - 11/06/10	IISc, Bangalore
Navin Chandra	08/06/10 - 13/06/10	CSIR, Bhopal
Ioulia Baoulina	24/02/10 - 14/06/10	HRI, Allahabad
Raghu Raghava	01/08/10 - 20/11/10 09/06/10 - 15/06/10	Theratraxix Research Lab, Maryland, USA
Auditya Sharma	16/06/10 - 17/06/10	University of California, Santa Cruz
Bobby Ezhuthachan	07/06/10 - 27/06/10	HRI, Allahabad
K Praveen Kumar	10/06/10 - 17/06/10	Indian School of Mines, Dhanbad
Eleonora Dellazuila	01/02/10 - 30/04/10	Perimeter Institute, Canada
Salin Subbash Sharma	21/06/10 - 23/06/10	IISc, Bangalore
Prakash Murali	06/01/10 - 18/06/10	BITS Pilani, Goa Campus
L Sunil Chandran	23/06/10 - 23/06/10	IISc, Bangalore
S Ramakrishnan	21/06/10 - 07/07/10	Northwestern University
Somnath Sikdar	19/06/10 - 27/06/10	RSTH, Aachen, Germany
Santhosh	14/06/10 - 26/06/10	IISER, Trivandrum
Ganesh Sundaram	24/05/10 - 2/07/10	Amrita Vishwa Vidyapeetham, Kollam, Kerala
N Narayanan	24/06/10 - 02/07/10	C R Rao Institute, Hyderabad
Sumedha	04/07/10 - 09/07/10	NISER, IOP Campus, Bhubaneswar
V Ravindran	01/07/10 - 05/07/10	HRI, Allahabad
Neeraj Pradhan	07/07/10 - 10/07/10	BITS Pilani
Jyotsna Singh	01/07/10 - 12/07/10	University of Lucknow
Koppula Venkata	16/05/10 - 13/07/10	IIT, Kanpur
B.P. Purnaprajna	18/06/10 - 30/06/10	University of Kansas, Kansas
P Venkata Raghu Tej	01/06/10 - 09/07/10	IISER, Pune
Shilpa Gondhali	03/12/10 - 23/07/10	TIFR, Mumbai
Swati Venkat	12/07/10 - 15/07/10	Indian Institute of Science Education and Research, Pune
Jayendra Nath Bandyopadhyay	18/07/10 - 20/07/10	Centre for Quantum Technologies, Singapore
Chinkal Sood	01/07/10 - 23/07/10	Delhi University, Delhi
Kalpana Bora	10/07/10 - 28/07/10	Gauhati University, Assam
P Chellathurai	01/05/10 - 03/05/10	Madurai Kamaraj University
Andreas Krebs	11/07/10 - 17/07/10	University of Tubingen, Germany
K.R. Parthasarathy	11/07/10 - 10/08/10	ISI, New Delhi

Raja Sridharan	16/07/10 - 26/07/10	TIFR, Mumbai
Ranabir Chakrabarti	03/05/10 - 30/06/10	Dept. of Physics, University of Madras
Manoj Kummini	20/07/10 - 23/07/10	Purdue University, USA
Udit Raha	21/07/10 - 25/07/10	National Taiwan University, Taipei
Jainendra Jain	27/07/10 - 30/07/10	Penn State University
Rishab S Ramani	03/06/10 - 20/07/10	-
Arun Maiti	01/06/10 - 31/07/10	CMI, Chennai
N.D. Hari Dass	18/07/10 - 01/08/10	IISc, Bangalore
Vinu Lukose	01/08/10 - 20/11/10	ICTP, Trieste, Italy
Srinivas Raghavendra	04/08/10 - 08/08/10	National University of Ireland, Galway
Amit Bhaduri	05/08/10 - 07/08/10	JNU, New Delhi
Patrick Huber	02/08/10 - 08/08/10	Virginia Tech, USA
Kumar Gupta	03/08/10 - 11/08/10	SINP, Kolkata
Fourier, Ghislain	06/08/10 - 11/08/10	Universitat zu Koln, Germany
Mithun Mukherjee	05/07/10 - 12/08/10	ISI, Bangalore
Michael Berry	12/08/10 - 23/08/10	Briston University
Karam Deo Shankhadhar	09/08/10 - 17/08/10	HRI, Allahabad
Jaban Meher	09/08/10 - 17/08/10	HRI, Allahabad
Mohd. Saad Bhamla	07/06/10 - 30/08/10	IIT, Madras
Pramod Padmanabhan	03/05/10 - 17/08/10	Syracuse University
S Rubramaniam	15/08/10 - 15/08/10	Tenkasi
Radulescu Flurin	07/08/10 - 18/08/10	University of Rome
A.P. Balachandran	10/04/10 - 28/08/10	Syracuse University
R Thangadurai	09/08/10 - 04/09/10	HRI, Allahabad
Vijayakumar Murty	27/07/10 - 25/08/10	University of Toronto
Marutiram P Murty	27/07/10 - 25/08/10	Queen's University
Satadal Ganguly	22/08/10 - 04/09/10	TIFR, Mumbai
Prakash Mathews	31/08/10 - 02/09/10	SINP, Kolkata
V Ravindran	31/08/10 - 02/09/10	HRI, Allahabad
P.T. Sumesh	03/09/10 - 11/09/10	JNCASR, Bangalore
Subhro Bhattacharjee	06/09/10 - 11/09/10	IISc, Bangalore
Saptarshi Mandal	23/08/10 - 13/09/10	IIP, UFRN, Natal, Brazil
Rudranil Basu	06/09/10 - 15/09/10	SN Bose National Centre for Basic Sciences, Kolkata
John Plaice	12/09/10 - 19/09/10	The University of New South Wales
Blanca Mancilla	12/09/10 - 19/09/10	The University of New South Wales
Soham Biswas	11/09/10 - 27/09/10	University of Kolkata
Prafulla Kumar Behera	20/09/10 - 25/09/10	CERN, Geneva
Atanu Nath	06/08/10 - 30/09/10	SN Bose National Centre for Basic Sciences
Alexander Panfilov	27/09/10 - 04/10/10	University of Utrecht, The Netherlands
Rizwan Khan	10/05/10 - 29/09/10	University of California, USA
Kiran M Kolwankar	04/10/10 - 09/10/10	R J College, Mumbai

Subinay Dasgupta	02/10/10 - 15/10/10	University of Calcutta, Kolkata
Parthasarathi Majumdar	04/10/10 - 11/10/10	SINP, Kolkata
J Solomon Ivan	23/09/10 - 09/10/10	RRI, Bangalore
Anil Ananthaswamy	08/10/10 - 08/10/10	-
Mainak Poddar	10/10/10 - 13/10/10	ISI, Kolkata
M Vanitha	15/09/10 - 15/10/10	Centre for Nonlinear Dynamics, Bharathidasan University
A Kundu	11/10/10 - 12/10/10	SINP, Kolkata
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K.R. Raghavendra	10/10/10 - 22/10/10	IISc, Bangalore
Abhisekh Sankaran	18/09/10 - 23/10/10	IIT, Bombay
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Zahera Jabeen	25/10/10 - 29/10/10	Brandeis University, US
Anuradha Misra	25/10/10 - 29/10/10	University of Mumbai
Kavitha Telikepalli	26/10/10 - 26.10/10	TIFR, Mumbai
Umesh V Waghmare	27/10/10 - 28/10/10	JNCASR, Bangalore
Prashant M Gade	04/11/10 - 27/11/10	Nagpur University
Prajakta Nimbhorkar	24/10/10 - 31/10/10	-
Kiran Kolwankar	31/10/10 - 03/11/10	RJ College, Mumbai
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N.D. Hari Dass	05/11/11 - 09/11/11	IISc, Bangalore
Chee K Yap	15/11/10 - 16/11/10	Courant Inst., New York
Janani Vijaykumar	11/11/10 - 28/11/10	Jyoti Nivas Degree College, Bangalore
V Kumar Murti	217/11/10 - 27/11/10	University of Toronto
J Solomon Ivan	16/11/10 - 04/12/10	RRI, Bangalore
V.K. Bharadanj	05/11/10 - 04/12/10	St. Joseph College, Bangalore
L.R. Krishnan	05.07.10 - 14/12/10	BITS Pilani
Siddharth Karumanchi	105.07.10 - 14/12/10	BITS Pilani
B Radheshyam	22/06/10 - 28/12/10	BITS Pilani
Jayagannath Mahapatra	01/12/10 - 06/12/10	A.P.S. College, Roth
Robert Wald	12/12/10 - 16/12/10	
Yngve Villanger	04/12/10 - 15/12/10	University of Bergen
Robert Berderck	05/12/10 - 18/12/10	University of Jena, Germany
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Carlo Gasbarri	05/12/10 - 21/01/11	University of Strasbourg, France
Balaji R Rao	08/12/10 - 16/12/10	Poornaprajna Institute of Scientific Research, Bangalore
K Venkata	01/12/10 - 19/12/10	IIT, Kanpur
Sudhir Kumar Pujahari	29/10/10 - 17/12/10	Inst. Of Mathematics and Applications, Bhubaneswar

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H.B. Ravikumar	09/01/11 - 11/01/11	University of Mysore
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Jaban Meher	07/01/11 - 22/01/11	HRI, Allahabad
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A Sudbery	19/01/11 - 25/01/11	University of York, Heszington, UK
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Sharanya Ravi	17/11/10 - 16/02/11	IMSc Visitor
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Sudipto Paul Chowdhury	21/02/11 - 26/02/11	Indian Association for the Cultivation of Science, Kolkata
Philippon	07/02/11 - 05/03/11	University of Paris VI
Divide Bigoni	25/02/11 - 04/03/11	University of Torento
Sujit Sarkar	28/02/11 - 01/03/11	Poornaprajna Institute of Scientific Research, Bangalore
Lucilla	26/02/2011	De Arcangelis

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Chan Chi Keung	03/03/11 - 08/0311	Institute of Physics, Academic Sinica, Taiwan
Anil V Kulkarni	04/03/11 - 09/03/11	IISc, Bangalore
S.D. Adhikarai	07/03/11 - 16/03/11	HRI, Allahabad
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Prabal Paul	20/02/11 - 27/03/11	C.R.Rao, AIMSCS, Hyderabad
V Kumar Murty	14/03/11 - 27/03/11	University of Toronto
Karam Deo Shankhadhar	20/03/11 - 02/04/11	HRI, Allahabad
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Matthias Stemmler	21/03/11 - 26/03/11	TIFR, Mumbai
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Jesper Nederlof	02/03/11 - 30/03/11	University of Bergen, Norway
G.N. Chandan	23/02/11 - 30/03/11	University of Mysore, Mysore
M.S. Prasanth	21/02/11 - 30/03/11	University of Mysore, Mysore
Simon Kamer	02/02/11 - 31/03/11	University of Luxemburg
M Vanitha	03/03/11 - 31/03/11	Bharathidasan University

Maitreyee Kulkarni	25/02/11 - 28/03/11	S.P. College, Pune
Sumathi Rao	31/03/11 - 01/04/11	HRI, Allahabad
S Arunagiri	10/03/11 - 05/04/11	Pohang University of Science and Technology, Korea
Johannes Koebler	08/03/11 22/04/11	Humboldt University, Berlin
Sebastian Kuhner	08/03/11 - 01/04/11	Humboldt University, Berlin

Chapter 6

Infrastructure

6.1 Computer Facilities

Enhancement of Computer Facility during 2010-2011

Hardware facility:

- A SMP type compute server of 4-Way 24cores of Intel Xeon processor based Supermicro Rack server was introduced in the network for the need to handle the heavy computational jobs of sequential codes.

  ```
  The details are as follows:
  System Name : imsc9
  O/S : x86_64 GNU/Linux
  H/W : 4xIntel Xeon E7540 6Core Processors
  Memory : 96GB DDR3 1066MHz ECC RAM
  MotherBoard : SuperMicro X8QBE, Intel 7500chipset
  Disk : 4x1TB SATA disk
  Cabinet : 4U Rack Mountable
  Compilers : All GNU compilers
  Performance : HighPerformanceLinpack Peak 172GigaFLOPS
  ```

- 40 Netbooks of make Acer Aspire ONE were made available to research fellows stay in off-campus accommodation provided by IMSc.

- Laptops of different makes(Apple/Dell/Lenovo/Sony) were issued to faculty as a long term loan for those who have not availed the facility earlier.

- The 1Giga LAN switches of Dlink makes were installed and replaced on demand for maintaining the services in the IMSc network.

- A new Ricoh Aficio MP C2050 color laser printer(A3) with the capability of Scanner and Copier added in the IMSc network to enhance the printing facility through CUPS. It prints at 25ppm, built-in duplex printing and also for scanner with ARDF/ADF facility. It has a touch screen of size 8.5" for navigation of setups and also provides for scan to e-mail with access control facility.

- National Knowledge Network(NKN) link is established at IMSc with the necessary H/Ws to make the service available in the IMSc network. On trial basis the IMSc media server is hosted through the NKN network.
- A parallel redundant 2x60KVA EATON make online UPSs are installed in the mainbuilding by replacing the 30KVA standalone MGE Comet UPS to handle the computer system loads of the IMSc office buildings. It is being integrated into IMSc LAN through the SNMP for alert signals and for maintenance monitoring.

Software facility:

- The Mathematica version 7 Software with 10 users license was installed in the network.
- The COMSOL Multiphysics version 4 simulation software environment with 2 licenses were installed to facilitate all steps in the modeling process defining the geometry, meshing, specifying physics, solving, and then visualizing the results.
- A Matlab version 2010b with 15 network licenses are installed in the network with the additional toolboxes as follows:

```
Image Processing Toolbox 1
MATLAB Compiler 1
Optimization Toolbox 1
Signal Processing Toolbox 1
SimBiology 1
Statistics Toolbox 1
Symbolic Math Toolbox 1
```

- McAfee AVS was made available to the laptop users.

Students are encouraged to use Institute laptops/netbooks while attending conferences and workshops.

6.2 The Library

The Institute Library holds a total collection of 65500 books and bound periodicals as on March 31, 2011. This includes an addition of 2068 volumes during the current year April 2010 - March 2011. The NBHM has recognized this Institute library as the Regional Library for Mathematics. An average of about 5000 outside users in a year from colleges, universities and research institutions from different parts of the country make use of the library facilities for their academic and research information needs.

The library has a well balanced collection both print and online on the major subject areas of research such as Theoretical Physics, Mathematics and Theoretical Computer Science. The library subscribes to over 350 national and international journals.

The library has access to over 3000+ online journals from major publishers such as Elsevier, American Mathematical Society, American Physical Society, Springer Verlag, World Scientific, Institute of Physics, Wiley, etc.

Library has also access to Nature online, Science Online, ACM Digital Library, SIAM Journals Archive, Duke Mathematical Journal, and JSTOR Full digital archive. It has also perpetual online access to backfile collection of journals from Elesevier under DAE consortium, Springer and Annual Reviews Electronic Backvolume collection. The library has added this year the online journal archives from Cambridge University Press, Institute of Physics Publishing, World Scientific, Turpion and deGruyter that provide perpetual access to journals from Volume 1.

Access to online journals is restricted to members of the Institute.

Services

Apart from developing the collection, the library offers reprographic and inter library loan services. Using Libsys software on a linux platform, the library catalogue has been computerized and made available online to the readers both within and outside the Institute Campus. Online request for acquisition of books and status of borrowings have also been enabled using Libsys. Library has implemented RFID based system for self check-in and checkout of library materials. The library also provides effective 24x7 access to its resources with the help of RFID enabled access control system, perhaps the only library of this kind in the country.

Library has a website dedicated to host all the electronic information resources and to provide information about the library and its services.

Library is a member of DAE Libraries Consortium that subscribes to SCIENCE DIRECT SERVICE of Elsevier.

Library is also coordinating the MathSciNet consortium which provides online access to MathSciNet for 8 participating institutions at a deeply discounted rate in the southern region.

Library is an institutional member of AMS, MALIBNET and CURRENT SCIENCE Association.

Acknowledgment

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