THE INSTITUTE OF MATHEMATICAL SCIENCES

C. I. T. Campus, Taramani,

Chennai - 600 113.

ANNUAL REPORT

Apr 2015 - Mar 2016

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Foreword

The Institute of Mathematical Sciences, Chennai has completed 53 years and I am pleased to present the annual report for 2015-2016 and note the strength of the institute and the distinctive achievements of its members.

Our PhD students strength is around 170, and our post-doctoral student strength is presently 59.

We are very pleased to note that an increasing number of students in the country are benefiting from our outreach programmes (for instance, Enriching Mathematics Education, FACETS 2015, Physics Training and Talent Search Workshop) and we are proud of the efforts of our faculty, both at an individual and at institutional level in this regard.

IMSc has started a monograph series last year, with a plan to publish at least one book every year. A book entitled "Problems in the Theory of Modular Forms" as 'IMSc Lecture Notes - 1' has been published this year

Academic productivity of the members of the Institute has remained high. There were several significant publications reported in national and international journals and our faculty have authored a few books as well. Five students were awarded Ph.D., and three students have submitted their Ph.D. theses. Four students were awarded M.Sc. by Research, and two students have submitted their master's theses under the supervision of our faculty.

15 conferences and workshops were organized at IMSc during 2015-2016. These include, 'Discussion Meeting on New Scientific Approaches to Understanding the Indus Valley Phenomenon', 'FACETS 2015', 'Enriching Mathematics Education', 'ATMW Analytic Number Theory', 'Teacher Enrichment Workshop on Engineering Mathematics', '3rd Workshop and Conference on Modeling Infectious Diseases', 'A conference in Number Theory', '3rd Indo-French conference in Mathematics', 'Nag Memorial Endowment Lecture-2016', 'Advanced Instructional School in Operator Theory/Algebras', 'School and Conference on Quantum Disordered Systems', 'Friction and Fracture: Bridging the Scales', 'Open Source Library Software (Koha) and RFID Integration for DAE Libraries', 'ATM Workshop on Probability and Representation Theory', 'Frontiers in High Energy Physics', to name but a few. There were 51 lectures (lecture courses) conducted at the Institute during the reporting period. In addition, 3 lecture courses were given at Chennai Mathematical Institute for their National Undergraduate Programme.

The list of off-site conferences organized by IMSc faculty also continues to be impressive. This academic year 11 conferences were organized outside including, 'Advanced Foundational School II' , 'Advanced Instructional School In Analytic Number Theory', ' Summer School on Quantum Correlation: Foundation, Information Processing and Various Applications ', 'To Be Announced! Synthesis of Epistemic Protocols', '50 years of Narasimhan-Seshadri Theorem', 'Mathematical Aspects of Computer and Information Sciences', 'Complex Geometry and Operator Theory', 'XXVII IUPAP Conference on Computational Physics', 'Physics Training and Talent Search (PTTS) Workshop', 'Soft Matter Young Investigators Meet III', and 'Science at the Sabha'.

We are proud to note the awards and honors bestowed on our faculty at the individual level. Shrihari Gopalakrishna was elected as a Kavli Fellow, National Academy of Sciences (NAS) and The Kavli Foundation, USA, 2015; D.S. Nagaraj was awarded Fellow, The National Academy of Sciences, India, for the year 2015; Amritanshu Prasad was awarded Swarnajayanti Fellowship, for 2016, by the Department of Science and Technology, Government of India; V.S. Sunder was awarded Distinguished Faculty Award of HBNI on its completion of 10 years of existence, by the Homi Bhabha National Institute, during 2015.

This report was compiled through the efforts of the IMSc Annual Report Committee comprising of Drs. C. R. Subramanian, Shrihari Gopalakrishna, Pralay Chatterjee, Paul Pandian and Usha Devi. I owe my gratitude to all of them.

August, 2016 **V. Arvind**

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The Institute

1.1 Governing Board

Thiru. **P. Palaniappan**, Hon'ble Minister for Higher Education, Government of Tamil Nadu, Fort St. George, Chennai 600 009
(**Chairman**)

Dr. **R. K. Sinha**, Chairman, AEC & Secretary to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Vice-Chairman**)

Prof. **S. K. Joshi**, Honorary Scientist Emeritus CSIR, Vikram Sarabhai Professor, National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi 110 012
(**Member**)

Prof. **Mustansir Barma**, Distinguished Professor, Tata Institute of Fundamental Research, Mumbai 400 005
(**Member**)

Prof. **C. S. Seshadri**, Director-Emeritus, Chennai Mathematical Institute, Plot Nos. D19 & D20, SIPCOT Information Technology Park, Padur Post, Siruseri-603 103, Kancheepuram District
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Prof. **Amitava Raychaudhuri**, Sir Tarak Nath Palit Professor of Physics, University of Calcutta, 92 Acharya Profulla Chandra Road, Kolkata - 700 009
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(**Member**)

Prof. **Sudhanshu Jha**, 402 Vigyanshila, Juhu-Version Link Road, Seven Bungalow, Andheri(W), Mumbai 400 061
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(**Member** upto 64th Board Meeting)

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(**Member** Forthcoming Meeting)

Shri **R. A. Rajeev**, IAS, Joint Secretary (Finance) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Selvi **Apoorva**, IAS, Secretary to Government, Secretariat, Higher Education Department, Govt of Tamil Nadu, Fort St. George, Chennai - 600 009
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Prof. **V. Arvind**, Director-in-Charge, The Institute of Mathematical Sciences, CIT Campus, Taramani, Chennai - 600 113
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1.2 Executive Council

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Prof. **Mustansir Barma**, Distinguished Professor, Tata Institute of Fundamental Research, Mumbai 400 005
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1.3 Faculty

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1.9 Administrative & Accounts Staff members

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Rajasekaran, N.
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Chapter 2

Research and Teaching

2.1 Computational Biology

2.1.1 Research Summary

Computational Biology

In collaboration with the experimental group of Sandhya Koushika at TIFR, Mumbai, the detailed model of axonal transport we have been developing over the past few years has been expanded and benchmarked to the experimental data. The simulations allow us to assess multiple aspects of the experiments that are not directly accessible to measurement. We find that transport in the crowded axonal environment is regulated by stationary clusters of stalled cargo, providing fresh insights into how cells deal with the inevitability of crowding. Further, such clusters of stationary vesicles might act as "depots" from which vesicles can be released or sequestered on demand. Constraints arising from crowding are especially important in the narrow confines of the axon and our work provides the first detailed picture of how cells may have evolved ways of ensuring that axonal transport of vesicle-encapsulated cargo can occur efficiently[**Ku**]

A related line of work, with the same group, concerns image analysis and modeling of mitochondrial positions along axons. That the distribution functions for mitochondrial positions is non-trivial has been known for awhile. We suggest that these distributions may reflect the length distribution of microtubule ends, leading to specific predictions for how such distributions might look like both in wild-type and in mutant *C. elegans* worms. A detailed analysis of mitochondrial positioning across different stages in the life-cycle of the worm is currently being completed.

A model for the positioning and other properties of chromosomes in human cells first proposed in Nucl. Acids Res (2014), which emphasizes the importance of active energy transduction into work arising from the hydrolysis of ATP molecules, has been extended in several ways. The model now incorporates several cell-type specific features, such as activity distributions computed from RNA-seq experiments and looping as inferred from Hi-C experiments. It predicts a variety of physical behaviour, including the distribution of individual chromosomes by gene density and by their centre of mass, the shapes and other statistical properties of individual chromosome territories as well as the nature of contacts between individual chromosomes. This work attempts to solve a number of outstanding problems in the understanding of nuclear architecture, the origins of chromosome territories, the separation of heterochromatin and euchromatin and the separation of distribution functions of active and inactive X chromosomes. It represents currently the only model which can reproduce these features

A general agent-based model for the transmission of infectious diseases is being developed in-house. This model uses GIS-derived information as well as information from synthetic populations to model the movement and disease dynamics of a large number of individuals (agents). Benchmarking of these results to field data is in progress, as are discussions with a number of public health specialists concerning how these models may be applied.

A frontier area in systems biology is to develop methods to integrate the multi-omics datasets into constraint-based models of reconstructed metabolic networks to build improved models [**A**]. A better method is being developed to integrate next generation RNA-seq and ChIP-seq data into FBA model of available genome-scale metabolic networks to build integrated regulatory-metabolic models.

In collaboration with Emil Saucan and Jürgen Jost at the Max Planck Institute, the Forman's discretization of Ricci curvature was adapted to the case of complex networks. Forman's curvature for complex networks was investigated in a variety of model and real-world networks [**Sr**], and the curvature was found to display significant negative correlation with degree and centrality measures. Importantly, it is found that both model and real networks are vulnerable to targeted deletion of nodes with highly negative Forman curvature. These results suggest that Forman curvature can be employed to gain novel insights on the organization of complex networks.

We are modeling the collective behavior of bacteria, specifically the motion of Synechocystis spp. towards light, using agent based models.

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.

[**A**]
Vivek Ananth and Areejit Samal.
Advances in the integration of transcriptional regulatory information into genome-scale metabolic models.
2016.
(Submitted).

[**K**]
Gagan Deep Jhingan*, Sangita Kumari*, Shilpa V. Jamwal*, Haroon Kalam*, Di-

vya Arora*, **Neharika Jain***, **Lakshmi Krishnakumaar, Areejit Samal, Kanury V. Rao***, **Dhiraj Kumar***, **and Vinay K. Nandicoori***.
Comparative proteomic analyses of avirulent, virulent and clinical strains of Mycobacterium tuberculosis identifies strain-specific patterns.
2015.
(Submitted).

[**Ku**]
Kausalya Murthy*, **Parul Sood***, **Aparna Ashok***, **T. V. Kumar, Gautam I. Menon, and Sandhya Koushika***.
Stationary Cargo act as Local Regulators of Transport in Neurons.
2016.
(Submitted).

[**S1**]
Marco Bardoscia*, **Matteo Marsili***, **and Areejit Samal**.
Phenotypic constraints promote latent versatility and carbon efficiency in metabolic networks.
Physical Review E, **92**, 012809, 2015.

[**S2**]
Areejit Samal and Olivier C. Martin*.
Statistical physics methods provide the exact solution to a long-standing problem of genetics,.
Physical Review Letters, **114**, 238101, 2015.

[**S3**]
Joseph X. Zhou*, **Areejit Samal, Aymeric Fouquier d'Hèrouël***, **Nathan D. Price** *, **and Sui Huang***.
Relative stability of network states in Boolean network models of gene regulation in development.
Biosystems, **142**, 15, 2016.

[**Sr**]
R. P. Sreejith, Karthik Mohanraj, Jürgen Jost*, **Emil Saucan***, **and Areejit Samal**.
Forman curvature for complex networks.
2016.
arxiv:1603.00386 (Submitted).

2.2 Mathematics

2.2.1 Research Summary

Algebraic Geometry

Automorphism group of some natural compactification of the torus was studied [**Sn1**].

If G is a complex semi-simple Lie group, then some results, on G connections on equivariant principal bundles with G actions, were obtained [**Sn2**].

Projections of Veronese surface in $\mathbb{P}^5$ to smaller dimensional projective spaces were studied using vector bundles on $\mathbb{P}^2$ [**Sn3**].

Analytic Number Theory

Let $S_k(N)$ denote the space of cusp forms of weight k and level N on the congruence subgroup $\Gamma_0(N)$ of $SL_2(\mathbb{Z})$. Let $f(z) = \sum_{n\geq 1} a_n q^n \in S_k(N)$ be a normalized Hecke eigenform, i.e., f is an *eigenfunction* for all the Hecke operators T_p's and U_p's and $a_1 = 1$. In [**Ks2**] it is proved that for a fixed prime p, the number of pairs (f, g) of normalized eigenforms in $S_k(N)$ such that $\theta_p(f) = \pm\theta_p(g)$ is bounded by

$$O\left(\frac{(\dim S_k(N))^2 (\log p)}{(\log kN)}\right).$$

A heuristic argument was also given to support the famous conjecture of Maeda and Tsaknias.

In [**Ks1**] it is proved that Epstein's zeta-function $\zeta_Q(s)$, related to a positive definite integral binary quadratic form, has a zero $1/2 + i\gamma$ with $T \leq \gamma \leq T + T^{3/7+\varepsilon}$ for sufficiently large positive numbers T.

Currently working on discrepancy estimates for certain arithmetic sequences. Work in also in progress on certain correlation estimates of multiplicative functions.

In [**P**] Multiple Zeta Values are studied and by considering what we have called Double Tails of Multiple Zeta Values, under the guidance of J. Oesterlé. We have obtained a fast algorithm to compute these zeta values. And now working on its generalizations in multiple polylogarithms jointly with J. Oesterlé and Henri Cohen.

Mathematical Physics

In the work [**Kr2**] Gaussian measures on $\mathbb{R}^n$ were considered and lower bounds obtained on their gap probabilities when the spectral measures have non-zero support containing the origin in $\mathbb{T}^n$.

In further work on eigenvalue statistics of random operators it was shows that in the case of Anderson model with large disorder having point spectrum, the Poisson random measures associated with distinct points in the spectrum are independent of each other. This theorem vastly generalizes the known theorems in one dimension and some special cases in higher dimensions.

In [**M1**], we worked with Anderson tight binding model for unbounded random potential and showed Poisson statistics for the distribution of eigenvalues under certain limit. We were also able to show analyticity of Green's function.

In [**M2**], we worked with one dimensional discrete Anderson model with decaying potential but with unbounded randomness. Under certain conditions, we were able to show that the eigenvalue statistics converges to clock statistics. To do this we worked with Puffer phase and showed its convergence in probability.

Modular Forms

In [**G4**], the authors consider the question of simultaneous sign change of Fourier coefficients of two modular forms with real Fourier coefficients. In an earlier work, Kohnen with Sengupta proved that two cusp forms of different (integral) weights with real algebraic Fourier coefficients have infinitely many Fourier coefficients of the same as well as opposite sign, up to the action of a Galois automorphism. In the first part of the paper, the authors strengthen their result by doing away with the dependency on the Galois conjugacy. In fact, they extend their result to cusp forms with arbitrary real Fourier coefficients. Further, they consider simultaneous sign change at prime powers of Fourier coefficients of two integral weight Hecke eigenforms which are new forms. Finally, they consider an analogous question for Fourier coefficients of two half-integral weight Hecke eigenforms.

In [**G6**], the authors extend two identities proved by Ramanujan involving the Riemann zeta function and the Dirichlet L-function associated to the non-trivial Dirichlet character modulo 4. More precisely, given two power series

$$\sum_{n=0}^{\infty} a_n T^n \qquad \textit{and} \qquad \sum_{n=0}^{\infty} b_n T^n$$

which are both rational functions with certain property, the authors show that

$$\sum_{n=0}^{\infty} a_n b_n T^n$$

is again a rational function with similar property. This they do by obtaining explicit descriptions of the said rational function. They use this to explain Ramanujan's identities and also analyse the Rankin-Selberg convolutions of automorphic L-functions.

In [**G9**], the authors establish a lower bound on the number of sign changes of Fourier coefficients of a non-zero degree two Siegel cusp form of even integral weight on a Hecke congruence subgroup. They also provide an explicit upper bound for the first sign change of Fourier coefficients of such Siegel cusp forms. Explicit upper bound on the first sign change of Fourier coefficients of a non-zero Siegel cusp form of even integral weight on the Siegel modular group for arbitrary genus were dealt in an earlier work of Choie, the first author and Kohnen.

Operator Algebras

Analogous to the very useful and basic fact that the Schur product of two positive semi-definite matrices in $M_n(C)$ is again a positive semi-definite matrix in $M_n(C)$, it was shown that if $\mathcal{A}, \mathcal{B}, \mathcal{C}$ are C^*-algebras such that $\mathcal{C}$ contains the algebraic tensor-product $\mathcal{A} \otimes_{alg} \mathcal{B}$, and if $R \in M_n(\mathcal{A})$ and $S \in M_n(\mathcal{B})$ are positive, the so is the matrix in $M_n(\mathcal{C})$ with ij entry $r_{ij} \otimes s_{ij}$. This is then used to derive a marginal generalisation of Choi's characterisation of completely positive maps between matrix algebras, and to give a few examples of completely positive maps. [**K**].

Bases for finite index inclusion of II_1 factors and connected inclusion of finite dimensional C^*- algebras are examined. These bases behave nicely with respect to basic construction towers. As applications automorphisms of the hyperfinite II_1 factor R which are 'compatible with respect to the Jones' tower of finite dimensional C^*-algebras' have been studied. As a further application, in both Cases a characterization, in terms of bases, of basic constructions has been obtained. Finally these bases are used to describe the phenomenon of multistep basic constructions (in both the Cases). This is the subject of [**B**].

Representation Theory

Let n be a positive integer. It has a well-defined binary expansion $n = 2^{k_1} + \cdots + 2^{k_r}$, where $0 \leq k_1 < \cdots < k_r$. For each partition λ of n, let V_λ denote the irreducible representation of S_n indexed by λ. Macdonald showed that the number of partitions of n such that the dimension of V_λ is odd, is given by $2^{k_1+\cdots+k_r}$. Instead of looking at representations of S_n in isolation for each n, it is often revealing to look at relationships between them as n varies. Thus Alfred Young considered the partially ordered set of all partitions of all integers, the partial order being containment of Young diagrams. In [**Pr1**] it was found that in Young's lattice, the partitions λ for which V_λ is odd form a binary tree. A simple recursive definition of this tree was found. This recursive definition is a reflection of Macdonald's enumerative formula in Young's lattice.

An analogous, but harder problem is that of counting the number of partitions of n for which the representing matrices of odd permutations of S_n in V_λ have non-trivial determinant. A closed formula for this enumerative problem has been discovered recently.

Filtrations of higher level Demazure modules for representations of the affine Lie algebra $\widehat{\mathfrak{sl}}_2$ were studied. The generating functions for multiplicities were computed and shown to involve the Chebyshev polynomials and Ramanujan's fifth order mock theta functions [**Bi**].

Topology

It is shown in [**S2**] that several classes of groups G of PL-homeomorphisms of the real line admit non-trivial homomorphisms from G to the additive group of reals that are fixed by every automorphism of G. The classes of groups enjoying the stated property include the generalisations of Thompson's group F studied by K. S. Brown, M. Stein, S. Cleary, and Bieri-Strebel but also the class of groups investigated by Bieri-Neumann-Strebel. It follows that every automorphism of a group in any one of these classes has infinitely many associated twisted conjugacy classes.

Given two locally symmetric spaces which are smooth oriented manifolds and whose universal covers are irreducible non-compact globally symmetric spaces of higher rank (that is, rank at least 2), it is shown in [**Mo**] that any continuous map between them is either null-homotopic or is homotopic to a covering map. The Brouwer degree of any non-null homotopic map is a number d whose absolute value depends only the fundamental group of the locally symmetric spaces. The question of when both d and $-d$ arise is settled completely in the case the isometry groups of the universal covers are classical and in some exceptional types as well.

Transcendental Number Theory

In [**G8**], the authors generalise an identity of Lehmer. The techniques developed in this work allows them to furnish a new proof of Lehmer's identity. Further, this generalised identity facilitates the investigation of the (conjectural) transcendental nature of generalized Briggs-Euler-Lehmer constants. Consequently, the authors strengthen their earlier work.

Possible transcendental nature of Euler's constant γ has been the focus of study for sometime now. One possible approach is to consider γ not in isolation, but as an element of the infinite family of generalised Euler-Briggs constants. In a recent work, it is shown that the infinite list of generalized Euler-Briggs constants can have at most one algebraic number. In [**G5**], the authors study the dimension of spaces generated by these generalized Euler-Briggs constants over number fields. More precisely, they obtain non-trivial lower bounds on the dimension of these spaces and consequently establish the infinite dimensionality of the space spanned. Further, they study the linear and algebraic independence of these constants over the field of all algebraic numbers.

In [**G1**], the authors study generalized Euler-Briggs constants. In particular, they prove certain results which allow them to generalise as well as reinterpret some earlier works of Lehmer. Their proof uses tools from algebraic number theory and relies upon our recent works with Sinha. Further, they give a criterion for the convergence of certain L-functions at $s = 1$. These L-functions arise naturally in the study of generalised Euler-Briggs constants.

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.

[**A**]
Anirban Mukhopadhyay, M. Ram Murty*, and Sukumar Adhikari*.
The analog of the erd.

[**B**]
Keshab Chandra Bakshi.
On Pimsner Popa bases.
Proc. Indian Acad. Sci. Math. Sci, 2015.
(To be published).

[**Bi**]
Rekha Biswal, Vyjayanthi Chari*, Lisa Schneider*, and Sankaran Viswanath.
Demazure flags, chebyshev polynomials, partial and mock theta functions.
Journal of Combinatorial Theory, Series A, 2016.
arXiv:1502.05322 (To be published).

[**G1**]
S. Gun and E. Saha.

A note on Generalized Euler-Briggs constants.
In *Ramanujan Math Soc. Lecture notes*, Oct 2015.
(To be published).

[**G2**]
T. Chatterjee*, **S. Gun, and P. Rath***.
A number field extension of a question of Milnor.
Contem Math, 2015.
(To be published).

[**G3**]
Y. Choie*, **S. Gun, and W. Kohnen***.
An Explicit bound for the first sign change of the Fourier coefficients of a Siegel cusp form.
International Mathematics Research Notices, **12**, 3782, 2015.

[**G4**]
S. Gun, W. Kohnen*, **and P. Rath***.
Simultaneous sign change of Fourier-coefficients of two cusp forms.
Archiv der Mathematik, **105(5)**, 413, 2015.

[**G5**]
S. Gun, K. Murty*, **and E. Saha**.
Linear and algebraic independence of Generalized Euler-Briggs constants.
2015.
(Submitted).

[**G6**]
S. Gun and R. Murty*.
Generalization of an identity of Ramanujan.
J. Ramanujan Math. Soc., 2015.
(To be published).

[**G7**]
S. Gun and J. Oesterlé*.
The circle method and non-lacunarity of modular functions.
Journal für die reine und angewandte Mathematik, **703**, 1, 2015.

[**G8**]
S. Gun, E. Saha, and S. Sinha*.
A generalisation of an identity of Lehmer.
Acta Arithmetica, 2016.
(To be published).

[**G9**]
S. Gun and J. Sengupta*.
Sign changes of Fourier coefficients of Siegel cusp forms of degree two on Hecke congruence subgroups.

2015.
(Submitted).

[**K**]
Sumesh Koppil and V. S. Sunder.
A tensor-analogue of the schur product.
Positivity, 2015.
(To be published).

[**Kr1**]
M. Krishna and Dhriti R. Dolai.
Level repulsion for a class of decaying random potentials.
Markov Processes and Related Fields, **21(3)**, 449, 2015.

[**Kr2**]
M. Krishna and Manjunath Krishnapur*.
Persistence probabilities in centered, stationary, gaussian processes in discrete time.
Indian Journal of Pure and Applied Mathematics, 2015.
(To be published).

[**Ks1**]
Stephan Baier*, K. Srinivas, and Usha Keshav Sangale*.
A note on the gaps between zeros of epstein's zeta-functions on the critical line.
(Submitted).

[**Ks2**]
M. Ram Murty* and K. Srinivas.
Some remarks related to maedas conjecture.
Proceedings of AMS, 2016.
PROC13167 (To be published).

[**M1**]
Dhriti R. Dolai* and Anish Mallick.
Spectral statistics of random schrödinger operators with unbounded potentials.
2015.
(Submitted).

[**M2**]
Anish Mallick and Dhriti R. Dolai*.
Spectral statistics for one dimensional anderson model with unbounded but decaying potential.
2016.
(Preprint: arXiv:1602.02986).

[**Me**]
Jay Mehta, Biswajyoti Saha, and G. K. Viswanadham.
Analytic properties of multiple zeta functions and certain weighted variants, an elementary

approach.
2015.
(Submitted).

[**Mo**]
Arghya Mondal and Parameswaran Sankaran.
Degrees of maps between locally symmetric spaces.
Bulletin des Sciences Mathématiques, 2015.
(To be published).

[**Mu1**]
Anirban Mukhopadhyay and Kamalakshya Mahatab.
Measure theoretic aspects of oscillations of error terms.
2016.
(Submitted).

[**Mu2**]
Anirban Mukhopadhyay, R. Thangadurai*, and Kasi Vishwanadham*.
Unique representation of integers with base a.
Archiv Der Mathematik, 2015.
(To be published).

[**P**]
P. Akhilesh.
Double tails of multiple zeta values.
2015.
(Submitted).

[**Pr1**]
Arvind Ayyer*, Amritanshu Prasad, and Steven Spallone*.
Odd partitions in young's lattice.
2016.
arXiv:1601.01776 (Submitted).

[**Pr2**]
T. Geetha* and Amritanshu Prasad.
Centre of the Schur algebra.
Asian European Journal of Mathematics, **9(1)**, 1650006, 2016.

[**Pr3**]
Amritanshu Prasad, Pooja Singla*, and Steven Spallone*.
Similarity of matrices over local rings of length two.
Indiana University Mathematics Journal, **64(2)**, 471, 2016.

[**R1**]
R. Balasubramanian and Sumit Giri.
Poisson distribution of a prime counting function corrospending elliptic curves.

IMRN, 2015.
(To be published).

[**R2**]
R. Balasubramanian and Sumit Giri.
The mean value of a product of shifted multiplicative functions and the average number of points of an elliptic curve.
Journal of Number Theory, **157**, 37, 2015.

[**R3**]
R. Balasubramanian, Sumit Giri*, **and Priyamvad Srivastav**.
on correlations of certain multiplicative functions.
2016.
(Submitted).

[**S1**]
Daciberg L. Gonçalves* and Parameswaran Sankaran.
Sigma theory and twisted conjugacy-ii: Houghton groups and pure symmetric automorphism groups.
Pacific Journal of Mathematics, **280(2)**, 349, 2016.

[**S2**]
Daciberg L. Gonçalves*, Parameswaran Sankaran, and Ralph Strebel*.
Groups of PL-homeomorphisms admitting non-trivial invariant characters.
2015.
Arxiv:1511.07088 (Submitted).

[**Sn1**]
Biswas Indranil*, Kannan S. Senthamari*, and D. S. Nagaraj.
Automorphisms of $\overline{T}$..
C. R. Math. Acad. Sci. Paris, **353(9)**, 785, 2015.

[**Sn2**]
Biswas Indranil*, Kannan S. Senthamari*, and D. S. Nagaraj.
Equivariant principal bundles for gactions and gconnections.
Complex manifolds, **2(1)**, 1, 2015.

[**Sn3**]
Abdelghani E. Mazouni*, Fatima Laytimi*, and D. S. Nagaraj.
Special projections of veronese surfaces.
Proc. Indian Acad. Sci., 2016.
(To be published).

[**Su1**]
Madhushree Basu* and V. S. Sunder.
Continuous minimax theorems.
Operator Theory: Advances and Applications, Springer, Basel, 2015., **247**, 37, 2015.

[**Su2**]
V. S. Sunder.
Fuglede's theorem.
Indian J. of Pure and Appl. Math., **46(4)**, 415, 2015.

[**V**]
G. K. Viswanadham.
On the q-exponents of generalized modular function.
2015.
(Submitted).

[**Vi1**]
Sachin S. Sharma* and Sankaran Viswanath.
The t-analog of string functions for $A_1^{(1)}$ and Hecke indefinite modular forms.
The Ramanujan Journal, **39(3)**, 465, 2015.

[**Vi2**]
R. Venkatesh* and Sankaran Viswanath.
Chromatic polynomials of graphs from kac-moody algebras.
Journal of Algebraic Combinatorics, **41(4)**, 1133, 2015.

Books/Monographs Authored/Edited

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

[**S**]
V. S. Sunder.
Operators on Hilbert Space, volume 71 of *TRIM*.
Hindustan Publishing Agency, New Delhi, 2015.

2.3 Physics

2.3.1 Research Summary

Astro-particle Physics

The case of a light dark matter around 10 GeV, stable and unstable, is discussed in a simple Z2 model of scalar self interacting dark matter which may explain the anomalous Kolar events observed few decades ago [**Mu**]

Astrophysics

After their death through supernova explosions, moderate mass (10 to 25 times of the Sun) stars become neutron stars. Neutron stars are mostly composed of neutrons and a few protons, electrons and probably other baryons. Density at the centre of a neutron star can be as high as 10^{14} gm cm^{-3} . Neutron stars usually weigh around 1.4 times that of the Sun but have radii of only around 10 km. These stars take only 1 millisecond to 1 second to complete one full rotation around their own axis. The value of the magnetic field at the surface of neutron stars usually lies between $10^8 - 10^{15}$ Gauss. These stars emit electromagnetic beams along their magnetic axis which are generally misaligned with the spin axes. Thus the beam also rotates and might fall onto earth once in each rotation, i.e., the neutron star behaves like a light-house and called as a pulsar. Pulsars, especially when in binary systems, are excellent tools to test various theories of basic physics including general relativity and the physics of ultra-dense matter.

Binary pulsars are of particular interest. Population synthesis studies are ongoing to understand their overall properties. Orbital dynamics under general relativity is being explored. An effort is going on to build an "Indian Pulsar Timing Array" which will join the "International Pulsar Timing Array" to detect nano-Hertz gravitational waves.

Pulsar surveys to discover new pulsars are being undertaken.

Biological Physics

The representation of proteins as networks of interacting amino acids, referred to as protein contact networks (PCN), and their subsequent analysis using graph theoretic tools, can provide novel insights into the key functional roles of specific groups of residues. A recent study [**Sin**] has characterized the networks corresponding to the native states of 66 proteins (belonging to different families) in terms of their core-periphery organization. The resulting hierarchical classification of the amino acid constituents of a protein arranges the residues into successive layers having higher core order with increasing connection density, ranging from a sparsely linked periphery to a densely intra-connected core (distinct from the earlier concept of protein core defined in terms of the three-dimensional geometry of the native state, which has least solvent accessibility). The results show that residues in the inner cores are more conserved than those at the periphery. Underlining the functional importance of the network core, it is seen that the receptor sites for known ligand molecules of most proteins occur in the innermost core. Furthermore, the association of residues with structural pockets and cavities in binding or active sites increases with the core order. From mutation sensitivity analysis, it is observed that the probability of deleterious or intolerant mutations also increases with the core order. It is also seen that stabilization center residues are in the innermost cores, suggesting that the network core is critically important in maintaining the structural stability of the protein. A publicly available web resource for performing core-periphery analysis of any protein whose native state is known has been made available.

Classical and Quantum Gravity, Black Holes, Cosmology

The concordance model of cosmology favours a universe with a tiny positive cosmological constant. The extension of the gravitational radiation theory in presence of Λ is non-trivial due to the space-like nature of the null infinity of the de Sitter background space-time. Nevertheless it turns out that for candidate sources such as compact binaries, the influence of cosmological constant can be obtained as small corrections to the leading order Minkowski background results. Two different computations are presented for the leading order gravitational field [**D**].

Condensed Matter Physics

Using different numerical techniques, we have investigated the response of various soft matter systems, viz. glasses, suspensions, to applied mechanical perturbations of different kinds.

Understanding the failure of amorphous solids, from a microscopic point of view, remains a challenging task. Using large-scale molecular dynamics simulations for a system of a million particles, we have investigated the response of a dense amorphous solid to the continuous expansion of its volume [**Ch1**]. We find that the spatially uniform glassy state becomes unstable via the formation of cavities, which eventually leads to failure. By scanning through a wide range of densities and temperatures, we determine the state points at which the instability occurs and thereby provide estimates of the co-existence density of the resultant glass phase. Evidence for long-lived, inhomogeneous configurations with a negative pressure is found, where the frozen-in glass structure contains spherical cavities or a network of void space. Furthermore, we demonstrate the occurrence of hysteretic effects when the cavitated solid is compressed to regain the dense glassy state. As a result, a new glass state is obtained, the pressure of which is different from the initial one due to small density inhomogeneities that are generated by the dilation-compression cycle.

The response of glasses to mechanical loading often leads to the formation of inhomogeneous flow patterns that strongly affect materials properties. Among them, shear bands are ubiquitous in a wide variety of materials, ranging from soft matter systems to metallic alloys. Shear banding is associated with strain localization, i.e. the deformation of the sheared glassy solid is localized in space in form of band-like structures. These structures are often precursors to catastrophic failure, implying that a proper understanding of the underlying mechanisms could lead to the design of smarter materials. However, despite its importance in material science, the microscopic origin of shear banding in glassy materials is only poorly understood. We have elucidated the formation of shear banding in glassy systems by non-equilibrium molecular dynamics simulations (NEMD) of a binary Lennard-Jones mixture, subject to a constant strain rate [**Ch4**]. In its glass state, this system exhibits for all considered strain rates the formation of a percolating cluster of mobile regions at a critical strain. We show that this percolation transition belongs to the universality class of directed percolation. Only at low shear rates, where the steady-state stress is close to the yielding threshold, the percolating cluster evolves into a transient (but long-lived) shear band with a diffusive growth of its width.

Flow of soft matter suspensions under confinement of varying degrees happens during various applications. Proper characterization of the steady state flow properties in such circumstances is still missing. To address that, we study the rheology of confined suspensions of neutrally buoyant rigid monodisperse spheres in plane-Couette flow using direct numerical simulations [**Ch3**]. We find that if the width of the channel is a (small) integer multiple of the sphere diameter, the spheres self-organize into two-dimensional layers that slide on each other and the effective viscosity of the suspension is significantly reduced. Each two-dimensional layer is found to be structurally liquidlike but its dynamics is frozen in time.

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

It is shown that the hadronic "heat capacity" calculated as a function of temperature may be used to infer the possible presence of different scales underlying the dynamical structure of hadronic resonances using the phenomenon of Schottky anomaly. We first demonstrate this possibility with well known meson spectrum in various channels and comment on the possibility of using this method as a diagnostic to distinguish the exotic states [**Bi**].

A new idea for the RG evolution of neutrino mixing angles is developed. The earlier assumption of high scale mixing unification is really not necessary for the successful amplification of two of the neutrino mixing angles keeping the third small. All that is needed is the perturbative structure for the mixing matrix originally discovered by Wolfenstein in the context of quarks. If this structure is assumed for the neutrino mixing matrix at high scale, RG evolution will lead to the observed large neutrino mixing angles at low energy scales.

Worked on extended Higgs scenario in the context of LHC. One of the great option for directly access extended Higgs sector is the presence of charged scalar (Higgs). We consider a UV complete scenario in presence of supersymmetry. We want to study charged Higgs decaying to some non-standard modes which are not well studied.

Also doing a project o electroweak phase transition and baryogenesis mechanism.

Foundations of Quantum Mechanics

The question whether indeterminism in quantum measurement outcomes is fundamental or is there a possibility of constructing a finer theory underlying quantum mechanics that allows no such indeterminism, has been debated for a long time. We [**G1**] show that within the class of ontological models due to Harrigan and Spekkens, those satisfying preparation-measurement reciprocity must allow indeterminism of the order of quantum theory. Our result implies that one can design quantum random number generator, for which it is impossible, even in principle, to construct a reciprocal deterministic model.

Mixed states of a quantum system, represented by density operators, can be decomposed as a statistical mixture of pure states in a number of ways where each decomposition can be viewed as a different preparation recipe. However the fact that the density matrix contains full information about the ensemble makes it impossible to estimate the preparation basis for the quantum system. Here we present [**G2**] a measurement scheme to (seemingly) improve the performance of unsharp measurements. We argue that in some situations this scheme is capable of providing statistics from a single copy of the quantum system, thus making it possible to perform state tomography from a single copy. One of the by-products of the scheme is a way to distinguish between different preparation methods used to prepare the state of the quantum system. However, our numerical simulations disagree with our intuitive predictions. We show that a counterintuitive property of a biased classical random walk is responsible for the proposed mechanism not working.

It has been recently shown that measurement incompatibility and fine grained uncertainty, a particular form of preparation uncertainty relation, are deeply related to the nonlocal feature of quantum mechanics. In particular, the degree of measurement incompatibility in a no-signaling theory determines the bound of the violation of Bell-CHSH inequality and similar role is also played by (fine-grained) uncertainty along with steering, a subtle non-local phenomena. We review [**G3**] these connections along with comments on difference in the role played by measurement incompatibility and uncertainty. We also discuss why toy model of Spekkens shows no nonlocal feature though steering is present in this theory.

High energy physics phenomenology

Physics beyond the standard model: Extensions of the standard model of particle physics are being carried out relating to electroweak symmetry breaking and stability of the Higgs sector, such as, warped extra-dimensions, composite-Higgs, little-Higgs, super-symmetry, etc., with emphasis on precision, flavor and high energy (collider) probes of new physics, Large Hadron Collider (LHC) phenomenology, and dark matter candidates and detection prospects. The work is being carried out as part of the "High Energy Physics - Phenomenology" project at IMSc along with collaborators.

In Ref. [**?**] the little-Higgs model by Low, Skiba and Smith with SU(6)/Sp(6) symmetry group, which has a 2HDM structure was analyzed. The CP-even and CP-odd scalar couplings to two-gluons and two-photons were computed and the LHC phenomenology and decay branching ratios were worked out in regions of parameter space that satisfy the 8 TeV LHC constraints. In Ref. [**?**] the phenomenology of BSM heavy neutral scalars were studied that could be applied to many BSM models. The vector-like fermion contributions to the Higgs-gluon-gluon and the Higgs-photon-photon couplings were included. Among the models studied, an important scenario includes the 2-Higgs-doublet model (2HDM) in the alignment limit.

Nonlinear Dynamics, Solitons and Chaos

Recently, there have been many attempts to understand the collective dynamics of large, complex systems that occur in a variety of physical, biological and social contexts. Several of these studies suggest that detailed knowledge of the connection topology of a system is crucial for explaining the resulting dynamical behavior. Contrary to the expectation that complicated connection topologies are needed to generate the complex patterns observed in real-world systems, a recent study has shown that, in fact, even simple, homogeneous systems are capable of exhibiting non-trivial dynamical patterns through spontaneous symmetry breaking [**Me2**]. An important implication of this study is that certain features of the collective dynamics of complex systems can be explained even without complete knowledge of their wiring diagrams.

The study has looked at the specific example of a densely connected network of brain regions, whose collective dynamical activity correspond to large-scale patterns of neural excitation can have important physiological implications. Each node of the network is modeled using the well-known Wilson-Cowan model that describes the local aggregate activity in a brain region. A rich variety of dynamical patterns has been observed that arise through spontaneous symmetry breaking, some of which qualitatively resemble those seen using a realistic connection topology of a primate brain (indicating their relative independence from the specific details of the underlying connectivity structure). Another important observation, of particular importance to physicists, is that while the attractors of the globally coupled system are preserved if the connectivity is decreased, even a marginal deviation from this mean-field situation can radically alter the robustness of certain patterns. The study also suggest an intriguing connection between seemingly contradictory findings from two recent experiments: while the disruption of communication between areas of the cerebral cortex has been linked to loss of consciousness in one set of experiments, another study has found that the development of fatigue is accompanied by an increase in the degree of synchronization between brain areas. Taken together these results imply that decreased strength of communication between brain regions can be accompanied by increased synchronization in their activity. Although this may appear counter-intuitive, the study results demonstrate that these observations need not in fact be incompatible.

The heart is a fascinating example of nonlinear dynamics at work in biology. Disruptions in the normal rhythmic functioning of the heart, termed as arrhythmia, often result from qualitative changes in the excitation dynamics of the organ. The transitions between different types of arrhythmia are accompanied by alterations in the spatio-temporal pattern of electrical activity that can be measured by observing the time-intervals between successive excitations of different regions of the cardiac tissue. Using biophysically detailed models of cardiac activity, a recent study [**E**] has shown that the distribution of these time-intervals exhibit a systematic change in their skewness during such dynamical transitions. Further, the leading digits of the normalized intervals appear to fit Benfords law better at these transition points. This raises the possibility of using these observations to design a clinical indicator for identifying changes in the nature of arrhythmia. More importantly, the results of this study reveal an intriguing relation between the changing skewness of a distribution and its agreement with Benfords law, both of which have been independently proposed earlier as indicators of regime shift in dynamical systems.

Perturbative QCD

1. One of the most popular extensions of the SM, namely, the MSSM and two Higgs doublet model have richer Higgs sector containing more than one Higgs boson and there have been intense search strategies to observe them at the LHC. In particular, the production of CP odd Higgs boson/pseudo-scalar at the LHC has been studied in detail, taking into account higher order QCD radiative corrections, due to similarities with its CP even counter part. In the light of recent third order computation on the inclusive production cross section of the SM scalar Higgs boson, we have obtained 3-loop QCD corrections to the form factor of the pseudo-scalar production which is an important component of the observables involving pseudo-scalar. The calculation has been performed in the framework of the dimensional regularisation using the effective Lagrangian. The evaluation of this 3-loop form factors is truly a non-trivial task not only because of the involvement of a large number of Feynman diagrams but also due to presence of the axial vector coupling which is highly complicated to deal with. The state-of-the-art techniques have been employed to accomplish this task. The ultraviolet (UV) renormalisation is quite involved since the two operators, present in the Lagrangian, mix under UV renormalization due to axial anomaly and additionally, a finite renormalisation constant needs to be introduced in order to fulfill the chiral Ward identities. Our findings are consistent with the universal structure of the infrared (IR) poles. This form factor is an important ingredient to the precise prediction of the pseudo-scalar Higgs boson production cross section at hadron colliders. We have also studied some potential

applications in the context of soft-collinear effective (SCET) theory and N = 4 super Yang-Mills theory.

2. In addition to the pseudo-scalar Higgs boson, spin-2 particle is often a potential candidate in physics beyond the Standard Model (BSM), namely, the models with extra-dimensions where spin-2 Kaluza-Klein gravitons couple to the fields of the SM. Also, in the context of Higgs searches, spin-2 fields have been studied as an alternative to the scalar Higgs boson. In addition to the phenomenological interest, I think there is much more theoretical motivation to unveil the many interesting characteristics of the scattering amplitudes involving spin-2 particles. With these motivations, we have performed the complete 3-loop QCD radiative corrections to the massive spin-2 form factors in SU(N) gauge theory which is highly non-trivial due to the complicated tensorial structure of spin-2 coupling. We have also studied the structure of the IR singularities in these form factors using Sudakov integro-differential equation and found that it is in agreement with the universal structure of IR singularities. These form factors contribute to the precision studies at third order of the processes involving spin-2 particle in the hadronic reactions at the LHC.

3. Presently, it is of paramount importance to go beyond the existing accuracy for the observables associated with the productions of the Higgs boson and Drell-Yan (DY) like processes due to several strong motivations, most importantly to minimize the renormalisation and factorisation scale uncertainties and to provide a more reliable predictions. But, it is a highly non-trivial task to accomplish these. Hence, it is very natural to try an alternative approach to capture the dominant contributions from the missing higher order corrections until one has the complete tools for the fixed higher order computations beyond NNLO. The very first approach towards this direction is to compute the observables under soft-virtual (SV) approximation which often captures the dominant contributions and are often seen to provide a good results. However, this may give rise to large logarithms for certain observables in some kinematics regions which can spoil the convergence of the perturbation theory and hence, those must be resummed to all orders to get a more reliable predictions. This has been accomplished through soft-gluon resummation technique. The very first milestone towards this direction was accomplished through the computation of the Higgs boson production cross section in gluon fusion at threshold N3LO QCD which contained some valuable and universal information on soft gluon contribution. Extracting that relevant information and exploiting the factorization property of QCD amplitude along with Sudakov resummation of soft gluons and renormalization group invariance, we have established an elegant formalism to compute the SV cross section and differential rapidity distribution of the processes, in which the final state particle is colourless. Using this framework, we have computed in QCD : "Pseudo-scalar Higgs boson production at threshold N3LO and N3LL"

QFT, Topological QFT, Conformal Field Thoery

Non-perturbative aspects of QFTs are an area of active pursuit. Currently a study involving spontaneous symmetry breaking in quantum optical models is being pursued. Issues concerning coexistence of gauge invariance and mass are also being carefully looked at. Attention is also being devoted to studying soluble models, both in classical and quantum domain, and their non-trivial vacuum sectors.

Quantum Computations

We develop [**Si2**] a very simple necessary condition for the perfect distinguishability of any set of maximally entangled states in a $\mathbb{C}^d \otimes \mathbb{C}^d$ system. This condition places constraints on the starting measurement of the LOCC protocol, and, by doing so, reduces the the complexity of the distinguishability problem, particularly for any set of d maximally entangled states (MES). To test the strength of this necessary condition we use it for the perfect distinguishability of all sets of four generalized Bell basis states in $\mathbb{C}^4 \otimes \mathbb{C}^4$. To do this we first partition all ${}^{16}C_4$ such sets into 122 equivalent classes, such that any two sets within an equivalence class are related by action of a local unitary performed by Alice or Bob. Thus establishing whether any such set is perfectly distinguishable by LOCC merely requires one to know if any other set from the same equivalence class is perfectly distinguishable by LOCC. After this partitioning, we proceed to establish whether each of the 122 sets are distinguishable by LOCC by testing some representative set from each equivalence class for the necessary condition we developed earlier on. Those sets which do not pass the test are not perfectly distinguishable by LOCC and are hence isolated from the remaining. Surprisingly, all sets which pass the test are found to be perfectly distinguishable by LOCC implying that the necessary condition is sufficient for sets of four generalized Bell States in $\mathbb{C}^4 \otimes \mathbb{C}^4$. Even more, the sets which pass the necessary test, can be distinguished by a one-way LOCC protocol using projective measurements. For each set that passes the test, we give the one-way LOCC protocol employing rank-one projective measurements for the perfect distinguishability of states in the set.

Experimental detection of entanglement of an arbitrary state of a given bipartite system is crucial for exploring many areas of quantum information, and even to judge the quality of entanglement producing source. We [**M2**] combine here the ideas of Branciard et al.'s measurement device independent protocol Branciard et al. and Augusiak et al.'s universal entanglement witness scheme for two-qubit case, and aim at generalizing it for the case of two-qudits. We provide a set of universal witness operators to check NPT-ness (negative under partial transpose) of two-qudit states in a measurement device independent way. We conjecture that no such entanglement witness exists for PPT (positive under partial transpose) entangled states. We also analyze the robustness of a entanglement witnessing process in the presence of noise in the inputs as well as in the measurement operators.

Interesting connection has been established between two apparently unrelated concepts, namely, quantum nonlocality and Bayesian game theory. It has been shown that nonlocal correlations in the form of advice can outperform classical equilibrium strategies in common interest Bayesian games and also in conflicting interest games. However, classical equilibrium strategies can be of two types, fair and unfair. Whereas in fair equilibrium payoffs of different players are same, in unfair case they differ. Advantage of nonlocal correlation has been demonstrated over fair strategies. In this work we show that quantum strategies can outperform even the unfair classical equilibrium strategies. For this purpose we consider [**G4**] a class of two players games which as a special case includes the conflicting game proposed in [Phys. Rev. Lett. 114, 020401 (2015)]. These games can have both fair and unfair classical equilibria and also can have only unfair ones. We provide a simple analytic characterization of the nonlocal correlations that are advantageous over the classical equilibrium strategies in these games.

Obtaining the asymptotic function of the any classical or quantum dynamics is very important to understand long time behaviour of the dynamics. Obtain asymptotic function when the dynamics is complex is mathematical demanding and for quantum dynamics such as quantum walks obtaining limit theorems for different evolution conditions (forms) is challenging and a topic of interest to both, mathematicians as well as physicists. Functions obtained from limiting theorems of quantum walks will helps us to characterize the long time probability distribution of the evolutions which will further help us to choose the configuration of quantum walks that will help us for specific quantum information process. In [**C3**] we defined a three-state alternate discrete-time quantum walks (DTQW) with a parametrized coin-flip operator and showed that it can produce localization that is also observed for a certain other configuration of the four-state DTQW and non-reproducible using the two-state alternate DTQW. In the paper we presented two limit theorems for the three-state alternate DTQW. One of the limit theorems described a long-time limit of a return probability, and the other presented a convergence in distribution for the position of the walker on a rescaled space by time. We also showed that the spatial entanglement generated by the three-state alternate DTQW is higher than that by the four-state DTQW. In an other work [**C2**], we defined and presented a comprehensive study of three two-dimensional quantum walks, which are self-avoiding in coin space, in position space and in both, coin and position space. We showed that all result in delocalization of the probability distribution for initial states which are strongly localised for a walk with a standard Grover coin operation. We also presented analytical results for the evolution in the form of limit distributions for the self-avoiding walks in coin space and in both, coin and position space.

Quantum memory is an integral part of any quantum information processing protocols and various groups across the world are working on different possible forms of storing quantum state for a longer duration so that quantum tasks can be performed efficiently. In [**C1**] we have shown that a quantum walk process can be used to construct and secure quantum memory. More precisely, we showed that a localized quantum walk with temporal disorder can be engineered to store the information of a single, unknown qubit on a compact position space and faithfully recover it on demand. Since the localization occurs with a finite spread in position space, the stored information of the qubit will be naturally secured from the simple eavesdropper.

In [**M1**] we discuss simulations of one quantum system by an other quantum system. It has an implications in realization of quantum machine that can imitate any quantum systems and solve problems that are not accessible to classical computers. One of the approach to engineer quantum simulations is to discretize the space-time degree of freedom in quantum dynamics and define the quantum cellular automata (QCA), a local unitary update rule on a lattice. Different models of QCA are constructed using different set of conditions which are not uniquely defined. The form of the operators in these model are not always in implementable configuration on an other system. In our work, starting from a split-step discrete-time quantum walk (DTQW) which are uniquely defined for experimental implementation, we recover the Dirac quantum cellular automaton (DQCA). This will bridge the connection between Dirac equation(DE)-DQCA-DTQW and eliminate the explicit use of invariance, symmetries and limiting range of parameter to establish the connections. For a combination of parameters defining the split-step DTQW, we showed the recovery of all the fine oscillation of the probability distribution in position observed in DQCA but not in conventional DTQW. We also presented the Zitterbewegung oscillations and quantify the entanglement as a function of that parameters that define split-step DTQW. The unique definition of DTQW along with the parameter tuneability demonstrated in experimental implementation will establish it as an efficient tool to design quantum simulator with access to different physical regime and approach quantum field theory from principles of quantum information theory.

Statistical Mechanics

Understanding the behavior of rational agents interacting with each other and having the aim of maximizing a personal utility function has recently become an area of intense activity in statistical physics. Moving from the motion of particles acted upon by external forces to a setting where the entities act according to strategies designed for achieving a certain goal has greatly expanded the arena of possible natural phenomena that can be analyzed using the techniques of physics. One of the most challenging scientific questions in this area concerns the origin and development of cooperation in society, i.e., whether it is rational for selfish individuals to cooperate when they are not likely to encounter each other more than once and thus there is a high temptation to "cheat". The established mathematical theory of games suggests that agents will in fact cheat and cannot explain why cooperation among unrelated individuals is seen so commonly in nature. In fact, there are many situations where if each individual argues in the non-cooperative manner suggested by game theory, everyone will end up in a worse situation than had they cooperated. This incompatibility between individual rationality and collective benefit lies at the heart of many social dilemmas such as the Prisoners Dilemma (PD) game. Recently a new general framework for solving non-cooperative games, the co-action equilibrium, that leads to rational selfish individuals choosing "nicer" strategies, resulting in better collective outcomes has been proposed [**S**]. The key idea underlying the co-action solution is that agents make independent choices from the possible actions available, taking into account that other agents will behave the same way as them and they are also aware of this. This is in contrast to the conventional Nash equilibrium solution concept used for solving non-cooperative games - a strategy choice by each player so that no player can do better by deviating unilaterally from it. The co-action equilibrium is guaranteed to exist for all games having a symmetric payoff structure. It also has the advantage of being unique for a given game. Several well-known two-person single-stage games, viz., PD, Chicken and Stag Hunt, have been analyzed in detail to illustrate the differences between Nash and co-action solutions. The latter, in general, lead to "nicer" strategies being selected by the agents resulting in globally more efficient outcomes. For example, the co-action equilibrium in PD corresponds to full cooperation among agents at lower values of temptation to defect, while for higher temptation each agent employs a probabilistic (or mixed) strategy, thus essentially solving the dilemma.

The movement of large numbers of vehicles along the complex network of roads in a city result in interactions between them that become stronger as the traffic density increases. The non-trivial behavior arising from the collective dynamics of vehicles include the occurrence of persistent congestion at different points of the transport network that typically reduce the efficiency of overall traffic flow. In order to understand the mechanisms responsible for the characteristic spatio-temporal patterns of urban traffic, we first need to identify statistically robust features from empirical observations, which one can then try to recreate in computational models of traffic dynamics. A recent study [**N**] has analyzed the GPS traces collected round the clock for more than a hundred taxis operating in a major Indian city over a period of 1 month. The available information allows precise measurement of the periods during which the vehicle is static and when it is moving. The study focuses on the intermittent patterns of rest and motion that a car exhibits during its passage through city traffic, which provides a window into key aspects of collective dynamics resulting from congestion. The distribution of waiting time, i.e., the period during which a car is static between two successive epochs of movement, has a highly skewed nature. The bulk of the probability distribution appears to follow power-law scaling. As city traffic has very different densities during peak hours and off-peak hours, this distribution has been computed for different times of the day. While the power-law scaling is found to be robust, the exact value of the exponent does change slightly. The empirical results have been sought to be reproduced using a model of vehicular movements based on a novel kinetic Monte Carlo updating scheme. Using a gamma distribution of vehicle speeds to These results can be used to help understand how the statistical properties of large-scale traffic movement over complex road networks which characterize cities deviate from that of other types of collective dynamics, e.g., the diffusion of random walkers.

Many complex systems can be represented as networks of dynamical elements whose states evolve in response to interactions with neighboring elements, noise and external stimuli. The collective behavior of such systems can exhibit remarkable ordering phenomena such as chimera order corresponding to coexistence of ordered and disordered regions. Often, the interactions in such systems can also evolve over time responding to changes in the dynamical states of the elements. Link adaptation inspired by Hebbian learning, the dominant paradigm for neuronal plasticity, has been earlier shown to result in structural balance by removing any initial frustration in a system that arises through conflicting interactions. A recent study [**P**] was done to show that the rate of the adaptive dynamics for the interactions is crucial in deciding the emergence of different ordering behavior (including chimera) and frustration in networks of Ising spins. In particular, it was observed that small changes in the link adaptation rate about a critical value result in the system exhibiting radically different energy landscapes, viz., smooth landscape corresponding to balanced systems seen for fast learning, and rugged landscapes corresponding to frustrated systems seen for slow learning.

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 related problem of hard rectangles with varying aspect ratio is studied on two dimensional lattices. The phase diagram of a system of monodispersed hard rectangles of size $2 \times d$ is determined for all d using a combination of Monte Carlo simulations and Bethe approximations. The existence of a disordered phase, a nematic phase with orientational order, a columnar phase with orientational and partial translational order, and a crystalline sublattice phase is shown. The solid phase is shown to exist only when the greatest common divisor of the length and width is different from one. The nematic-columnar transition occurs surprisingly at a finite density even in the limit of large aspect ratio. A systematic calculation of the interfacial tension between two columnar phases is developed leading to an accurate estimate of the critical parameters for the hard square and hard rectangle gases [**K**, **Na**].

The effect of polydispersity on the isotropic-nematic transition of long, hard rods is less understood than the monodispersed cases. Here, the phase diagram of a model system of bidispersed rods on a square lattice is obtained using a combination of Monte Carlo simulations, virial expansions and high density perturbation expansions. The existence of a high density reentrant isotropic phase is established [**Ra1**]

Cortical bone, found in the central part of long bones like femur, is known to adapt to local mechanical stresses. This adaptation has been linked exclusively with Haversian remodelling involving bone resorption and formation of secondary osteons. Compared to primary/plexiform bone, the Haversian bone has lower stiffness, fatigue strength and fracture toughness, raising the question why nature prefers an adaptation that is detrimental to bone's primary function of bearing mechanical stresses. It is shown that in the goat and bovine femur, Haversian remodelling occurs only at locations of high compressive stresses. At locations corresponding to high tensile stresses, a microstructure that is non-Haversian is observed. Compared with primary/plexiform bone, this microstructure's mineralisation is significantly higher with a distinctly different spatial pattern. Thus, the Haversian structure is shown to be an adaptation only to high compressive stresses rendering its inferior tensile properties irrelevant. The advantage of the Haversian structure to support compressive loading is determined using compression testing [**Ra2**].

How does the dynamics of aggregation of similarly charged polymers depend on the valency of the counterions, charge density, and density of the polymers? Using large scale molecular dynamics simulations, it is shown that the morphology of the aggregates depends on the value of the charge density of the polymers. For values close to the critical value, the shape of the aggregates is cylindrical with height equal to the length of a single polymer. However, for larger values of charge, the linear extent of the aggregates increases as more and more polymers aggregate. In both the cases, it is shown that the number of aggregates decrease with time as power laws with exponents that are not numerically distinguishable from each other, and are independent of charge density of the polymers, valency of the counterions, density, and length of the polymer. The aggregation dynamics are modelled using the Smoluchowski coagulation equation with kernels determined from the molecular dynamics simulations, and justify the numerically obtained value of the exponent. It is concluded that, once counterions condense, effective interactions between polyelectrolyte chains short-ranged and the aggregation of polyelectrolytes is diffusion-limited [**T**].

Intermolecular correlations in liquid water at ambient conditions have generally been characterized through short range density fluctuations described through the atomic pair distribution functions. Recent numerical and experimental results have suggested that such a description of order or structure in liquid water is incomplete and there exist considerably longer ranged orientational correlations in water that can be studied through dipolar correlations. Using large scale classical, atomistic molecular dynamics simulations employing various models of water such as TIP4P-Ew and TIP3P, we study how salts such as sodium chloride (NaCl), potassium chloride (KCl), caesium chloride (CsCl), and magnesium chloride (MgCl2) affect the long range dipolar correlations, which cannot be explained by the notion of structure making and breaking by dissolved ions. Observed effects are explained through orientational stratification of water molecules around ions and their long range coupling to the global hydrogen bond network by virtue of the sum rule for water. The observations for single hydrophilic solutes are contrasted with the same for a single methane (CH4) molecule. We observe that even a single small hydrophobe can result in enhancement of long range orientational correlations in liquid water, contrary to the case of dissolved ions, which have been observed to have a reducing effect. The observations from this study are discussed in the context of hydrophobic effect.

A system of particles which on undergoing a two-body collision either coalesce to form a single particle or are removed from the system have been studied using Smoluchowski equation. The system is driven to a steady state by a constant input of particles of the smallest mass. The collision kernel studied is a generic one: $K(m_1, m_2) = (m_1^{\mu} m_2^{\nu} + m_1^{\nu} m_2^{\mu})/2$. The Smoluchowski equation for this kernel is analyzed using the relation between different moments, the singular structure of the generating functions, a numerical solution, and exact solutions of solvable limits. The exponents characterizing the mass distribution for small and large masses are also found. This study has also been extended to a similar, but mass conserved model.

String Theory

This work is an application of AdS/CFT to condensed matter physics. The consequences of the Schwinger effect for conductivity is computed for strong coupling systems using holography. The one loop diagram on the flavor brane introduces an O(955;Nc) imaginary part in the effective action for a Maxwell flavor gauge field. This in turn introduces a real conductivity in an otherwise insulating phase of the boundary theory. Moreover in certain regions of parameter space the differential conductivity is negative. This is computed in the context of the Sakai-Sugimoto model.

The Exact Renormalization Group is applied to a world sheet theory describing string propagation in a general background involving both massless and massive modes. This gives interacting equations of motion for the modes of the string. Loop variable techniques are used to obtain gauge invariant equations. Since this method is not tied to flat space time or any particular background metric, it is manifestly background independent. The technique can be applied to both open and closed strings. Thus gauge invariant and generally covariant interacting equations of motion can be written for massive higher spin fields in arbitrary backgrounds. Some explicit examples are given. This brings to a conclusion the first part of the loop variable program. The next step is to find a space time interpretation for the equations and find new solutions.[**Sa**]

Holographic techniques are used to study zero temperature dissipation for a Brownian particle moving in a strongly coupled CFT at finite temperature in various space-time dimensions. The dissipative term in boundary theory for T8594;0 doesn't match the same at T=0. This phenomenon indicates a confinement-deconfinement type phase transition at T=0 in the field theory. [**Ban3**]

In a loop space description of string theory in an arbitrary curved space, the semi-classical expansion needs to be obtained from the tubular expansion of the geometry of loop space around the submanifold of vanishing loops, which is isomorphic to the original target space $\mathcal{M}$. Moreover, terms in this expansion are divergent. These are usual UV divergences of non-linear sigma model (NLSM) which arise in this new language geometrically due to the infinite dimensionality of loop space $\mathcal{LM}$ corresponding to $\mathcal{M}$.

To proceed further with this problem, one has to compute the tubular geometry of loop space and find a suitable regularization for the divergences. The tubular geometry was obtained earlier in 2014 (arXiv:1407.7355) where the problem of regularization was implicitly addressed within the construction. The question was answered by replacing $\mathcal{LM}$ by a cut-off space, namely $\left(\mathcal{M}^{2N+1}\right)_{cyc}$ which is the cartesian product of $(2N+1)$ number of copies of $\mathcal{M}$ with a cyclic ordering. Then one computes the tubular geometry of the cut-off space around the diagonal submanifold (isomorphic to $\mathcal{M}$) and takes a large-N limit in a suitable manner to obtain the geometry of $\mathcal{LM}$.

The following are further questions arising from the previous work which are under investigation.

1. The above method is ad-hoc in the sense that it is not *a priori* clear if the large-N limit indeed reproduces the correct loop space geometry. In the previous work it was verified that the final result does have the desired property of admitting the reparametrization isometry of loop space to all orders in tubular expansion. In an ongoing work we try to verify if the above result does reproduce the correct geodesics of loop space. A geodesic in $\mathcal{LM}$ corresponds to a geodesic evolution of loops (giving rise to a cylindrical structure) in $\mathcal{M}$. Since the latter is known, given the geometry of $\mathcal{M}$, the geodesics of $\mathcal{LM}$ are in principle known. The question is whether the tubular geometry derived earlier reproduces the same geodesics in $\mathcal{LM}$. The work addresses carefully the issues of parametrizing a geodesic in $\mathcal{LM}$ and a geodesic cylinder in $\mathcal{M}$ and the relation between them.

2. The procedure followed in 2014-paper uses a general theorem regarding tubular expansion as derived earlier in 2012 (arXiv:1203.1151). The content of the latter is as follows. Given an arbitrary ambient space and a submanifold embedded in it admitting a tubular neighbourhood, there always exists a special coordinate system, namely generalized Fermi normal coordinates (FNC), in terms of which the tubular expansion of vielbein can be solved in closed form to all orders. However, in applications in physics, one usually has to work with an arbitrary (*a priori*) coordinate system and equations determining the submanifold given in the same coordinate system. Therefore, the results of the 2012-paper seem not very useful in this case. In an ongoing work the problem of writing down the tubular expansion in terms of the *a priori* data has been solved. Various applications are being worked out.

3. Recalling the issue of regularization, one notes that the work of 2014-paper suggests a regularization of the configuration space (the cut-off loop space being the regularized version of the original loop space). However, a complete regularization would require the dynamical model to be regularized as well. Therefore the following question arises: Is it possible to construct a relativistic dynamical model whose configuration space is given by the cut-off loop space such that the following properties are satisfied?

    - The model possesses crucial properties at finite N so as to qualify as a regularization of NLSM.
    - The model approaches NLSM at large N.

    In an ongoing work, such a model (conformal string bits) in flat space is being considered which possesses local symmetries analogous to that of NLSM giving rise to constraints. Fixing the local symmetries gives rise to a discrete version of the original conformal invariance.

    The complete BRST treatment of the model is currently being worked out. If successful, it will provide an explicit example of fully relativistic description of a quantum bound state problem. Moreover, it can be coupled to a background metric in a straightforward manner following the same approach as considered in the loop space framework of string theory. It is also expected that this will give rise to a controllable toy example of computing higher derivative corrections to the effective theory in spacetime.

Equivariant localisation is used to obtain the contribution to the prepotential of four dimensional gauge theories as a power series in the bare coupling constant. The focus was on superconformal theories because such gauge theories have non-perturbative dualities (S-dualities) that strongly constrain the form of the prepotential and allow one to completely resume the instanton series.

In a series of papers [**As2**, **As3**], we studied supersymmetric QCD with gauge group SU(N) and 2N fundamental flavours. We began with the power series expansion obtained using the localisation formalism and managed to resum the instanton contributions to the prepotential in terms of modular forms. This is a novel and interesting result and is a non-trivial consequence of the power of S-duality in constraining the observables of the gauge theory. We also make contact with recent interesting results in the mathematics literature related to j-invariants of triangle groups.

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.

[**A1**]
Taushif Ahmed, Goutam Das*, M. C. Kumar, Narayan Rana, and V. Ravindran.
RG improved Higgs boson production to N^3LO in QCD.
2015.
(Preprint: 1505.07422).

[**A2**]
Taushif Ahmed, Goutam Das*, Prakash Mathews*, Narayan Rana, and V. Ravindran.
Spin-2 Form Factors at Three Loop in QCD.
JHEP, **1512**, 084, 2015.

[**A3**]
Taushif Ahmed, Thomas Gehrmann*, Prakash Mathews*, Narayan Rana, and V. Ravindran.
Pseudo-scalar Form Factors at Three Loops in QCD.
JHEP, **1511**, 169, 2015.

[**A4**]
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2.4 Theoretical Computer Science

2.4.1 Research Summary

Algorithms and Data Structures

In [**Ram4**] fast algorithms are obtained for finding the median from a list of n integers in a read-only memory using small extra space.

In [**Ram2**] and [**Ram3**] tight upper and lower bounds are obtained for finding a mode of a sequence of elements that are not from a totally ordered set. Here the relation between elements are obtained using equality comparisons. Extensions to sorting (finding the frequency of every element) are also obtained.

In [**Ram1**] a characterization is given for when finding the shortest path between two satisfying assignments of a boolean formula is polynomial time solvable or NP-complete. This generalizes an earlier characterization that was available for determining the existence of a path between two satisfying assignments. Here two satisfying assignments are *adjacent* if we can obtain one from the other by flipping the value of a variable.

In [**Mu**], two approximation algorithms for the maximum independent set (MIS) problem over the class of B_1-VPG graphs and also for the subclass, equilateral B_1-VPG graphs, are presented. The first algorithm is shown to have an approximation guarantee of $O((\log n)^2)$ whereas the second one is shown to have an approximation guarantee of $O(\log d)$ where d denotes the ratio d_{max}/d_{min} and d_{max} and d_{min} denote respectively the maximum and minimum length of any arm in the input L-representation of the graph. No approximation algorithms have been known for the MIS problem for these graph classes before. Also, the NP-completeness of the decision version restricted to unit length equilateral B_1-VPG graphs is established.

In the context of graph editing problems, two generalizations of well known Feedback

Vertex Set (FVS) problem were studied in the realm of parameterized complexity. The main goal of [**R1**] was to study the following problem: How can we generalize the family of forests such that the nice structural properties of forests and the interesting algorithmic properties of FVS can be extended to problems on this class? Towards this, a graph class $\mathcal{F}_l$ was defined, that contains all graphs where each connected component can transformed into a forest by deleting at most l edges. In [**R1**], FPT algorithms and uniform kernels we given for deletion to $\mathcal{F}_l$. In [**R2**], the problem of deleting at most k vertices and at most l edges to get to a forest was studied, and it was shown that this problem admits an algorithm with running time $2^{\mathcal{O}(l+k)}n^{\mathcal{O}(1)}$ and a kernel of size $\mathcal{O}(kl(k+l))$.

In [**Sh1**] we give a bound of $O(n \log n)$ on the size of the subdivision tree of an algorithm for real root isolation that uses termination predicates based on the Descartess rule of signs. This is the first application of the continuous amortization framework to a non-uniform subdivision algorithm. Using this framework we obtain the same bound on the tree size of the algorithm combined with Sturm sequences. In [**Sh3**], we further simplify the algorithm from [**Sh1**] and extend the results to the combination of the algorithm above with an algorithm called Eval that uses predicates based on interval-arithmetic. We derive an $O(n^{2.5} \log n)$ bound on the size of the subdivision tree of this combination.

[**Me1**] considers the problem of reducing the rank of the adjacency matrix of a simple undirected graph by the operations of vertex deletion and edge editing. These problems are shown to be NP-Complete. Using number of edits (or deletions) as a parameter, polynomial sized kernel and FPT-algorithms are obtained.

[**Me2**] extends a previous work to the domain of directed graphs. It is shown that the problem of reducing the rank of the adjacency matrix of a “simple” directed graph via edge or vertex deletion is NP-Complete. Using number of edge (or vertex) deletions as a parameter, polynomial sized kernel and FPT-algorithms are obtained.

Automata, Logic and Concurrency

Work continues on epistemic logics and games. [**Ra4**] discusses the logical structure of local actions and their implications for knowledge of agents. [**Ra3**] studies automata as memory structure for “online” strategizing in extensive form games, where players start with potential (partial) strategies that are generic plans for (local) subgames and dynamically compose and switch between them.

Work has been initiated in new areas of logic in proof complexity and foundational first order combinatorial theories. [**Ra1**] studies definability in first order theories of graph orderings, and [**Ra2**] maps the complexity of provability in several fragments of propositional intuitionistic logic.

Computational Complexity

Resolution-based systems for refuting Quantified Boolean Formulas were explored in a series of papers.

In sharp contrast to classical proof complexity, lower bound techniques are currently lacking for QBF proof systems. In [**M1**], the feasible interpolation technique was established for all resolution-based QBF systems, whether modelling CDCL or expansion-based solving. This both provided the first general lower bound method for QBF proof systems as well as largely extended the scope of classical feasible interpolation. This technique was applied to obtain new exponential lower bounds to all resolution-based QBF systems for a new class of QBF formulas based on the clique problem. Finally, it was shown how feasible interpolation relates to a recently established lower bound method based on strategy extraction.

The groundbreaking paper 'Short proofs are narrow – resolution made simple' by Ben-Sasson and Wigderson (J. ACM 2001) introduced what is today arguably *the* main technique to obtain resolution lower bounds: to show a lower bound for the width of proofs. Another important measure for resolution is space, and in their fundamental work, Atserias and Dalmau (J. Comput. Syst. Sci. 2008) showed that space lower bounds again can be obtained via width lower bounds. Whether similar techniques are effective for resolution calculi for quantified Boolean formulas (QBF) was assessed in [**M3**]. A mixed picture emerged. The main results of [**M3**] showed that both the relations between size and width as well as between space and width drastically *fail* in Q-resolution, even in its weaker tree-like version. On the other hand, positive results were obtained for the expansion-based resolution systems $\forall$Exp+Res and IR-calc, however only in the weak tree-like models. Technically, the negative results relied on showing width lower bounds together with simultaneous upper bounds for size and space. The positive results were shown by exhibiting space and width-preserving simulations between QBF resolution calculi.

In [**M10**], Level-ordered Q-resolution and Tree-like Q-resolution, two restrictions of the Q-resolution system for proving false QBFs false, were shown to be incomparable. While the $\forall$Exp+Res system is known to p-simulate Tree-like Q-resolution, it was observed that it cannot p-simulate Level-ordered Q-resolution.

In [**M9**], it was shown that over fields of any characteristic, exponential sums of Boolean instantiations of polynomials computed by multilinear circuits can be computed by multilinear circuits with polynomial blow-up in size. In particular, multilinear-VNP equals multilinear-VP. This result showing closure under exponential sums was also shown to hold for other restricted multilinear classes – polynomials computed by multilinear (bounded-width) algebraic branching programs and formulas. Furthermore, it was shown to hold even if the circuit class is not fully multilinear but computes a polynomial that is multilinear in the summation variables.

The work in [**M2**] continued the study of the *shifted partial derivative measure*, introduced by Kayal (ECCC 2012), which has been used to prove many strong depth-4 circuit lower bounds starting from the work of Kayal, and that of Gupta et al. (CCC 2013).

A strong lower bound was shown on the dimension of the shifted partial derivative space of the Elementary Symmetric Polynomials of degree d in N variables for $d < \lg N / \lg\lg N$. This extended the work of Nisan and Wigderson (Computational Complexity 1997), who studied the *partial derivative space* of these polynomials. Prior to this work, there had been no results on the shifted partial derivative measure of these polynomials.

The shown result implies a strong lower bound for Elementary Symmetric Polynomials in the homogeneous $\Sigma\Pi\Sigma\Pi$ model with bounded bottom fan-in. This strengthens (under certain degree assumptions) a lower bound of Nisan and Wigderson who proved the analogous result for homogeneous $\Sigma\Pi\Sigma$ model (i.e. $\Sigma\Pi\Sigma\Pi$ formulas with bottom fan-in 1).

The main technical lemma in [**M2**] gave a lower bound for the ranks of certain inclusion-like matrices.

Polynomial Identity Testing (PIT) algorithms have focussed on polynomials computed either by small alternation-depth arithmetic circuits, or by read-restricted formulas. Read-once polynomials (ROPs) are computed by read-once formulas (ROFs) and are the simplest of read-restricted polynomials. Building structures above these, in [**M8**], the following results were shown:

1. A deterministic polynomial-time non-black-box PIT algorithm for $\sum^{(2)} \cdot \prod \cdot \mathsf{ROF}$.
2. Weak hardness of representation theorems for sums of powers of constant-free ROPs and for $\mathsf{0\text{-}justified}$ alternation-depth-3 ROPs.
3. A partial characterization of multilinear monotone constant-free ROPs.

SubsetSum is a well known NP-complete problem: given $t \in Z^+$ and a set S of m positive integers, output YES if and only if there is a subset $S' \subseteq S$ such that the sum of all numbers in S' equals t. The problem and its search and optimization versions are known to be solvable in pseudo-polynomial time in general.

In [**M7**], a 1-pass deterministic streaming algorithm was developed, that uses space $O\left(\frac{\log t}{\epsilon}\right)$ and decides if some subset of the input stream adds up to a value in the range $\{(1 \pm \epsilon)t\}$. Using this algorithm, space efficient Fully Polynomial-Time Approximation Schemes (FPTAS) solving the search and optimization versions of SubsetSum were designed. These algorithms run in $O(\frac{1}{\epsilon}m^2)$ time and $O(\frac{1}{\epsilon})$ space on unit cost RAMs, where $1 + \epsilon$ is the approximation factor. This implies constant space quadratic time FPTAS on unit cost RAMs when ϵ is a constant. Previous FPTAS used space linear in m.

In addition, it was shown that on certain inputs, when a solution is located within a short prefix of the input sequence, the algorithms may run in sublinear time. The techniques were applied to the problem of finding balanced separators, and the results were extended to some other variants of the more general knapsack problem.

When the input numbers are encoded in unary, the decision version has been known to be in log space. In [**M7**], streaming space lower and upper bounds for unary SubsetSum were given. If the input length is N when the numbers are encoded in unary, it was shown that randomized s-pass streaming algorithms for exact SubsetSum need space $\Omega(\frac{\sqrt{N}}{s})$, and a simple deterministic two pass streaming algorithm using $O(\sqrt{N} \log N)$ space was given.

Finally, an encoding was formulated under which unary SubsetSum is monotone, and it was shown that the exact and approximate versions in this formulation have monotone $O(\log^2 t)$ depth Boolean circuits. It was also shown that any circuit using ε-approximator gates for Subset Sum under this encoding needs $\Omega(n/\log n)$ gates to compute the Disjointness function.

The VP versus VNP question, introduced by Valiant, is probably the most important open question in algebraic complexity theory. Thanks to completeness results, a variant of this question, VBP versus VNP, can be succinctly restated as asking whether the permanent of a generic matrix can be written as a determinant of a matrix of polynomially bounded size. Strikingly, this restatement does not mention any notion of computational model. To get a similar restatement for the original and more fundamental question, and also to better understand the class itself, a complete polynomial for VP is needed. Ad hoc constructions yielding complete polynomials were known, but not natural examples in the vein of the determinant. In [**M6**], several variants of natural complete polynomials for VP are given, based on the notion of graph homomorphism polynomials.

Color refinement is a classical technique used to show that two given graphs G and H are non-isomorphic; it is efficient, although it does not succeed on all graphs. We call a graph G amenable if the color-refinement procedure succeeds in distinguishing G from any non-isomorphic graph H. Tinhofer (1991) explored a linear programming approach to Graph Isomorphism and defined compact graphs: A graph is compact if its fractional automorphisms polytope is integral. He noted that isomorphism testing for compact graphs can be done efficiently by linear programming. However, the problem of recognizing compact graphs efficiently remains open. Our results are summarized below: We determine the exact range of applicability of color refinement by showing that amenable graphs are recognizable in time O((n + m)logn), where n and m denote the number of vertices and the number of edges. We show that all amenable graphs are compact. Exploring the relationship between color refinement and compactness further, we study related combinatorial and algebraic graph properties introduced by Tinhofer and Godsil. We show that the corresponding classes of graphs form a hierarchy and we prove that recognizing each of these graph classes is P-hard. In particular, this gives a first complexity bound for recognizing compact graphs. These results are reported in the conference papers [**A2**, **A3**].

In the conference paper [**A1**] we study the complexity of factorization of polynomials in the free noncommutative ring of polynomials over the field F and noncommuting variables $x_1, x_2, \ldots, x_n$. Although this is not a unique factorization ring, we note that variable-disjoint factorization has the uniqueness property. Furthermore, we prove that computing the variable-disjoint factorization is polynomial-time equivalent to Polynomial Identity Testing (both when the input polynomial is given by an arithmetic circuit or an algebraic branching program). We also show that variable-disjoint factorization in the black-box setting can be efficiently computed, where the factors computed will be also be output as black-boxes, analogous to the work of Kaltofen and Trager (1991) in the commutative setting. As a consequence of the previous result we show that homogeneous noncommutative polynomials and multilinear noncommutative polynomials have unique factorizations in the usual sense, which can be efficiently computed. Finally, we discuss a polynomial decomposition problem in the free noncommutative ring which is a natural generalization of homogeneous polynomial factorization and prove some complexity bounds for it.

In [**Sh2**] we consider the local root clustering problem, to compute the natural -clusters of roots of $F(z)$ in some box region B_0 in the complex plane; it may be viewed as a kind of generalization of the classical root isolation problem. We describe an exact subdivision algorithm for this problem, extending the fundamental techniques in [**Sh4**]. We provide a bit-complexity analysis of our algorithm based on the intrinsic geometry of the roots. This result is the first complexity bound for local root clustering problem.

In [**Sh4**], we describe a subdivision algorithm for isolating the complex roots of a polynomial F in $\mathbb{C}[x]$. Our model assumes that each coefficient of F has an oracle to return an approximation to any absolute error bound. Given any box B in the complex plane containing only simple roots of F, our algorithm returns disjoint isolating disks for the roots in B. Our complexity analysis bounds the absolute error to which the coefficients of F have to be provided, the total number of iterations, and the overall bit complexity. This analysis shows that the complexity of our algorithm is controlled by the geometry of the roots in a near neighbor- hood of the input box B, namely, the number of roots and their pairwise distances. The number of subdivision steps is near-optimal. For the benchmark problem, namely, to isolate all the roots of an integer polynomial of degree n with coefficients of bitsize less than τ, our algorithm needs $O(n^3 + n^2\tau)$ bit operations, which is comparable to the record bound of Pan (2002). It is the first time that such a bound has been achieved using subdivision methods, and independent of divide-and-conquer techniques such as Schönhage's splitting circle technique. Our algorithm uses the quadtree construction of Weyl (1924) with two key ingredients: using Pellet's Theorem (1881) combined with Graeffe iteration, we derive a soft test to count the number of roots in a disk. Using Newton iteration combined with bisection, in a form inspired by the quadratic interval method from Abbot (2006), we achieve quadratic convergence towards root clusters. Relative to the divide-conquer algorithms, our algorithm is simple with the potential of being practical. This paper is self-contained: we provide pseudo-code for all subroutines used by our algorithm.

Graph Theory and Combinatorics

In an essentially expository work [**S**], it is observed that 3-colorability of an arbitrary graph can be tested in $O((1.0905)^n)$ (or $O((1.245)^n)$) time provided the minimum degree is at least 50 (or 15). Also, presented in [**S**] is a generalization of an early and classical result of Erdös on tournaments. A tournament $T = (V, A)$ satisfies property $T_{d,s}$ if for every set I of at most $i \leq d$ vertices and for every i-tuple of in/out directions, there are at least s other vertices each obeying the specified i-tuple for directions with respect to I. It is shown that for every d, s, there exists a $N = N(d, s)$ such that for every $n \geq N$, there is a tournament on n vertices satisfying $T_{d,s}$. Also, a new upper bound on the oriented chromatic number of an arbitrary graph is established in [**S**] (using only structural arguments) and this bound is expressed in terms of its maximum degree and its distance-2 chromatic number. Also, presented in [**S**] are explicitly described and sharp thresholds for some monotone graph properties of random graphs and digraphs. Previously such thresholds were only known in an implicit form.

Work is in progress 'on b-coloring and Harmonious coloring of graphs'. It is noted that finding the harmonious coloring or b-coloring of a graph is NP-complete.

Also, working on 'graceful labeling and antimagic labeling of trees'. It was conjectured that "All trees are graceful" by Rosa, Ringel and Kotzig in the year 1967. Further, in 1990, Ringel and Hartsfield conjectured that Every tree other than K_2 is antimagic.

2.4.2 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.

[**A1**]
P. Joglekar* **V. Arvind and G. Rattan**.
On the complexity of noncommutative polynomial factorization.
In G. Pighizzini G. Italiano and D Sannella, editors, *Mathematical Foundations of Computer Science – 40th Inl Symposium, LNCS 9235*, page 38. Springer, Aug 2015.

[**A2**]
V. Arvind, J Koebler*, G. Rattan, and O. Verbitsky*.
On the power of color refinement.
In Kosowski and Walukiewicz, editors, *Fundamentals of Computation Theory – 20th Intl Symposium*, page 339. Springer, Aug 2015.
(Submitted).

[**A3**]
V. Arvind, J Koebler*, G. Rattan, and O. Verbitsky*.
On tinhoferś linear programming approach to isomorphism testing.
In G. Italiano G. Pighizzini and D. Sannella, editors, *Mathematical Foundations of Computer Science – 40th Intl Symposium, LNCS 9235*, page 26. Springer, Aug 2015.

[**A4**]
V. Arvind, J. Koebler*, S. Kuhnert*, G. Rattan, and Y. Vasudev*.
On the isomorphism problem for decision trees and decision lists.
Theoretical Computer Science, **590**, 38, 2015.

[**As1**]
Pradeesha Ashok, Aditi Dudeja, and Sudeshna Kolay.
Exact and fpt algorithms for max-conflict free coloring in hypergraphs.
In *ISAAC 2015*, Dec 2015.

[**As2**]
Pradeesha Ashok, Sudeshna Kolay, Neeldhara Misra*, and Saket Saurabh.
Unique covering problems with geometric sets.
In *COCOON 2015*, Aug 2015.

[**B**]
Niranka Banerjee, Sankardeep Chakraborty, Venkatesh Raman, Sasanka Roy*, and Saket Saurabh.
Time-space tradeoffs for dynamic programming in trees and bounded treewidth graphs.
In Dachuan Xu, Donglei Du, and Ding-Zhu Du, editors, *Computing and Combinatorics - 21st International Conference, COCOON 2015*, pages 349–360. Springer-Verlag Lecture Note in Computer Science series (LNCS), Volume 9198, Aug 2015.

[**K1**]
Sudeshna Kolay, Daniel Lokshtanov*, Fahad Panolan, and Saket Saurabh.
Quick but odd growth of cacti.
In *IPEC 2015*, Sep 2015.

[**K2**]
Sudeshna Kolay and Fahad Panolan.
Parameterized algorithms for deletion to (r,l)-graphs.
In *FSTTCS 2015*, Dec 2015.

[**L1**]
Andreas Krebs*, **Kamal Lodaya, Paritosh Pandya***, **and Howard Straubing***.
Two-variable logic with a between predicate.
In *31st ACM/IEEE Symp. Logic in Computer Science, New York City, USA*, 2016.
(To be published).

[**L2**]
Ramchandra Phawade* **and Kamal Lodaya**.
Kleene theorems for synchronous products with matching.
Trans. Petri nets and other models of concurrency, **X**, 84–208, 2015.

[**M1**]
Olaf Beyersdorff*, **Leroy Chew***, **Meena Mahajan, and Anil Shukla**.
Feasible interpolation for QBF resolution calculi.
In *Proceedings of 42nd International Colloquium on Automata, Languages, and Programming ICALP, LNCS Vol. 9134*, pages 180–192. Springer, Jul 2015.

[**M2**]
Herve Fournier*, **Nutan Limaye***, **Meena Mahajan, and Srikanth Srinivasan***.
The shifted partial derivative complexity of elementary symmetric polynomials.
In *40th MFCS - International Symposium on Mathematical Foundations of Computer Science. LNCS Vol. 9235*, pages 324–335. Springer, Aug 2015.

[**M3**]
Olaf Beyersdorff*, **Leroy Chew***, **Meena Mahajan, and Anil Shukla**.
Are short proofs narrow? QBF resolution is *not* simple.
In *33rd International Symposium on Theoretical Aspects of Computer Science (STACS 2016)*, pages 15:1–15:14. LIPIcs, Feb 2016.

[**M4**]
Meena Mahajan and Anuj Tawari.
Sums of read-once formulas: How many summands suffice?
In *Proceedings: 11th International Computer Science Symposium in Russia (CSR 2016)*. Springer (LNCS), 2016.
ECCC TechRep 2015-204 (To be published).

[**M5**]
Meena Mahajan and Nitin Saurabh.
Some complete and intermediate polynomials in algebraic complexity theory.
In *11th International Computer Science Symposium in Russia (CSR 2016)*. Springer, 2016.
LNCS 9691 (To be published).

[M6]
Arnaud Durand*, Guillaume Malod*, Meena Mahajan, Nicolas de Rugy-Altherre*, and Nitin Saurabh.
Homomorphism polynomials complete for VP.
Chicago Journal of Theoretical Computer Science, 2016(3), 2016.

[M7]
Anna Gál*, Jing-Tang Jang*, Nutan Limaye*, Meena Mahajan, and Karteek Sreenivasaiah*.
Space-efficient approximations for subset sum.
ACM Transactions on Computation Theory, 2016.
(To be published).

[M8]
Meena Mahajan, Raghavendra B. Rao*, and Karteek Sreenivasaiah*.
Building above read-once polynomials: identity testing and hardness of representation.
Algorithmica, special issue for *COCOON 2014*, 2015.
(To be published).

[M9]
Meena Mahajan, Nitin Saurabh, and Sebastien Tavenas*.
VNP = VP in the multilinear world.
Information Processing Letters, **116(2)**, 179–182, 2016.

[M10]
Meena Mahajan and Anil Shukla.
Level-ordered Q-resolution and tree-like Q-resolution are incomparable.
Information Processing Letters, **116(3)**, 256–258, 2016.

[Ma]
Diptapriyo Majumdar, Venkatesh Raman, and Saket Saurabh.
Kernels for structural parameterizations of vertex cover - case of small degree modulators.
In Thore Husfeldt and Iyad Kanj, editors, *10th International Symposium on Parameterized and Exact Computation (IPEC 2015)*, page 331. Leibniz International Proceedings in Informatics, Sep 2015.

[Me1]
Syed M. Meesum, Saket Saurabh, and Pranabendu Misra.
Reducing rank of the adjacency matrix by graph modification.
In Dachuan Xu, Donglei Du, and Dingzhu Du, editors, *Computing and Combinatorics: 21st International Conference, COCOON 2015*, page 361. Springer International Publishing, Jun 2015.

[Me2]
Syed M. Meesum and Saket Saurabh.
Rank reduction of directed graphs by vertex and edge deletions.

In Edgar Chvez Evangelist Kanakis, Gonzalo Navarro, editor, *LATIN 2016: Theoretical Informatics*, page 619. Springer Berlin Heidelberg, Mar 2016.

[**Me3**]
Syed M. Meesum, Pranabendu Misra, and Saket Saurabh.
Reducing rank of the adjacency matrix by graph modification.
Theoretical Computer Science, (0304-3975), 2016.
(To be published).

[**Mi1**]
Daniel Lokshtanov*, **Pranabendu Misra, Fahad Panolan, and Saket Saurabh**.
Deterministic truncation of linear matroids.
In *ICALP 2015*, Jul 2015.

[**Mi2**]
Prachi Goyal*, **Pranabendu Misra, Fahad Panolan, Geevarghese Philip***, **and Saket Saurabh**.
Finding even subgraphs even faster.
In *FSTTCS 2015*, Dec 2015.

[**Mu**]
Abhiruk Lahiri*, **Joydeep Mukherjee, and C.R. Subramanian**.
Maximum independent set in b1-vpg graphs.
In Z.Lu (et. al.), editor, *The 9th Annual International Conference on Combinatorial Optimization and its Applications, December 18-20, Houston, Texas, USA.*, pages 633–646. Springer, Dec 2015.

[**R1**]
Geevarghese Philip*, **Ashutosh Rai, and Saket Saurabh**.
Generalized pseudoforest deletion: Algorithms and uniform kernel.
In Giovanni Pighizzini Giuseppe F. Italiano and Donald Sannella, editors, *Mathematical Foundations of Computer Science 2015 - 40th International Symposium, MFCS 2015, Milan, Italy, August 24-28, 2015, Proceedings, Part II*, page 517. Springer, Aug 2015.

[**R2**]
Ashutosh Rai and Saket Saurabh.
Bivariate complexity analysis of almost forest deletion.
In Donglei Du Dachuan Xu and Ding-Zhu Du, editors, *Computing and Combinatorics - 21st International Conference, COCOON 2015, Beijing, China, August 4-6, 2015, Proceedings*, page 133. Springer, Aug 2015.

[**Ra1**]
R. Ramanujam and Ramanathan S. Thinniyam.
Definability in first order theories of graph orderings.
In Sergei Artemov, editor, *Logical Foundations of Computer Science*, page 331. Springer, Jan 2016.

[**Ra2**]
R. Ramanujam, Vaishnavi Sundararajan*, **and S. P. Suresh***.
The complexity of disjunction in intuitionistic logic.
In Sergei Artemov, editor, *Logical Foundations of Computer Science*, page 349. Springer, Jan 2016.

[**Ra3**]
Soumya Paul*, **R. Ramanujam, and Sunil Simon***.
Automata and compositional strategies in extensive form games.
In Sujata Ghosh Johan van Benthem and Rineke Verbrugge, editors, *Models of Strategic Reasoning*, page 174. Springer, 2015.

[**Ra4**]
R. Ramanujam.
Knowledge and local action.
In Fenrong Liu and Hiraokira Ono, editors, *Modality, Semantics and Interpretations*, page 87. Springer, 2015.

[**Ram1**]
Amer E. Mouawad*, **Naomi Nishimura***, **Vinayak Pathak***, **and Venkatesh Raman**.
Shortest reconfiguration paths in the solution space of boolean formulas.
In Naoki Kobayashi Bettina Speckmann Magnus Halldorson, Kazuo Iwama, editor, *International Conference on Automata, Languages and Programming (ICALP)*, page 985. Springer-Verlag, Jun 2015.

[**Ram2**]
Varunkumar Jayapaul*, **Ian J. Munro***, **Venkatesh Raman, and Srinivasa R. Satti***.
Sorting and selection with equality comparisons.
In Ulrike Stege Frank Dehne, Jorg-Rudiger Sack, editor, *14th International Symposium, WADS*, page 434. Springer-Verlag, Jul 2015.

[**Ram3**]
Varunkumar Jayapaul*, **Venkatesh Raman, and Srinivasa R. Satti***.
Finding mode using equality comparisons.
In *The Tenth International Workshop on Algorithms and Computation (WALCOM)*, page 351. Springer-Verlag, Mar 2016.

[**Ram4**]
Timothy Chan*, **J. I. Munro***, **and Venkatesh Raman**.
Finding median in read-only memory on integer input.
Theoretical Computer Science, **583**, 51, 2015.

[**Ram5**]
Varunkumar Jayapaul*, **Seungbum Jo***, **Rajeev Raman***, **Venkatesh Raman, and Srinivasa R. Satti**.

Space efficient data structures for nearest larger neighbor.
Journal of Discrete Algorithms, **36**, 63, 2016.

[**S**]
Sourav Chakraborty*, **Raghav Kulkarni***, **Satyanarayana Lokam***, **and Nitin Saurabh**.
Upper bounds on fourier entropy.
In Donglei Du Dachuan Xu and Ding-Zhu Du, editors, *Computing and Combinatorics - 21st International Conference (COCOON)*, pages 771–782. Springer, Aug 2015.

[**Sh1**]
Prashant Batra* and Vikram Sharma.
Near optimal subdivision algorithms for real root isolation.
In *International Symposium on Symbolic and Algebraic Computation (ISSAC)*, Jul 2015.

[**Sh2**]
Ruben Becker*, **Michael Sagraloff***, **Vikram Sharma, Juan Xu***, **and Chee Yap***.
Complexity analysis of root clustering for a complex polynomial.
In *International Symposium on Symbolic and Algebraic Computation*, Jan 2016.
(Submitted).

[**Sh3**]
Prashant Batra* and Vikram Sharma.
Near optimal subdivision algorithms for real root isolation.
Journal of Symbolic Computation, 2015.
(Submitted).

[**Sh4**]
Becker*, **Sagraloff***, **Vikram Sharma, and Yap***.
A simple near-optimal subdivision algorithm for complex root isolation based on the pellet test and newton iteration.
Journal of Symbolic Computation, 2015.
(Submitted).

Books/Monographs Authored/Edited

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

[**S**]
C.R. Subramanian.
Invited Chapter (No. 33, pages 945-996) on "Probabilistic Arguments in Combinatorics" in the Handbook of Graph Theory, Combinatorial Optimization and Algorithms,.
CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA., 2015.

2.5 Student Programmes

2.5.1 Degrees Awarded

Doctoral Degrees Awarded during 2015 – 2016

Mathematics

Name: **Dolai, Dhriti Ranjan**
Thesis Title: Spectral statistics for Anderson Model with decaying randomness and singular potentials.
Thesis Advisor: Krishna, M.
University: HBNI

Name: **Dan, Krishanu**
Thesis Title: Null correlation bundle and secant bundles
Thesis Advisor: Nagaraj, D. S.
University: HBNI

Physics

Name: **Kundu, Joyjit**
Thesis Title: Phase transitions in systems of hard anisotropic particles on lattices
Thesis Advisor: Rajesh, R.
University: HBNI

Theoretical Computer Science

Name: **Panolan, Fahad**
Thesis Title: Dynamic Programming using Representative Families
Thesis Advisor: Saurabh, Saket
University: HBNI

Name: **Phawade, Ramchandra**
Thesis Title: Labelled free choice petri nets, finite product Automata, and Expressions
Thesis Advisor: Lodaya Kamal
University: HBNI

Doctoral Theses Submitted during 2015 – 2016

Mathematics

Name: **Mallick, Anish**

Thesis Title: Spectral multiplicity for Random Operators with projection valued randomness
Thesis Advisor: Krishna, M.
University: HBNI

Physics

Name: **Kajuri, Nirmalya**
Thesis Title: Aspects of polymer quanrtization
Thesis Advisor: Date, G.
University: HBNI

Name: **Singal, Tanmay**
Thesis Title: Some Problems in Quantum State Discrimination
Thesis Advisor: Ghosh, Sibasish
University: HBNI

Masters Degrees Awarded during 2015 – 2016

Physics

Name: **Krishnan, Madhav V.**
Thesis Title: Understanding Quantum Mechanics via Different Notions of Non-Classicality
Thesis Advisor: Ghosh, Sibasish
University: HBNI

Theoretical Computer Science

Name: **Padmanabha, Anantha**
Thesis Title: Modal logics for unboundedly many agents
Thesis Advisor: Ramanujam, R.
University: HBNI

Name: **Tale, Prafullkumar**
Thesis Title: Parameterized Algorithms using decompositions
Thesis Advisor: Saurabh, Saket
University: HBNI

Computational Biology

Name: **Sreejith, RP**
Thesis Title: Reconstruction of genome-scale metabolic networks of fungi
Thesis Advisor: Samal, Areejit
University: University of Kerala

Masters Theses Submitted during 2015 – 2016

Theoretical Computer Science

Name: **Dudeja, Aditi**
Thesis Title: Algorithmic and Combinatorial survey on Art Gallery Problems
Thesis Advisor: Saurabh, Saket
University: BITS Pilani, Goa

Name: **Sharma, Roohani**
Thesis Title: Tree Decompositions: Lean and Canonical
Thesis Advisor: Saurabh, Saket
University: CMI

2.5.2 Lecture Courses During 2015 – 2016.

The following **lecture courses** were offered during 2015 – 2016.

Course Title	Period	Lecturer
Mathematics		
Topology I	Jan-Apr 2015	Gun, S.
Algebra II	Jan-Apr 2015	Kodiyalam, Vijay
Analytic number theory-II	Jan-Apr 2015	Mukhopadhyay, Anirban
Topology II	Jan-Apr 2015	Nagaraj, D. S.
Algebra-1	Aug-Nov 2015	Mukhopadhyay, Anirban
Complex analysis	Aug-Dec 2015	Sankaran, Parameswaran
Lie groups	Aug-Oct 2015	Sankaran, Parameswaran
Measure Theory	Aug-Dec 2015	Prasad, Amritanshu
Sieve Methods	Aug-Nov 2015	Gun, S.
Topology I	Aug-Nov 2015	Raghavan, K. N.
Algebra II	Jan-Apr 2016	Viswanath, Sankaran
Functional Analysis	Jan-Apr 2016	Sunder, V. S.
Topology-II	Jan-Mar 2016	Sankaran, Parameswaran
Physics		
Advanced Particle Physics (in part-along with others)	Jan-Apr 2015	Murthy, M.V.N.
Classical Theory of Fields	Jan-Apr 2015	Ashok, Sujay K.

Computational Neuroscience	Jan-Apr 2015	Sinha, Sitabhra
Gravitation and Cosmology	Jan-Apr 2015	Sathiapalan, Balachandran
Nonlinear Dynamics	Jan-Apr 2015	Sinha, Sitabhra
Quantum Information Theory (reading course)	Jan-May 2015	Ghosh, Sibasish
Quantum Mechanics II	Jan-Apr 2015	Mukhopadhyay, Partha
Systems Biology	Jan-Apr 2015	Sinha, Sitabhra
Classical Mechanics	Aug-Dec 2015	Ghosh, Sibasish
Mathematical Methods in Physics II	Aug-Dec 2015	Ashok, Sujay K.
Quantum Mechanics 1 (core course)	Aug-Dec 2015	Chandrashekar, C. M.
Systems Biology	Aug-Dec 2015	Sinha, Sitabhra
Advanced Particle Physics (in part-along with others)	Jan-Apr 2016	Murthy, M.V.N.
Classical Field Theory	Jan-Apr 2016	Date, G.
Quantum Information and Quantum Computation (elective)	Jan-Apr 2016	Chandrashekar, C. M.
Statistical Field Theory	Jan-Apr 2016	Sathiapalan, Balachandran
Statistical Mechanics I	Feb-May 2016	Chaudhuri, Pinaki P.

Theoretical Computer Science

Computational Complexity	Aug-Nov 2015	Arvind, V.
Dynamic Graph Algorithms	Jan-Apr 2015	Bhattacharya, Sayan S.
Infinite discrete structures	Jan-Apr 2015	Ramanujam, R.
Parameterized Complexity	Jan-Apr 2015	Saurabh, Saket
Algorithm Design and Analysis	Aug-Dec 2015	Raman, Venkatesh
Linear Programming and Combinatorial Optimization	Aug-Dec 2015	Sharma, Vikram
Mathematical Logic	Aug-Dec 2015	Ramanujam, R.
Randomness and Computation	Aug-Dec 2015	Subramanian, C. R.
Theory of computation	Aug-Dec 2015	Lodaya, Kamal
Computational Complexity	Jan-May 2016	Mahajan, Meena
Graph Classes: Classical and Parameterized	Jan-May 2016	Saurabh, Saket
Infinite Discrete Structures	Jan-Apr 2016	Ramanujam, R.
Mathematical Foundation of Computer Science	Jan-May 2016	Saurabh, Saket
Parameterized Complexity	Jan-May 2016	Saurabh, Saket

Computational Biology

Biology-2	Jan-Apr 2015	Samal, Areejit
Infectious Diseases	Jan-Apr 2015	Menon, Gautam I.
Biology-1	Aug-Nov 2015	Samal, Areejit
Physical Biology	Aug-Nov 2015	Menon, Gautam I.
Advanced Condensed Matter	Jan-May 2016	Menon, Gautam I.
Biology-2	Jan-Apr 2016	Samal, Areejit
Modeling Infectious Diseases	Jan-May 2016	Menon, Gautam I.

In addition, the following **lecture courses** were offered during 2015 – 2016 by IMSC faculty in the National Undergraduate programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer
Physics		
Quantum Mechanics II	Jan-Apr 2015	Rajasekaran, G.
Quantum Mechanics I	Aug-Nov 2015	Rajasekaran, G.
Quantum Mechanics II	Jan-Apr 2016	Rajasekaran, G.

2.5.3 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 Apr, 2015 - Mar, 2016.

Student	Faculty
Mathematics	
Murali, Adithya, BITS Pilani, Hyderabad Campus	Raghavan, K. N.
Physics	
Anishya, T. H., IISER-Mohali	Bagchi, Manjari
Jena, Debashish, NISER-Bhubaneswar	Bagchi, Manjari
Sahoo, Ananya , NISER Bhubaneswar	Bagchi, Manjari
Ghosh, Anindhya, IIT-Madras	Bagchi, Manjari
Shevate, Sayali, IISER - Pune	Chandrashekar, C. M.
Talukdar, Jugal , IISER - Pune	Chandrashekar, C. M.
B, Anjana M., IIT - Madras	Chandrashekar, C. M.
Raman, Krithika, Stella Maris College, Chennai	Chandrashekar, C. M.
Jayaram, Ashreya, Stella Maris College, Chennai	Chaudhuri, Pinaki P.
Rao, Aravind, IISc., Bangalore	Chaudhuri, Pinaki P.
Biswas, Tanmoy, IISER-Kolkata	Ghosh, Sibasish
Menon, Shankar G., IISER-Kolkata	Ghosh, Sibasish
Sen, Indrajit, IIT-Madras	Ghosh, Sibasish
Dhevi, Kaarunya, Centre for Excellence in Basic Sciences, Dept. of Atomic Energy, Mumbai	Ghosh, Sibasish

Mandal, Suman, IISER-Kolkata	Ghosh, Sibasish
Sampathkumar, Pranav, Sastra University, Thanjavur	Ray, Purusattam
Dhar, Aishwarya, University of Pune	Sinha, Sitabhra
Kushal, Appilineni, IISc., Bangalore	Sinha, Sitabhra
Gianchandani, Kaushal, NISER Bhubaneswar	Sinha, Sitabhra

Theoretical Computer Science

Palanikumar, Vani, PSG Tech, Coimbatore	Ramanujam, R.
Lohani, Devashish, BITS Bhimtal	Saurabh, Saket

Computational Biology

Allaparthi, Ravikumar, IIT Chennai	Samal, Areejit
Bharath, S., IIT Chennai	Samal, Areejit
Praveen, Arul B., IIT Chennai	Samal, Areejit
Lakshmi, K., Anna University	Samal, Areejit
Harish, K., NIT Trichy	Samal, Areejit

2.5.4 Other Students

Students also do their projects under the supervision of our faculty during the academic year.The following students visited the institute during Apr, 2015 - Mar, 2016.

Student	Faculty

Physics

Vaithiyanathan, Renuka, DG Vaishnav College, Chennai	Bagchi, Manjari
Kumar, Pradeep , Poornaprajna Institute of Scientific Research, Bangalore	Chandrashekar, C. M.
Kumar, Shreya P., Perimeter Institute for Theoretical Physics, Canada	Chandrashekar, C. M.
Ahmed, Shahnawaz, BITS Pilani, Goa Campus	Sinha, Sitabhra

Theoretical Computer Science

Rao, Anish, PSG Tech, Coimbatore	Ramanujam, R.
Gajapathy, Harish, PSG Tech, Coimbatore	Raman, Venkatesh

2.6 Honours and Awards

Gopalakrishna, Shrihari was elected as a Kavli Fellow, National Academy of Sciences (NAS) and The Kavli Foundation, USA, 2015.

Nagaraj, D. S. was awarded Fellow, for 2015, by The National Academy of Sciences, India.

Prasad, Amritanshu was awarded Swarnajayanti Fellowship, for 2016, by the Department of Science and Technology, Government of India.

Sunder, V. S. was awarded Distinguished Faculty Award of HBNI on its completion of 10 years of existence., for 2015, by the Homi Bhabha National Institute.

Chapter 3

Other Professional Activities

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

Bagchi, Manjari

Participated in skype chat with an astronomer session on the occasion of the Girls Day organized by the Netherlands Institute for Radio Astronomy (ASTRON) on 23 April 2015. This is an annual public outreach activity organised by ASTRON.

Lectures for school students at Chennai Mathematical Institute, Chennai on Jul 20, 2015. "Twinkle twinkle little stars; Yes, I know what you are!" An invited lecture for the high school students.

Lectures at Radio Astronomy Centre TIFR, Ooty on Oct 22, 2015. Lectures to participants (B.Sc/B.Tech/M.Sc. students from various universities/institutes in India) of the "Fourth Workshop for Pulsar Observatory for Students".

Lectures at NCRA-TIFR, Pune, India on Jan 6, 2016. "Pedagogical School on Neutron Stars", National Centre for Radio Astrophysics (NCRA) - TIFR, Pune; 6-13 January 2016. Lectures to participants (B.Sc/B.Tech/M.Sc/Ph.D. students and post-docs from various universities/institutes in India) on radio pulsars.

Lecture at IMSc, Chennai on Feb 17, 2016. A lecture on gravitation and astrophysics to school students from Puducherry.

Balasubramanian, R.

Member of National Board for higher mathematics

Convener of Local Organising Committee for Indo french programme for mathematics held at IMSc during Jan 11 – Jan 24, 2016.

Chandrashekar, C. M.

Popularization article at BASE-news-letter-August-2015, Jawaharlal Neharu Planetarium, Bangalore on Nov 15, 2015. Science popularization article on “Quantum Bit”

Chaudhuri, Pinaki P.

Convener of National Organising Committee for Soft Matter Young Investigators Meet III held at Hotel Atithi, Pondicherry on Dec 17, 2015.

Convener of Local Organising Committee for Friction and Fracture: Bridging the Scales held at IMSc during Feb 1 – Feb 4, 2016.

Date, G.

President of Indian Association for General Relativity and Gravitation

Ghosh, Sibasish

Member of National Organising Committee for Summer School on Quantum Correlation: Foundation, Information Processing and Various Applications held at Indian Statistical Institute, Kolkata during Jun 22 – Jul 3, 2015.

“Theoretical Aspects of Dark Matter and Dark Energy.” Tamilnadu Science and Technology Centre, Chennai, Oct 2015.

“Current Status of Extra Dimension (inspired) Models.” Workshop on High Energy Physics Phenomenology XIV, IIT-Kanpur, Dec 2015.

“Dark Matter: Evidence, Theory and Detection Prospects.” Current Issues in Cosmology, Astrophysics and High Energy Physics, Dibrugarh University, Nov 2015.

“Phenomenology of vector-like fermions and new scalars.” HEP seminar, California Institute of Technology, USA, Aug 2015.

“Particle Physics at the Energy and Intensity Frontiers.” Sixth Indo-American Frontiers of Science Symposium, Irvine, CA, Aug 2015

Gun, S.

Reviewer of Mathematical Reviews during Jul 2008 – Mar 2016.

Reviewer of Zentralblatt Reviews during Apr 2011 – Mar 2016.

Managing Editor of IMSc monograph series

Convener of International Organising Committee for A conference in number theory held at IMSc during Dec 14 – Dec 18, 2015.

Member of International Organising Committee for Indo-French Conference held at IMSc during Jan 11 – Jan 24, 2016.

External Member of JRF selection committee during Feb 2016.

Examiner of Thesis Defense committee during Mar 2016.

Lodaya, Kamal

Speaker at CMI on Jul 20, 2015. Gave a talk on "Programs, processes, phones".

Mahajan, Meena

Member of Programme Committee of Twenty-Sixth International Symposium on Algorithms and Computation (ISAAC) during Jun – Dec, 2015.

Member of Programme Committee of 35th Foundations of Software Technology and Theoretical Computer Science Conference (FSTTCS) during Jul – Dec, 2015.

Member of Programme Committee of 2nd Conference on Algorithms and Discrete Mathematics (CALDAM), 18-20 Feb 2016, Kerala during Sep 2015 – Feb 2016.

Menon, Gautam I.

Member of DBT Star College Scheme Committee, Department of Biotechnology, New Delhi during Mar 2015 – Mar 2016.

Editorial Board Member of IISc Popular Science Series during Mar 2015 – Mar 2016.

Editorial Board Member of Texts and Readings in the Physics Sciences (TRiPS) during Mar 2015 – Mar 2016.

Member of Academic Committee, Raman Research Institute, Bengaluru during Mar 2015 – Mar 2016.

Editorial Board Member of Scientific Reports (Nature) during Mar 2015 – Mar 2016.

Member of Grant Review Committee, Human Frontier Science Program, Strasbourg during Mar 2015 – Mar 2016.

Convener of Local Organising Committee for Third Workshop and Conference on Modeling Infectious Diseases held at IMSc during Nov 23 – Dec 3, 2015.

Panelist on SYNTALK Episode 49 at Mumbai on Jan 14, 2016. Panelist on SYNTALK Episode 49 - The Modalities of Traffic, an interdisciplinary talk show, typically running for an hour and with 2 or 3 participants.

Convener of Local Organising Committee for Science at the Sabha held at Music Academy, Chennai on Feb 14, 2016.

Convener of Local Organising Committee for School and Conference on Quantum Disordered Systems held at IMSc during Feb 24 – Mar 3, 2016.

Convener of Local Organising Committee for Open Source Library Software (Koha) and RFID Integration for DAE Libraries held at IMSc during Mar 17 – Mar 18, 2016.

Nagaraj, D. S.

Convener of International Organising Committee for 50 year of Narasimhan-Seshadri Theorem held at C.M.I., Chennai during Oct 5 – Oct 16, 2015.

Convener of International Organising Committee for 3rd Indo-French conference in Mathematics held at IMSc during Jan 11 – Jan 24, 2016.

Prabhakar, Varuni

Understanding mathematics through crafts for schools at Craft Education and Research Center (CERC), Kalakshetra Foundation [every 2 weeks, 07/2015-03/2016] on Jan 1, 2016. In collaboration with CERC and Sunita Vatuk (City University of New York), developing a course for students of the Besant Arundale Senior Secondary School to explore abstract Mathematical Concepts through block printing and weaving.

Prasad, Amritanshu

Member of Board of Studies, Mathematics, Homi Bhabha National Institute.

Member of Board of studies, Undergraduate studies, Homi Bhabha National Institute.

Presentation on Experimental Mathematics in Python and Sage. at IMSc, Chennai on Feb 27, 2016. At a meeting of the Chennai python users group, consisting of software developers and users from industry and academia, Prasad gave a presentation on how he used python-based software Sage to discover theorems in mathematics.

Raghavan, K. N.

Guest lecture at Vellore Institute of Technology, Chennai on Apr 16, 2015. Gave a lecture to B. Tech. students on applications of linear algebra

Convener of National Organising Committee for Advanced Foundational School II held at

Indian Institute for Science Education and Research, Thiruvananthapuram during May 25 – Jun 6, 2015.

Convener of Local Organising Committee for FACETS 2015 held at IMSc during Jun 29 – Jun 30, 2015.

Mentor in DST INSPIRE program for school children at Veltech University, Avadi, Chennai on Aug 31, 2015. Lectured to and interacted with school students.

Convener of Local Organising Committee for Teachers' Enrichment Workshop: Engineering Mathematics held at IMSc during Nov 23 – Nov 28, 2015.

Mentor in DST INSPIRE program for school children at Madras University Guindy Campus on Nov 16, 2015. Lectured to and interacted with school children

Mentor in DST INSPIRE program for school children at SRM University, Kattankulathur, Chennai on Dec 27, 2015. Lectured to and interacted with school students.

Mentor in DST INSPIRE program for school children at Madras University Guindy Campus on Jan 30, 2016. Lectured to and interacted with school students.

Mentor in DST INSPIRE program for school children at Sacred Heart College, Cochin on Feb 17, 2016. Lectured to and interacted with school students.

Convener of Local Organising Committee for Science at the Sabha held at Music Academy, Chennai on Feb 14, 2016.

Mentor in DST INSPIRE program for school children at Madras University Guindy Campus on Feb 29, 2016. Lectured to and interacted with school children.

Convener of National Organising Committee for ATM Workshop on Probability and Representation Theory held at IMSc during Mar 7 – Mar 12, 2016.

Rajasekaran, G.

Member of Academic Council, CMI

Convener of Local Organising Committee for IMSc School in Theoretical Physics (ISTP) 2-14 June 2014 held at IMSc during Jun 2 – Jun 14, 2015.

Member of Selection Committee, IOP, Bhubaneswar during Sep, 2015.

Popular Science Article at Madurai on Sep 1, 2015. Published a popular science article in Tamil "Dr Abdul Kalam and INO" in the journal "Mulumai Ariviyal Udayam" Vol 8, No 9.

Popular Science Talk at Coimbatore on Nov 1, 2015. Attended the Meeting of Centre for Tamil Culture and talked about the need for bringing out books on Science in Tamil and the ways of doing it.

Member of National Organising Committee for Physics Training and Talent Search (PTTS) Workshop held at Kuvempu University, Karnataka during Dec 8 – Dec 20, 2015.

Popular Science Article at Madurai on Dec 1, 2015. Published a popular science article in Tamil "Homi Jahangir Bhabha" in the journal "Mulumai Ariviyal Udayam" Vol 8, No 12.

Popular Science Talk at Coimbatore on Dec 20, 2015. Gave a Tamil talk on "Fundamental Physics" in the NGP College.

Member of Scientific Advisory Committee,IOP, Bhubaneswar during Jan, 2016.

Radio Talk at Trichy on Feb 28, 2016. Gave a talk in Tamil on INO at All India Radio, Trichy on the National Science Day

Radio Interview at Madurai on Feb 17, 2016. Gave an interview on "Neutrinos and INO" in Tamil to All India Radio, Madurai

Popular Science Article at Madurai on Mar 1, 2016. Published a popular science article in Tamil "The Story of the Neutrino and the Nobel Prizes" in the journal "Mulumai Ariviyal Udayam", Vol 9, No 3.

Raman, Venkatesh

Convener of National Organising Committee for Workshop on Design and Analysis of Algorithms held at Indian Institute of Information Technology and Management, Kerala during Apr 24 – Apr 29, 2015.

Member of Program Committee of 9th International Frontiers of Algorithms workshop during Jun – Jul, 2015.

Ramanujam, R.

Member of Steering committee of "Logic and Multi-Agent Systems" during Jan 2011 – Mar 2016.

Member of Editorial Board of journal ACM Transactions on Computational Logic during Jan 2011 – Mar 2016.

Member of Senate of IIIT-D&M, Kanchipuram during Apr 2011 – Mar 2016.

Member of Board of studies in Computer Science, Stella Maris College, Chennai during Apr

2012 – Mar 2016.

Member of Court of Central University of Tamil Nadu, Tiruvarur during Apr 2013 – Mar 2016.

Member of Governing Board of Vigyan Prasar, DST, during Aug 2013 – Mar 2016.

Program Chair of Program Committee of TARK 2015, Carnegie Mellon University, Pittsburgh, USA during Apr 2014 – Oct 2015.

Member, Program Committee of 4th International Conference on Tools for Teaching Logic during Oct 2014 – Jun 2015.

Program Committee Member of FSTTCS 2015 during Feb – Dec, 2015.

Programme Committee Member of 13th European Conference on Multi-Agent Systems during Apr – Dec, 2015.

Member of Governing board of TARK during Jun 2015 – Mar 2016.

Convener of International Organising Committee for To Be Announced! Synthesis of Epistemic Protocols held at Lorentz Center, Leiden, The Netherlands during Aug 17 – Aug 21, 2015.

Keynote speaker at Delhi University on Feb 17, 2016. Gave a talk titled "Science and Mathematics Education in the 21st century: old challenges, new prospects" in Conference on Emerging Trends in Science and Mathematics Education.

Ray, Purusattam

Convener of Advisory Committee for XXVII IUPAP Conference on Computational Physics held at IITG, Guwahati on Dec 2, 2015.

Convener of National Organising Committee for Friction and Fracture: Bridging the Scales held at IMSc during Feb 1 – Feb 4, 2016.

Sankaran, Parameswaran

Member, Editorial Board of Journal of Indian Mathematical Society during Jan 2014 – Dec 2015.

Member of Joint Science Education Panel, Indian Academy of Sciences, Bangalore

Associate Editor of Proceedings, Mathematical Sciences, Indian Academy of Sciences

Member of Mathematics selection committee, Indian Academy of Sciences, Bangalore

Editor of Journal of Indian Mathematical Society

Associate Editor of Proceedings, Mathematical Sciences, Indian Academy of Sciences

Convener of Local Organising Committee for Teacher Enrichment Workshop–Engineering mathematics held at IMSc during Nov 23 – Nov 28, 2015.

Convener of Local Organising Committee for Nag Memorial Endowment Lecture-2016 held at IMSc on Jan 4, 2016.

Sathiapalan, Balachandran

Scientific Committee of International Conference on Gravitation and Cosmology (ICGC) - 2015, during Dec 2014 – Dec 2015.

Saurabh, Saket

Member of 23rd European Symposium on Algorithms (ESA 2015) during Apr – Sep, 2015.

Member of 10th International Symposium on Parameterized and Exact Computation (IPEC 2015) during May – Sep, 2015.

Member of 26th International Symposium on Algorithms and Computation (ISAAC 2015) during Jun – Dec, 2015.

Member of 27th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2016) during Jun 2015 – Jan 2016.

Sharma, Vikram

Convener of International Organising Committee for Mathematical Aspects of Computer and Information Sciences held at Zuse Institute, Berlin, Germany during Nov 11 – Nov 13, 2015.

Sinha, Sitabhra

Member of Editorial Board of Frontiers in Fractal Physiology

Member of Frontiers in Physics Editorial Board

Convener of Local Organising Committee for Discussion Meeting on New Scientific Approaches to Understanding the Indus Valley Phenomenon held at IMSc during May 4 – May 5, 2015.

Convener of Local Organising Committee for 3rd Workshop and Conference on Modeling Infectious Diseases held at IMSc during Nov 23 – Dec 1, 2015.

Srinivas, K.

Secretary cum Treasurer of Executive Committee of RMS

VMC Member of KV, CLRI

Resource person at Velammal Institute of Technology, Chennai on Apr 8, 2015. Delivered a talk with the title *Some basic counting principles* in the DST sponsored INSPIRE programme.

Convener of Local Organising Committee for Advanced Instructional School In Analytic Number Theory held at KIIT, Bhubaneswar during Jun 1 – Jun 20, 2015.

Mentor at Chennai Institute of Technology, Chennai on Jul 28, 2015. Delivered two talks in the DST sponsored INSPIRE programme for XI-XII std students.

Convener of Local Organising Committee for ATMW Analytic Number Theory held at IMSc during Oct 19 – Oct 24, 2015.

Chief Guest at Sangford School, Kanchipuram on Jan 23, 2016. Addressed school students in their annual mathematics day event. Also gave a popular talk on elementary properties of numbers to instill interest towards mathematics.

Subramanian, C. R.

Member of Programme Committee, CALDAM-2016 (Second International Conference on Algorithms and Discrete Applied Mathematics), February 18-20, 2016, University of Kerala, Thiruvananthapuram during May 2015 – Feb 2016.

Sunder, V. S.

Convener of Local Organising Committee for Complex Geometry and Operator Theory held at ISI, Bangalore during Dec 1 – Dec 3, 2015.

Invited to lecture in the Inspire Programme organised by DST at Panjab University, Chandigarh on Jan 2, 2016. Gave a lecture titled *Catalan numbers*

Convener of Local Organising Committee for Advanced Instructional School in operator theory/algebras held at IMSc during Feb 1 – Feb 20, 2016.

Viswanath, Sankaran

Instructor of NPTEL online course "An Invitation to Mathematics" during May – Jun, 2015.

Convener of Local Organising Committee for Enriching Mathematics Education held at IMSc during Sep 3 – Sep 4, 2015.

Chapter 4

Colloquia

4.1 Conferences/Workshops Held at IMSc

4.1.1 Discussion Meeting on New Scientific Approaches to Understanding the Indus Valley Phenomenon

The Indus civilization, also known as the Mature Harappan civilization (25001900BCE), was geographically spread over an extremely large area covering approximately a million square kilometers in present-day Pakistan and northwestern India. It was marked by urbanization centered around large planned cities, as seen from the ruins of Harappa and Mohenjo-daro. Craft specialization and long-distance trade with Mesopotamia and Central Asia have been well-documented. Its existence was unknown until archaeological excavations in the early 20th century revealed the ruins of the large urban centers which characterized the civilization. Continued work on these and other sites that have been discovered later have given us fascinating glimpses into various aspects of this Civilization but there is much that is still unknown.

Among the artifacts uncovered in excavations are a variety of objects - seals, miniature tablets, pottery, bronze implements - that are inscribed with sequences of signs. Given the technical sophistication of the civilization and the level of social complexity it implies, with the concomitant requirements of coordination and communication, these inscriptions have been interpreted as corresponding to writing. However, despite periodic claims about their decipherment, there has as yet been no generally accepted interpretation of the Indus inscriptions.

The object of this two-day meeting was to have focused interactions on recent developments in applying statistical, numerical simulation and graph theoretic approaches to analyzing the Indus inscriptions and other aspects of the archaeological data obtained from excavation of Indus Valley sites. The meeting also considered the broader aspects of the civilizations, such as the trading network that connected it to contemporary Bronze-Age civilizations in Mesopotamia, Persian Gulf and elsewhere. It was the third in a series of meetings, the first being held at Roja Muthiah Research Library in Chennai in 2010 and the second in Victoria, British Columbia, Canada in 2014.

Invited speakers to the meeting were Prof Vasant Shinde (Deccan College, Pune), Dr Steven

Bonta (Penn State University, Altoona), Dr Nisha Yadav (TIFR Mumbai), Prof Mayank Vahia (TIFR Mumbai), Mr M I Ashraf (IMSc Chennai) and Mr C R Subramanian (RMRL Chennai). Prof Shinde also gave a public lecture on “Harappan Civilization’s contribution to the field of basic sciences and technologies” at IMSc.

4.1.2 FACETS 2015

This annual workshop is targeted primarily at college and university mathematics students. For more details of this particular program, visit http://www.imsc.res.in/ knr/facets15/

4.1.3 Enriching Mathematics Education

Workshop for school teachers. The aim was to bring research mathematicians and school teachers together in an effort to enrich mathematics education in schools. Activities included lectures on school level mathematics from alternate perspectives, talks on pedagogy, and discussions related to the teaching and learning of mathematics.

4.1.4 ATMW Analytic Number Theory

This was an NCM/NBHM sponsored workshop in Analytic Number Theory. About 30 out station participants attended this programme. The participants were research scholars working in analytic number theory and also some were from universities who are teaching number theory. Lectures were delivered by Prof. Balasubramanian (6 lectures on Circle method), Prof. Stephan Baier (4 lectures on Exponential sums), Prof. K. Srinivas (4 lectures on Consequences of Riemann hypothesis) and Prof. Anirban Mukhopadhyay (4 lectures on Sieve methods). The tutors were Dr. Kasi Viswanadham and Mr. Kamalakshya Mahatab.

4.1.5 Teacher Enrichment Workshop–Engineering Mathematics

This workshop was part of the IMSc outreach activity ‘Enriching Collegiate Education’ and was targeted at mathematics teachers of engineering colleges from in and around Chennai. About 35 teachers participated in the Workshop. There were three mini-courses: (1) Multivariate calculus by P Sankaran, (2) Complex analysis by K Srinivas, and (3) Linear algebra by P Vanchinathan, VIT, Chennai. This activity was funded by the National Centre for Mathematics, Mumbai, and co-sponsored by IMSc. For more details, visit http://www.imsc.res.in/ knr/ecenov15/

4.1.6 3rd Workshop and Conference on Modeling Infectious Diseases

The workshop aimed at providing hands-on training to researchers from different quantitative sciences in the modeling of several aspects of infectious diseases, including (a) Epidemiology: data analysis and mathematical modeling, (b) Genomics and evolutionary biology of pathogens, (c) Systems biology of host-pathogen interactions, and (d) Emergent Infectious Diseases: Data, Models and Public Health Implications.

The primary objective of the workshop was to expose the strong mathematical biology community in India and the UK to the area of infectious disease modeling, with particular emphasis on young scientists. The conference following the workshop brought together biologists, clinicians and public health specialists working on infectious diseases with scientists from a modeling background, with the aim of fostering cross-disciplinary interactions and long-term collaborations. Contributed talks by participants were selected from abstracts submitted at the time of application for the conference.

The meeting was jointly sponsored by the Institute of Mathematical Sciences, Chennai, the EPSRC-DST Indo-UK Initiative in Applied Mathematics, and the EU-FP7 supported Indo-European Research Network in Mathematics for Health and Disease (MATHDS). This was the third such conference, organized by Gautam I Menon and Sitabhra Sinha, IMSc. Speakers at the school included: Vineeta Bal (NII, Delhi), Anton Camacho (LSHTM, London), Edgar Delgado-Eckert (University of Basel, Basel), Sebastian Funk (LSHTM, London), Gwen Knight (Imperial College, London) , Saumyadipta Pyne (IIPH, Hyderabad), Satyajit Rath (NII, Delhi) and Nagasuma Chandra (IISc, Bengaluru). Conference speakers included Carmen Molina-Paris (Leeds), Anil Vullikanti (Virginia), Kaja Abbas (Virginia), NIyaz Ahmed (Hyderabad), Samit Bhattacharya (Delhi), Jose Faro (Vigo), S Pyne(IIPH, Hyderabad),B Ravindran (ILS, Bhubaneswar) and Nagasuma Chandra (IISc, Bengaluru).

4.1.7 A conference in Number Theory

Number constitutes a central theme in the development of modern Mathematics. It is also a domian in which IMSc has a strong foothold.

In this conference, leading experts of different aspects of number theory came together both from India and abroad, highlighted the state-of-the-art as well as indicated some of their recent works. This conference also provided a platform for the advanced graduate students and post-doctoral fellows to present their work.

4.1.8 3rd Indo-French conference in Mathematics

This meeting is part of the Indo-French Program for Mathematics, a Laboratoire International Associe (LIA) of CNRS. Since the scope of this program a priori encompasses the whole of mathematics, the themes of the conference are loosely defined around Algebraic Geometry, Analytic Geometry, Dynamical Systems, Mathematical Physics and Number Theory.

The purpose of this conference is to highlight the recent developments in the above mentioned subjects and to encourage interaction between Mathematicians of India and France working in these areas.

4.1.9 Nag Memorial Endowment Lecture-2016

The Nag Memorial Endowment Lecture for the year 2016 was delivered by Prof. Christopher Woodward, Rutgers University. The title of his lecture was 'Symplectic geometry and vortices'. It was well attended by members of IMSc as well as faculty members from Chennai Mathematical Institute. The Endowment Lecture was followed by a talks in the mathematics seminar on the same theme.

4.1.10 Advanced Instructional School in Operator Theory/Algebras

This AIS funded by the NCM, jointly organised by Prof. V.S. Sunder and Vijay Kodiyalam, IMSc. Gave six lectures on 'The spectral theorem'. This school had six inter-related one-week courses of six 90 minute lectures each. Details of this AIS can be found at https://www.imsc.res.in/ sunder/aisoa.html

4.1.11 School and Conference on Quantum Disordered Systems

This was a combined school and conference on disordered systems, supported and jointly organized by IMSc (Gautam Menon and R. Ganesh), IITM (Rajesh Narayanan) and ISI, Chennai (Prabuddha Chakraborty). The speakers at the school were: D. Belitz, T. Vojta, A. Altland, F. Evers, V. B. Shenoy and S. Parameshwaran. The school was open to young students, post-doctoral fellows and young researchers.A large number of Indian scientists working in this field spoke at the conference which followed, including Prof. T. V. Ramakrishnan (BHU), Kedar Damle (TIFR), Vikram Tripathi (TIFR), Amit Ghosal (IISER-Kolkata), Pinaki Majumdar (HRI), Arnab Sen (IACS) Krishnendu Sengupta (IACS), Amit Dutta (IIT-Kanpur), Sudhansu Mandal, (IACS), Pratap Raychaudhuri, (TIFR), R. Nirmala (IIT-Madras) and Satyajit Banerjee (IIT-Kanpur)

4.1.12 Friction and Fracture: Bridging the Scales

Friction and fracture, abundant in diverse natural and industrial phenomena, are often interlinked. The aim of the meeting is to focus on the multi-scale description of the processes and the mechanisms involved, from the micro to the macro scales. The meeting aims to focus on various experimental, theoretical and computational aspects of friction and fracture, summarize current understanding, discuss future directions and emerging problems

4.1.13 Open Source Library Software (Koha) and RFID Integration for DAE Libraries

This workshop was jointly organized with Jane Alam, VECC, Kolkata, Monirul Purkait, VECC, Kolkata, and Paul Pandian, IMSc, Chennai. The main objectives of the workshop were: a) To demonstrate the capabilities of Koha integrated with home-grown RFID solutions b) To explore the possibilities of extending these open source solutions across DAE Libraries

c) To set up an institutional support mechanism for the maintenance of Koha and RFID system across DAE libraries d) To explore how DAE libraries can collaborate for mutual benefits.

4.1.14 ATM Workshop on Probability and Representation Theory

This was one of the NCM sponsored workshops.

For more details, visit http://math.iisc.ernet.in/ arvind/ncm-workshop.html

4.1.15 Frontiers in High Energy Physics

The third meeting in the Frontiers in High Energy Physics (FHEP) series was held at the Institute during 22-25th March, 2016. In this four-day symposium, leading phenomenologists in high energy physics from across India discussed latest developments in the field.

The symposium also included few review talks and lectures for a general audience.

4.2 Other Conferences/Workshops Organized by IMSc

4.2.1 Advanced Foundational School II

This school is an annual event of the Advanced Training in Mathematics Schools (sponsored by the National Centre for Mathematics).

Professor K.N. Raghavan was academic coordinator of the school. Was also a resource person. Delivered eight lectures and conducted as many tutorials.

4.2.2 Advanced Instructional School In Analytic Number Theory

This programme was financially supported by NCM/NBHM, the logistical support were extended by KIIT. About 30 out station participants attended this 3 week long workshop-aimed at research scholars and university teachers who are working in/teaching number theory. The speakers and tutors did a splendid job. Details are available at http://www.atmschools.org/2015/ais/ant .

4.2.3 Summer School on Quantum Correlation: Foundation, Information Processing and Various Applications

Professor Sibasish Ghosh was an invited speaker at the Summer School. Delivered about seven lectures there – two are on Quantum Information Processing (QIP) of discrete systems and the rest are on continuous variable systems. Most of the participants had some working knowledge in QIP even though not all of them were from physics background. About fifty participants were there in the School.

4.2.4 To Be Announced! Synthesis of Epistemic Protocols

The workshop 'To be announced!' was on the subject of epistemic protocols. In protocols (or planning), various aspects can be called epistemic: the condition for executing an action in a protocol may be knowledge or ignorance, such an action may consist of imparting information (so, again, knowledge), actions may be partially observable (so that the agent does not know what really happened), and the goals of plans may be epistemic (the spy may not get to know the secret). Five workshop themes agency, concurrency, uncertainty, communication, strategy were investigated in discussion groups. There were 11 invited keynotes, who admirably focused on epistemic planning.

The workshop was co-organized by Thomas Bolander, Hans van Ditmarsch, Jan van Eijck and R. Ramanujam.

4.2.5 50 years of Narasimhan-Seshadri Theorem

The Famous Narasimhan-Seshadri Theorem proved 50 years back played a central role in many branchs of mathematics, including differential geometry, algebraic geometry, low dimensional topology, Teichmueller theory, etc., and more surprisingly in various areas of theoretical physics, like conformal field theory and string theory.

The goal of conference was to present a comprehensive view of some of the most important developments that have taken place in the last 50 years derived from the Narasimhan-Seshadri Theorem, and explore further directions of the theory.

4.2.6 Mathematical Aspects of Computer and Information Sciences

Organized a special session on Algorithms for Curves and Surfaces

4.2.7 Complex Geometry and Operator Theory

This conference was jointly hosted by ISI and IMSc, and Professor Gadadhar Misra was felicitated on the occasion of his 60th birthday during this conference.

4.2.8 XXVII IUPAP Conference on Computational Physics

CCP is a series of conferences held annually under the auspices of the International Union of Pure and Applied Physics (IUPAP) on the basis of endorsement by its Commission on Computational Physics (C20). The purpose of the conference series is to bring together computational scientists working in physics and closely related areas to exchange the latest developments in computational techniques and their applications.

4.2.9 Physics Training and Talent Search (PTTS) Workshop

The idea of initiating PTTS for Physics on the lines of MTTS for Mathematics (that has been going on with great success for the past 20 years or more) originated from Prof. G. Rajasekaran, but it was executed very successfully by the trio M Sivakumar, Raghavan Rangarajan and SVM Satyanarayana in December 2015 with some help from Prof. G. Rajasekaran. It was held at Kuvempu University, the local coordinator being Sudha. About 50 BSc students were selected at an all-India level and given a taste of innovative teaching of Physics for two weeks. It is hoped to continue this every year.

4.2.10 Soft Matter Young Investigators Meet III

Soft-Matter: Young Investigators Meeting (SM-YIM) is a forum for the soft matter community in India, specially young faculty members, to communicate their recent research and to exchange ideas. IMSc is one of the institutions which has been part of the organizing and funding of the event, since its inception. This meeting is thus an attempt to connect a rapidly growing interdisciplinary group working on colloidal/ polymer/granular matter-dynamics, self assembly of mesoscopic structures and the interface of soft matter, chemistry and biology, so that we can learn from each other; and build collaborations and friendships that will endure and enhance the quality of our science. Specifically, this focused meeting is aimed at building such networks among researchers who are in the early stages of their careers, and who might not ordinarily get a chance to meet each other at the discipline specific conferences that they usually attend.

4.2.11 Science at the Sabha

This was a novel outreach activity organized by Professors Gautam I. Menon and K.N. Raghavan, IMSc. This half-a-day program was targeted at the general public and featured talks with a view to increasing general awareness about science. Around 1000 people of all ages and from all walks of life, from students to senior citizens attended. The speakers were: Rama Govindarajan (TCIS, Hyderabad), Sanjay Sane (NCBS, Bengaluru), Meena Mahajan (IMSc, Chennai) and D. Indumathi (IMSc, Chennai). For more details, visit http://www.imsc.res.in/triveni/

4.3 Seminars

Date	Speaker Affiliation	Title
2-4-2015	Eric Bertin LIPhy, Grenoble	Continuous descriptions for dry active matter
2-4-2015	Kirsten Martens LIPhy, Grenoble	Dynamical phase transitions in athermally sheared disordered systems
2-4-2015	Malay Banerjee Department of Mathematics and Statistics, IIT Kanpur	Spatio8208;temporal pattern formation in Ecology
6-4-2015	Luis De La Higuera Romero Department of Applied Mathematics, University of Leeds, United Kingdom	A stochastic approach on T-cell co-stimulation
6-4-2015	Rahul Siddharthan IMSc, Chennai	Genome editing: techniques, applications and worries
6-4-2015	Kirtiman Ghosh Oklahoma State University	Probing constrained minimal supersymmetric standard model with top-quarks
8-4-2015	Bhaskaran Muralidharan IIT Bombay	The role of dual-nuclear baths on singlet-triplet dynamics in a double quantum dot
9-4-2015	R. Padma V I T, Vellore	How were the first error correcting codes constructed? A historical introduction to coding theory through Hamming's work
9-4-2015	Francois Bouchet Institute of Astrophysics, Paris	Cosmology with the Planck satellite
10-4-2015	Eleonora Dell'Aquila IMSc	Non-perturbative studies of N=2 conformal quiver gauge theories

10-4-2015	Issan Patri IMSc	Finiteness of Group Algebras
15-4-2015	Brajesh Mani University of South Florida	Properties of perovskite materials at finite temperatures
17-4-2015	Nandan Pakhira University of Queensland	Are there quantum limits to diffusion in quantum many-body systems?
17-4-2015	Rekha Biswal IMSc	Fusion product of finite dimensional g[t] modules
24-4-2015	Rekha Biswal IMSc	Fusion product of finite dimensional g[t] modules.
27-4-2015	Arghya Mondal IMSc	Cohomology of locally symmetric spaces
28-4-2015	Renjan John IMSc	Aspects of N=2 conformal quiver gauge theories
29-4-2015	M. Sambath Department of Mathematics, Bharathiar University, Coimbatore 641 046, India	Stability, bifurcation and pattern formation of a diffusive predator-prey model
30-4-2015	Stephan Baier TIFR	Inhomogeneous cubic congruences and rational points on Del Pezzo surfaces
4-5-2015	Vasant S. Shinde Deccan College Post Graduate and Research Institute, Pune	Harappan civilization's contribution to the field of basic sciences and technologies
4-5-2015	Dipankar Das SINP	Some phenomenological aspects of 2HDMs after the Higgs discovery
5-5-2015	Rakesh Tibrewala Center for High Energy Physics, IISc, Bengaluru	New second derivative theories of gravity for spherically symmetric spacetimes and emergent spacetime
6-5-2015	Prasad Perlekar TIFR-TCIS, Hyderabad	Coarsening arrest in three and two dimensional turbulence

6-5-2015	Sebastien Palcoux IMSc	Ore's theorem for subfactor planar algebras
8-5-2015	Arghya Mondal IMSc	Curvature and growth of fundamental group
13-5-2015	Sebastien Palcoux IMSc	Ore's theorem for subfactor planar algebras
14-5-2015	Vineeta Bal National Institute of Immunology, Aruna Asaf Ali Road, New Delhi, India	How does identifying subsets of cells in the human blood help in understanding heterogeneity in the human population?
15-5-2015	Anish Mallick IMSc	CMV matrices and Orthogonal Polynomials
21-5-2015	Krishnaswami Alladi University of Florida	Partitions with non-repeating odd parts: q-hypergeometric and combinatorial identities
22-5-2015	Sumit Giri IMSc	Poisson Distribution of a Prime Counting Function Corresponding to Elliptic Curves
25-5-2015	Deepak Dhar TIFR (Mumbai)	Rocks, rivers, and sand: simple models of complex systems
26-5-2015	Rati Sharma Dept. of Biophysics Johns Hopkins University Baltimore, USA	Directional Accuracy in a Model of Gradient Signaling during Yeast Mating
26-5-2015	Amritanshu Prasad IMSc	Partitions with an odd number of standard tableaux
27-5-2015	Kedar Damle TIFR, Mumbai	Melting of three-sublattice order in easy-axis antiferromagnets on triangular and kagome lattices
28-5-2015	Joyjit Kundu (Thesis Viva) IMSc, Chennai	Phase transitions in systems of hard anisotropic particles on lattices
28-5-2015	M.Sivakumar University of Hyderbad	Higher spins and holography

29-5-2015	Thomas Konrad School of Chemistry and Physics, University of KwaZulu-Natal, Durban	Classical optics described in the language of quantum mechanics
29-5-2015	Anirban Bose IMSc	Spin groups
2-6-2015	B. Ravinder IMSc	A bijection; a generalization of the Durfee square construction
5-6-2015	Ragothaman Yennamalli Department of Biosciences, Rice University, Houston, Texas USA	Thermostability and Cellulases: A Structural Perspective
5-6-2015	Sebastien Palcoux IMSc	Ore's theorem for subfactor planar algebras
5-6-2015	Sandipan De IMSc	2-cabling of a Planar algebra and Drinfeld double
10-6-2015	Laszlo Kozma Saarland University	Self-adjusting binary search trees: What makes them tick?
10-6-2015	Bulbul Chakraborty Brandeis University, Massachusetts, USA	Physics of Sand: Emergent Behavior in the Macro World
10-6-2015	Sebastien Palcoux IMSc	Weakly cyclic planar algebras
12-6-2015	Dhriti Ranjan Dolai IMSc	Spectral Statistics of Random Schrodinger Operators with Unbounded Potentials
13-6-2015	Sultan Ismail Ecoscience Research Foundation	"Understanding our Ecology, Soil, Food Waste Management as a Business Model"
19-6-2015	Chandan Maity IMSc	Nilpotent Orbit
23-6-2015	Sourav Tarafder Calcutta University	Non-classical set theories and logics associated with them

24-6-2015	Vijay Kodiyalam IMSc	Planar algebras
25-6-2015	V. Padmavati MIT	Conductors and minimal discriminants of hyperelliptic curves
26-6-2015	Aparna Baskaran Brandeis University	Self-propelled particles as an "Ising Model" for active materials
26-6-2015	Vijay Kodiyalam IMSc	Planar algebras
26-6-2015	Siddhi Pathak Queen's University	Chowla's problem and its generalizations
29-6-2015	Ivonne Zavala Swansea University, UK	Warping and the Weak Gravity Conjecture
30-6-2015	Nana Cabo-Bizet University of the Witwatersrand, South Africa	Generalized entanglement entropy and holography
1-7-2015	Arpita Choudhary Thuringer Landessternwarte Tautenburg, Tautenburg, Germany	V1331 Cyg - an outburst of results
1-7-2015	R Loganayagam IAS, Princeton	A topological gauge theory for the entropy current
2-7-2015	Shashank Kanade Rutgers University	Vertex operator algebras and integer partition identities of Rogers-Ramanujan type
2-7-2015	Sanjoy Biswas KIAS	Exploring the Higgs-sector at the LHC and Future Collider
3-7-2015	Vijay Kodiyalam IMSc	Planar algebras
3-7-2015	Vishnu Jejjala University of the Witwatersrand	Hot Attractors
3-7-2015	P A Narayanan IMSc	Schrodinger operators

6-7-2015	Anil Shukla IMSc	Feasible Interpolation for QBF Resolution Calculi
7-7-2015	K N Raghavan IMSc	Variations and Implications of a Theorem of Jordan
8-7-2015	Vijay Kodiyalam IMSc	Planar algebras
8-7-2015	Rahul Sinha IMSc	Implications from B8722;1 of LHCb data
8-7-2015	Sugata Gangopadhyay IIT, Rourkee	Normality of Boolean functions and its impact on stream cipher cryptanalysis
9-7-2015	Murali K Srinivasan IIT Bombay	On the representation theory of G S_n
9-7-2015	Ekata Saha IMSc	Linear independence of Briggs-Euler-Lehmer constants over number fields
10-7-2015	Sruthy Murali IMSc	Coxeter groups
10-7-2015	Biswajyoti Saha IMSc	Shifted convolution sum in the context of Ramanujan expansions
13-7-2015	Gautam Nambiar IISc, Bangalore (currently summer student at IMSc)	Square lattice antiferromagnet: extended degeneracy and the role of fluctuations
16-7-2015	Pradeep Sarvepalli IIT, Madras	Equivalence of 2D color codes (without translational symmetry) to surface codes
17-7-2015	M Vijayalakshmi School of Chemical Biotechnology, SASTRA University,Thanjavur	Dissecting the apoptotic cascades triggered by chromatin perturbations in cells
17-7-2015	Issan Patri IMSc	Haagerup Property for Discrete Groups

20-7-2015	Priyotosh Bandyopadhyay Universit'a di Lecce and INFN Sezione di Lecce	Higgs bosons: discovered and hidden, in extended supersymmetric standard models at the LHC
20-7-2015	Anupama Sharma Department of Mathematics, Banaras Hindu University, Varanasi	Epidemic and media campaigns: Understanding the interplay from mathematical standpoint
20-7-2015	Sruthy Murali IMSc	Coxeter groups
21-7-2015	Shouvik Datta IISc, Bangaluru	Universal features of left-right entanglement entropy
21-7-2015	Tanumoy Pramanik Telecom ParisTech, Paris	Theoretical and Experimental Study of Quantum Steering
21-7-2015	Amritanshu Prasad IMSc	Orbits of structures in finite abelian groups: a survey
21-7-2015	Subhadeep Roy	Doctoral Committee meeting
22-7-2015	Sayantari Ghosh Bose Institute, Kolkata	Early Signatures of Sudden Regime Shifts
22-7-2015	Sandipan De IMSc	$\mathrm{C}^* - algebras$
24-7-2015	Souradeep Majumder IMSc	An introduction to spectral curves
24-7-2015	V. S. Sunder IMSc	On a tensor-analogue of the Schur product
24-7-2015	Sruthy Murali IMSc	Coxeter groups
27-7-2015	Nirmal Raj University of Oregon/ University of Notre Dame	Dark Matter in Dilepton Production
28-7-2015	Vamsi Pritham Pingali Johns Hopkins University	Weighted L^2-Extension of holomorphic functions from singular hypersurfaces

29-7-2015	Jitendra Pattanaik IISER, Kolkata	Application of cosmogenic radionuclides ^{10}Be and ^{26}Al in the field of Earth sciences
29-7-2015	Narayan Rana, Taushif Ahmed and Shibasis Roy IMSc	2 DC talks and Project talk
30-7-2015	Ramchandra Phawade IIT Bombay	Labelled free choice petri nets, finite product automata and expressions
30-7-2015	T V H Prathamesh IMSc	Mechanising Mathematics: Excursions in Interactive Theorem Proving
31-7-2015	Zodinmawia IMSc	Integrable lattice models from four dimensional field theory
31-7-2015	Sanjay Kumar Singh IMPAN(Warsaw,Poland)	Representations of Fundamental Groups of Compact Riemann Surface
4-8-2015	B.J. Rao Department of Biological Sciences, TIFR, Mumbai	Replication Forks Chromosome Territories: Signaling mechanisms during their repairs
4-8-2015	Karimilla Bi IMSc	Cellularity, Modular Representations, and Gram Matrices of a Class of Diagram Algebra
5-8-2015	L. Merel University of Paris VII	The diophantine equation $y^2 = x^8 + x^4 + x^2$
5-8-2015	Soumyadeep Bhattacharya	Topological Signatures of Symmetry Enhancing Phase Transitions
6-8-2015	Manoj Gupta Xerox Research, India	Dynamic Graph Matching
6-8-2015	Ashok Garai IISc, Bangalore	Single molecule conformational dynamics and mechanics: Theory, simulation, analysis and interpretation
6-8-2015	Pranab Sardar UC Davis	Geometry of Metric Bundles

6-8-2015	M. V. N. Murthy IMSc	Remembering Hiroshima
7-8-2015	Shreedevi Masuti IMSc	Maps between Grassmann manifolds
10-8-2015	T N Venkataramana TIFR, Mumbai	Monodromy groups of hypergeometric functions
11-8-2015	Ashish Mishra IIT Bombay	Wreath product action on generalized Boolean algebras
12-8-2015	L. Merel University of Paris VII	Serres problem on Galois action on points of division of elliptic curves
12-8-2015	Alok Laddha CMI	Asymptotic symmetries and soft theorems
13-8-2015	Kaja Abbas Department of Population Health Sciences, Virginia Tech, USA	Mathematical Modeling of Infectious Disease Dynamics: Tuberculosis, Brucellosis, Influenza HIV
13-8-2015	Krishnakumar Sabapathy Fisica Teorica: Informacio i Fenomens Quantics, Universitat Autonoma de Barcelona, Spain	Operational Resource Theory of Coherence
14-8-2015	Gaurav Rattan IMSc	Color refinement and an LP based approach to Graph Isomorphism
14-8-2015	Mamta Balodi IMSc	Diamond lemma and applications
17-8-2015	Krishnakumar Sabapathy Fisica Teorica: Informacio i Fenomens Quantics, Universitat Autonoma de Barcelona, Spain	Nonclassicality depth for quantum-optical channels: a noisy approach
18-8-2015	V. S. Sunder IMSc	Hypergroups, and the associated combintorial magic
19-8-2015	L. Merel University of Paris VII	The geometry of the upper half-plane over the field with p elements

19-8-2015	Alok Laddha CMI	Asymptotic symmetries and soft theorems (continued)
19-8-2015	Jonathan Fernandes University of Maryland	An Introduction to ATLAS: Basic Background and Applications
20-8-2015	Debargha Banerjee IISER Pune	Eisenstein elements inside the space of modular symbols
21-8-2015	Sumit Kumar Upadhyay IMSc	Freeness of stably free modules via unimodular rows
21-8-2015	T V H Prathamesh IMSc	Formalizing Knot Theory in Isabelle/HOL
25-8-2015	Roop Mallik TIFR, Mumbai	Geometrical reorganization of Motor proteins and its relevance to transport of cellular cargos
25-8-2015	R Venkatesh TIFR	Fusion Products
26-8-2015	L. Merel University of Paris VII	Why is Serres problem difficult ?
26-8-2015	Basant K. Tiwary Centre for Bioinformatics, Pondicherry University	The deterministic organization of Biological Systems
27-8-2015	Arghya Dutta Institute of Mathematical Sciences	Modelling aggregation and fragmentation phenomena using the Smoluchowski equation
27-8-2015	Dileep Jatkar HRI, Allahabad	Lifshitz and Schrodinger metrics in pure Lovelock gravity
28-8-2015	Surajit Biswas IMSc	Example of a noncomplemented Banach subspace
1-9-2015	G. Koushik IIT Madras (summer student at IMSc)	Topology and thermal Hall effect in a Kagome antiferromagnet

2-9-2015	Prasad Hegde CCNU, Wuhan, China	The quark-gluon plasma: What the lattice can tell us
2-9-2015	Shiv Prakash Patel IIT Bombay	Restriction of representations and metaplectic groups
3-9-2015	T. R. Govindarajan Chennai Mathematical Institute, Siruseri, Chennai	Life at the boundary and novel physics
4-9-2015	Ajay Ranganathan University of Paris VI	Some arithmetic properties of dynamical systems
8-9-2015	Srikanth Sastry JNCASR, Bangalore	Yielding and memory in sheared amorphous solids
10-9-2015	Meena Mahajan IMSc	The shifted partial derivative complexity of elementary symmetric polynomials
11-9-2015	Kamalakshya Mahatab IMSc	Landau's Oscillation Theorem
14-9-2015	Bhaskar Saha Dept of Life Sciences, St Xavier's College, Mumbai	Adult Neurogenesis and Neurodegeneration: Is our brain self sufficient?
14-9-2015	Umesh Dubey IISc, Bangalore	Singularity category and Knorrer periodicity
15-9-2015	Senti Imsong IMSc	Extrapolation and unitarity bounds for the B to π form factor and its implication to $\lvert V_{ub}\rvert$
16-9-2015	S. Kalyana Rama IMSc, Chennai	On the Stability of (M theory) Stars against Collapse : Role of Anisotropic Pressures
18-9-2015	Prahladh Harsha TIFR	Polynomial Approximations Over Z/p$^k Z$
18-9-2015	Abhijit Chakraborty IMSc, Chennai	Analysis of network structure of the world currency market

18-9-2015	Biswajyoti Saha IMSc	Partial sums of arithmetical functions in the context of the theory of Ramanujan expansions
18-9-2015	Vijay Kodiyalam IMSc	Planar algebras
21-9-2015	Gaurav Narain AEI, Potsdam, Germany / Kavli Institute, Beijing, China	Green's function of the Vector fields on DeSitter Background
21-9-2015	Souvik Goswami University of Alberta	Business of height pairing
22-9-2015	Sayan Bhattacharya	Conditional Lower Bounds for Dynamic Problems
23-9-2015	V Sasidevan IMSc, Chennai	Co-action solves social dilemmas
24-9-2015	Hema A Murthy Computer Science and Engineering, IIT Madras	Signal processing and machine learning for Carnatic music
30-9-2015	Amit Sharma IMSc, Chennai	Conjugate coupling in excitable media
30-9-2015	V. Kumar Murty University of Toronto	Euler-Kronecker constants
5-10-2015	Golam Hossain IISER Kolkata	Polymer quantization and uniformly accelerated observer
5-10-2015	P Sankaran	Lie groups
5-10-2015	Aprameyan Parthasarathy Univ. Paderborn	Some aspects of Duflo's orbit method
6-10-2015	Aprameyan Parthasarathy Univ. Paderborn	Restrictions of discrete series representations of real reductive groups to parabolic subgroups
7-10-2015	N. D. Hari Dass TIFR-TCIS, Hyderabad	Light Coherence and Quantum Mechanics

7-10-2015	Abhay Ashtekar IGC, Penn. State University	Even a tiny positive cosmological constant casts a long shadow
7-10-2015	T. V. H. Prathamesh IMSc	Interactive Theorem Proving: A Short Course
8-10-2015	Ipsita Mandal Perimeter Institute of Theoretical Physics	Fun with Phases
8-10-2015	Abhay Ashtekar IGC, Penn. State University	Loop Quantum Cosmology and the Very Early Universe: Theory Meets Observations
8-10-2015	Vijay Kodiyalam IMSc	Planar algebras
13-10-2015	Shweta Agrawal IIT Delhi	Modeling and constructing cryptography for the cloud
14-10-2015	T. V. H. Prathamesh IMSc	Interactive Theorem Proving: A Short Course
15-10-2015	Ritwik Mukherjee TIFR, Mumbai	Enumerative Geometry of rational cuspidal curves on del-Pezzo surfaces
15-10-2015	Fabien Pazuki University of Copenhagen	Bad reduction of curves with CM jacobians
15-10-2015	Vijay Kodiyalam IMSc	Planar algebras
16-10-2015	Sruthy Murali IMSc	Coxeter groups
23-10-2015	Z. Blaszczyk Adam Mickiewicz University, Poznan	Motion planning from the topological point of view
23-10-2015	P Sankaran IMSc	Lie Groups
27-10-2015	Saroj Nandi MPIPKS, Dresden, Germany	Quantum mechanics-like behaviour of a classical object: a droplet walking on a vertically vibrated liquid surface

30-10-2015	Ronnie Sebastian IISER Pune	Voevodsky's smash nilpotence conjecture
30-10-2015	P Sankaran IMSc	Lie groups
2-11-2015	Ramprasad Saptharishi Tel Aviv University	Lower bounds for shallow arithmetic circuits
3-11-2015	Amrik Sen TIFR, Hyderabad	A Tale of Waves and Eddies in a sea of Rotating Turbulence
4-11-2015	Sumanta Chakraborty IUCAA, Pune	The Dynamical Evolution of the Spacetime and Equipartition
4-11-2015	T. V. H. Prathamesh IMSc, Chennai	Interactive Theorem Proving: A Short Course
5-11-2015	Shubhashis Rana IoP, Bhubaneswar	Stochastic thermodynamics of small Scale heat engines and refrigerators
5-11-2015	Amritanshu Prasad IMSc	Odd dimensional representations in Young's lattice
9-11-2015	Sutanu Roy Carleton University, Canada	Braided C*-quantum groups
11-11-2015	Shiraz Minwalla TIFR, Mumbai	Effective Theories of Horizons - I
11-11-2015	Krishanu Dan CMI	Null correlation bundle and secant bundles
12-11-2015	Shiraz Minwalla TIFR, Mumbai	Effective Theories of Horizons - II
12-11-2015	Subhro Bhattacharjee TIFR-ICTS, Bangalore	Integer Quantum Hall Effect of Bosons on a Lattice.
13-11-2015	Shiraz Minwalla TIFR	Effective Theories of Horizons - III

13-11-2015	Gunter Schutz Institute of Complex Systems II Forschungszentrum Jlich GmbH	The Fibonacci family of dynamical universality classes
13-11-2015	Shiraz Minwalla TIFR, Mumbai	Nag Memorial Lecture
14-11-2015	Sriram Iyer Nalandaway foundation	Issues of Children in difficult situations
16-11-2015	Indrava Roy ISI New Delhi	Analytic surgery exact sequences and ℓ^2 spectral invariants
16-11-2015	Jnanadeva Maharana Institute of Physics, Bhubaneswar	High Energy Scatterings in Higher Dimensional Theories
17-11-2015	Jnanadeva Maharana IOP Bhubhaneshwar	High Energy Scatterings in Higher Dimensional Theories
18-11-2015	Madhusudhan Raman IMSc	S-duality and modular anomaly equations in N=2 SQCD
19-11-2015	Manish Mishra University of Heidelberg	Hecke algebras and the Langlands program
19-11-2015	Michael Cadilhac University of Tuebingen	Recognizing languages: A unified approach of circuits, logic, and algebra
20-11-2015	T. S. Ganesan, MD, MNAMS, PhD (Lond), FRCP Department of Medical Oncology, Cancer Institute, Chennai	A panoramic view of cancer
20-11-2015	Arijit Kundu Technion, Haifa	Topology and Transport in Periodically Driven Systems
20-11-2015	Fahad Panolan	PC journal club
23-11-2015	Venkat Guruswami CMU	Progress in Error-Correction: New Codes for Old Noise Models
26-11-2015	Venkat Guruswami CMU	Repairing Reed-Solomon Codes

26-11-2015	Claus Koestler University College Cork, Ireland	On the representation theory of the Thompson group F
27-11-2015	Gautham Shekhar ISI, Chennai	Cryptography
27-11-2015	Claus Koestler UC Cork, Ireland	Representations of Thompson group F
30-11-2015	Gerardo Adesso University of Nottingham, Nottingham, United Kingdom	Signatures of quantumness in composite systems
1-12-2015	Gerardo Adesso Univ. of Nottingham	Discussion on steering
8-12-2015	Vivek Vyas IMSC	Quantum theory of nonlocal nonlinear Schrodinger equation
14-12-2015	Gergely HARCOS	Primes, Polignac, Polymath
15-12-2015	Mithun Biswas University of Freiburg, Germany	Selective Regulation of Nucleic Acid Complexes from a Molecular Dynamics Simulation Perspective
16-12-2015	Sridhar P Narayanan IMSc	Hall's Theorem on Couting Subgroups in Finite Abelian Groups
18-12-2015	Abhishek Chowdhury HRI	Hilbert Series and Black Hole Microstate Counting
18-12-2015	Sushant Raut KTH Royal Institute of Technology, Stockholm	Physics with ultra high energy neutrinos
21-12-2015	Raghu Murtugudde University of Maryland	ENSO Diversity, Asymmetry and Extremes: A Unifying High-Frequency Driver
21-12-2015	Prateek Karandikar LIAFA, Paris, France	Decidability in the logic of subsequences and supersequences
22-12-2015	Fahad Panolan IMSc	Dynamic Programming using Representative Families

23-12-2015	M. Ram Murty Queen's University	Ramanujan Expansions, Shifted Convolutions Twin Primes
28-12-2015	Ramanathan S Thinniyam IMSc	Definability in First order theories of graph orderings
28-12-2015	Sachin Gautam Perimeter Institute	Yangians, quantum loop algebras and elliptic quantum groups
29-12-2015	Maria Angelica Cueto Ohio State University	Non-Archimedean Combinatorics
4-1-2016	Christopher Woodward Rutgers University, USA	Symplectic geometry and vortices
5-1-2016	Christopher Woodward Rutgers University, USA	Quantum cohomology of quotients
6-1-2016	Mithun Biswas University of Freiburg, Germany	Selective Regulation of Nucleic Acid Complexes from a Molecular Dynamics Simulation Perspective
6-1-2015	Hans van Ditmarsch LORIA, Nancy, France	Five Funny Bisimulations
7-1-2016	Upayan Baul IMSc	Interaction of biomimetic antimicrobial polymers with model lipid bilayers
7-1-2016	Christopher Woodward Rutgers University, USA	Abelianization of moduli of bundles
8-1-2016	Abha Sur Massachusetts Institute of Technology	Caste-distance, Affinities, and Anxieties in Indian Anthropometry, 1920-1960
8-1-2016	Lakshya Bhardwaj Perimeter Institute of Theoretical Physics	UV-complete 6d theories from F-theory
14-1-2016	George Thomas IISER–Mohali	Role of coupling and prior information in quantum heat engines

14-1-2016	Olivier Ramare University of Lille1	The circle method after H. Iwaniec and a spectral resolution of the large sieve
18-1-2016	Abhishek Majhi IMSc	Energy spectrum of black holes : a new view
19-1-2016	T. P. Sreeraj S. N. Bose Institute	Gauge theories, spin models and hydrogen atoms
20-1-2016	Soumen Basak Astrophysics Department, SISSA, Italy	The Universe as seen by Planck
22-1-2016	Juergen Horbach University of Duesseldorf	Solids and fluids at interfaces: Novel simulation techniques
22-1-2016	Anil Shukla IMSc	Are Short Proofs Narrow? QBF Resolution is not Simple.
25-1-2016	I. Karthik TIFR, Mumbai	Chern-Simons matter theories
25-1-2016	Anvy Moly Tom IMSc	Aggregation Dynamics of Rigid Polyelectrolytes
27-1-2016	I. Karthik TIFR, Mumbai	Chern-Simons matter theories - II
27-1-2016	Sebastien Palcoux IMSc	Cyclic subfactors
27-1-2016	Sruthy Murali IMSc	Coxeter groups
28-1-2016	I. Karthik TIFR, Mumbai	Chern-Simons matter theories - III
28-1-2016	P. Philippon University of Paris VI	Mahler method and Galois theory
28-1-2016	Madhav Ranganathan IIT Kanpur	Numerical Modeling of Amoeboid Swimming of Cells

28-1-2016	Teodor Knapik Univ. of New Caledonia	Markov decision processes: building and playing a plantation game
29-1-2016	Manuel Asorey University of Zaragoza, Spain	Topological entropy and renormalization group flows
1-2-2016	Sandip Pakvasa University of Hawaii	The Stern-Gerlach experiment and the Discovery (?) of Electron Spin
1-2-2016	Daniel Bonamy CEA Saclay, Paris	Defects and fracture: some outcomes from statistical physics
4-2-2016	Sushmita Venugopalan Chennai Mathematical Institute	Moment map and the vortex equation
8-2-2016	Arghya Mondal IMSc	Cohomology of uniform lattices in $\mathrm{SO}^*(2n)$
8-2-2016	Sandipan De IMSc	Infinite iterated cross products, Drinfeld doubles and 2-cabling planar algebras
9-2-2016	Priyanka JNCASR	Correlation function of one-dimensional nonequilibrium lattice gas models with jamming transition
9-2-2016	Rohini Godbole IISc	The 750 GeV diphoton signal: will it light up the particle world?
12-2-2016	Kumar Eswaran Department of Computer Science, Sreenidhi Institute of Science and Technology, Hyderabad	On New Algorithms for AI and Neural Network Research
15-2-2016	Rahul Nandkishore University of Colorado	Disordered Dirac Fermions
16-2-2016	Tulsi Srinivasan Ben Gurion University, Israel.	Lusternik-Schnirelmann category of general spaces
16-2-2016	Prashant Batra Hamburg University of Technology	Some polynomial encounters

18-2-2016	Deshdeep Sahdev IIT Kanpur	Resolving Atom in our Backyards: Indigenous Technology in a Globalized World
19-2-2016	A.P. Balachandran Syracuse University	Localisation in Quantum Field Theory
19-2-2016	Jayadev Athreya UIUC	Rectangular Billiards and Volumes of Moduli Spaces
19-2-2016	Jaikumar Radhakrishnan TIFR, Mumbai	Communication assisted agreement distillation
22-2-2016	Manjari Bagchi IMSc	Ultra-compact objects in binaries: Looking through gravitational waves
24-2-2016	Nikolai Tyurin BLTPh, JINR	Geometric quantization and Lagrangian geometry - Part I
24-2-2016	Kamalakshya Mahatab IMSc	Measure theoretic analysis of error terms
25-2-2016	Rishi Vyas Ben Gurion University of the Negev	Anoncommutative Matlis-Greenlees-May equivalence
26-2-2016	Nikolai Tyurin BLTPh, JINR	Geometric quantization and Lagrangian geometry - Part II
26-2-2016	Priyotosh Bandyopadhyay INFN Lecce, Italy	Standard Model and the Higgs boson(s)
29-2-2016	Nikolai Tyurin BLTPh, JINR	Geometric quantization and Lagrangian geometry - Part III
1-3-2016	Amritanshu Prasad IMSc	Pingala's Meru Prastaara, Integer Partitions, and Young's Lattice
2-3-2016	Nikolai Tyurin BLTPh, JINR	Special Bohr - Sommerfeld geometry
3-3-2016	T Subba Rao Kalpakkam	Biology

4-3-2016	Dietmar Berwanger ENS-Cachan, France	Coordination with imperfect information (Part 3)
4-3-2016	K V Subrahmanyam CMI	Polynomial time algorithms for the invariant theory of the left-right action.
7-3-2016	Achamveddu Gopakumar TIFR-Mumbai	GW150914: A transient gravitational wave event from a binary black hole merger
8-3-2016	Kedar Natarajan Wellcome Trust Sanger Institute/EBI, Cambridge, UK	General cell-cycle lessons from single-cell profiling of mouse embryonic stem cells
8-3-2016	K G Arun CMI, Chennai	Testing General Relativity using GW150914
9-3-2016	Debarati Chatterjee Indian Institute of Science	A theoretical approach to understand various bio-inspired soft condensed matter systems
11-3-2016	Subinay Dasgupta Department of Physics, University of Calcutta	First Occurrence Problem in Quantum Mechanics
11-3-2016	Sanjoy Biswas Korea Institute for Advance Study	Di-Higgs production: a window to new physics
15-3-2016	Sanjoy Biswas Korea Institute for Advance Study	Closing in on the Standard Model like Higgs boson
15-3-2016	Biswajyoti Saha IMSc	Analytic properties of the multiple zeta functions and its variants
16-3-2016	Sudipta Mukherji Institute of Physics, Bhubaneswar	Time-dependent backgrounds in AdS and boundary correlators
17-3-2016	Dileep Jatkar HRI	Free field realization of $\mathrm{BMS}_3 algebra$

17-3-2016	Sharma V. Thankachan Georgia Institute of Technology	Indexing Parameterized Text Succinctly
18-3-2016	Meena Mahajan IMSc	Enumerator polynomials: Completeness and Intermediate Complexity
18-3-2016	Aleksy Tralle University of Warmia and Mazury, Olsztyn	Homology Smale-Barden manifolds with K-contact and Sasakian structures
21-3-2016	Stefan Schuster Friedrich Schiller University Jena, Germany	Use of Evolutionary Game Theory for Biochemistry and Microbiology
21-3-2016	Rahul Sinha IMSc	Signal of right-handed currents in B meson decays
23-3-2016	V.Ravindran IMSc	FHEP - Public Talk
24-3-2016	Aprameyan Parthasarathy University of Paderborn	Domains of holomorphy for admissible Banach representations
24-3-2016	Prahladh Harsha TIFR	Partition bound is quadratically tight for product distributions
30-3-2016	Naresh Dadhich IUCAA, Pune and JMI, Delhi	Some features of Lovelock gravity
31-3-2016	Suman Ganguli IMSc	Collapse of Charged Null Fluid and Energy Conditions

Chapter 5

External Interactions

5.1 Collaborative Projects with Other Institutions

5.1.1 Algorithms and Complexity of Algebraic problems

The focus of this project is on algorithms and complexity theoretic questions for algebraic problems; more specifically, on identity testing problems, arithmetic circuit lower bounds, and isomorphism problems.

The project is funded by the Indo Max Planck Centre for Computer Sciences (IMPECS). The principal investigators include V Arvind and Meena Mahajan from IMSc, and Markus Bläser from Saarland University, Germany, and runs for a duration of 5 years beginning April 2011.

5.1.2 An integrated omics approach for a systems-level understanding of the metabolic dynamics during fungal biomass degradation

In this collaborative project, the investigators plan to better characterize the metabolic network of the model cellulolytic filamentous fungus, Neurospora crassa. This proposal was funded by EMSL/PNNL, USA for a period of 2 years (2015-2017). The investigators of this project are J. Philipp Benz (TU Munich, Germany), N. Louise Glass (UC Berkeley, USA), Luis F. Larrondo (Chile), Chaoguang Tian (Chinese Academy of Sciences) and Areejit Samal (IMSc).

5.1.3 CEFIPRA Project Proposal No 5401-A Sums of integers : Fourier Combinatorics computation

Colloborative project with R.Balasubramanian as the principal investigator from the Indian side and professor jean Marc Deshouillers from the French side. This is a three year project, starting from 2016.

5.1.4 Computational methods for identifying and analyzing design features of metabolic networks

This proposal was funded by the Max Planck Society and Indo-German Science and Technology Centre for a period of 4 years (2015-2018) to maintain the existing collaboration between Areejit Samal at IMSc and Jürgen Jost at Max Planck Institute for Mathematics in the Sciences, Leipzig. The aim of the proposal is to develop improved methods for analyzing metabolic networks to address specific challenges in systems and synthetic biology.

5.1.5 Correctness by Construction (CORCON)

This project is funded by the Marie Curie Actions – International Research Staff Exchange Scheme (IRSES) of the European Union FP7. It involves multiple nations and researchers, and runs for five years beginning January 2014. IMSc is involved in the sub-project on proof verification and proof complexity, jointly with the University of Leeds, UK. The principal investigators for this sub-project are Meena Mahajan from IMSc and Olaf Beyersdorff from the University of Leeds.

5.1.6 Correlation between hWW and tth coupling at the LHC

We intend to work on correlation between Higgs couplings with weak gauge bosons and the top quark. LHC measurement shows good agreement with the SM expectation. But there are room for new physics and it is our intention to dig out from the Higgs' coupling, if any hint of new physics may turn up.

5.1.7 EU-FP7 Indo-European Network on Mathematics in Health and Disease

This is a project which links multiple Indian and European institutions. Several meetings have been funded by this network and both European and IMSc researchers have made multiple visits under this project for collaborative research

5.1.8 Exact Geometric Computation for Nonlinear Problems

The EGC paradigm [Yap97] has been very successful at handling the issues of non-robustness in ge- ometric algorithms. The aim of the project is devise new algorithms for some of the fundamental nonlinear problems such as finding roots of analytic functions, and computing arrangements of curves and surfaces. We also provide worst case complexity bounds on the running time of these algorithms. The aim is to develop practical algorithms with optimal guarantee on the worst case running time.

5.1.9 India-based Neutrino Observatory (INO)

During this year INO reached an important stage. The project which had its birth at IMSc exactly 15 years ago in January 2000 got the full approval of the Government of India in January 2015. We have traveled quite far but have many more miles to go.

5.1.10 India-EU program on Mathematics for Health and Disease

The main aim of this project is to set up an Indo-European Research Network in Mathematics for Health and Disease, INDOEUROPEAN-MATHDS, that will allow the transfer of knowledge, research and training between partners. The Network involves physicists, mathematicians, statisticians, probabilists, biologists, immunologists and engineers. The Network will create new collaborations between previous INTI partners (Leeds, UCL, Utrecht, Vigo, Comillas, UBC, LANL, WEHI and IISc) and new partners (Basel, Hamilton, MIT, University of Hyderabad, JNCASR, IMSc and NII), and reinforce existing ones between INTI partners, in order to develop a lasting and fruitful research cooperation between all partners. It is planned to develop mathematical and computational models of host-pathogen and virus dynamics, with a focus on pathogenic and molecular characterisation of HIV-1, and the distribution of virulence in intra-host HIV quasispecies, in order to understand if regulation of immune activation can be a potentially optimum way for disease management,to develop mathematical and computational models of immune cellular processes, such as differentiation and cellular fate, as well as ageing, validated by experimental data, with a focus on T cells, to develop stochastic mathematical models of receptor-mediated processes in health and disease, with a focus on the CCR5 receptor, VEGF receptor, T cell receptor and B cell receptor, and to develop statistical tools and methods, using evolutionary game theory, to characterise the genomic fluidity of human pathogens, in order to understand microbial pathogen evolution and what constitutes the boundary between commensal and pathogenic organisms.

5.1.11 Indo-German research grant funded by the Humboldt Foundation

This research grant is to support exchange visits between IMSc and Humboldt University, Berlin. Originally a 3-year grant, this is currently in an extension period.

5.1.12 ITRA-Media Lab Asia Project on De-congesting India's transportation networks using mobile devices

The project envisages the use of mobile phones to estimate congestion and traffic patterns on urban roads. Based on the congestion metrics thus obtained, the project aims to develop algorithms and tools for traffic planning and management, using the mobile phone as a service platform. The proposed solution strategy consists of two distinct focus areas. The first focus area deals with the problem of estimating mobile phone densities to measure prevailing congestion and traffic patterns. The second focus area involves developing algorithms for traffic routing, control and prediction, based on the estimated congestion. The proposed work has enormous potential for applications, such as dynamic route planning, peak hour rush control, routing of emergency vehicles to and from disaster affected areas, evacuation planning, and traffic prediction. In addition, this work is expected to shed new conceptual insights into the general problem of control of complex networks with strategic agents, by bringing together ideas from several technical disciplines.

5.1.13 Mechanism of Active Intracellular Transport: Connecting Theory and Experiment

This DAE-Plan project attempts to combine experimental investigations, using fluorescence microscopy, of the motion of vesicle in axons of touch neurons of C. elegans with theoretical models. Smooth axonal transport is crucial for the healthy functioning of nerve cells and impairment of this transport is often seen in neurodegenerative disease. We plan to closely link the theory and experimental observations to come up with a detailed simulation of axonal transport mechanisms which can then be compared to experiments.

5.1.14 Quantitative analysis of Mitochondrial positioning in C. elegans axons

Dr. Varuni Prabhakar along with Prof. Gautam Menon, in collaboration with Prof. Sandhya Koushika (TIFR, Mumbai), have been working on Quantifying mitochondrial positioning in Caenorhabditis elegans neurons. Varuni Prabhakar has been working on an image analysis algorithm to process the microscope images that have been collected in Prof. Koushika's lab in order to understand how mitochondria are positioned along axons of neurons over the development of the worm.

5.2 Institute Associateships

The Institute has established short-term associateships in Mathematics, Theoretical Physics, Theoretical Computer Science and Computational Biology 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 01.04.15 to 31.03.16 are :

Dr. **S.K. Monowar Hossien**
Aliah University, Kolkata
15.10.2015 to 05.11.2015

Dr. **Gopal Chandra Shit**
Jadavpur University, Kolkata
11.10.2015 to 31.10.15

Dr. **K. Reji Kumar**
NSS College, Nilamel, Kerala
02.04.2015 to 31.05.2015 10.08.2015 to 04.09.2015 12.11.2015 to 30.12.2015

Dr. **Bikas Chandra Paul**
North Bengal University, Siliguri, Darjeeling.
21.06.2015 to 05.07.2015 01.11.2015 to 05.07.2015

Dr. **MD. Mehedi Kalam**
Aliah University, Kolkatta, India
15.10.2015 to 05.11.2015

Dr. **V. Sunitha Vadivel Murugan**
Dhirubhai Ambani Inst. of ICT, Gandhi Nagar, Gujarat
11.05.2015 to 20.06.2015 10.08.2015 to 30.08.2015

5.3 Conference Participation and Visits to Other Institutions

Ahmed, Taushif

Participated in *Summer School on Particle Physics* held at ICTP, Italy during Jun 15 – Jun 26, 2015. The goal of the school was to give a detailed overview of particle physics and cover the most important areas where significant progress has been achieved recently.

Visited INFN Torino, Italy during Jul 2 – Jul 4, 2015. Presented seminar on "Threshold Corrections to DY and Higgs at N3LO QCD"

Visited INFN Milan, Italy during Jul 5 – Jul 11, 2015. Presented seminar on "Threshold Corrections to DY and Higgs at N3LO QCD"

Visited DESY, Germany during Jul 12 – Jul 18, 2015. Presented seminar on "Threshold Corrections to DY and Higgs at N3LO QCD"

Visited Wuppertal University, Germany during Jul 19 – Jul 25, 2015. Presented seminar on "Threshold Corrections to DY and Higgs at N3LO QCD"

Participated in *Multi-loop and Multi-leg processes for precision physics at the LHC* held at SINP, Kolkata during Feb 23 – Feb 27, 2016. This workshop mainly focused to discuss precision QCD+EW physics at the hadron collider.

Participated in *MHV @ 30: Amplitudes and Modern Applications* held at Fermilab, USA during Mar 16 – Mar 19, 2016. The workshop featured presentations on the latest progress in the understanding of amplitude properties in gauge theories and in gravity. It covered advances on both formal and applied sides and was being organized on the occasion of 30 years of MHV.

Visited University of Buffalo, USA during Mar 21 – Mar 24, 2016. Presented seminar on "Pseudo-scalar Form Factors at 3-loop in QCD"

Akhilesh, P.

Participated in *A conference in Number Theory* held at Institute of Mathematical Sciences, Chennai during Dec 14 – Dec 18, 2015.

Participated in *Indo-French Program for Mathematics* held at Institute of Mathematical Sciences, Chennai during Jan 11 – Jan 24, 2016.

Participated in *Workshop on Automorphic forms* held at Kerala School of Mathematics (KSOM),Kozhikode during Feb 10 – Feb 16, 2016.

Visited Harish-Chandra Research Institute (HRI) during Feb 20 – Mar 31, 2016.

Participated in *Triveni: Number Theory Meet* held at Harish-Chandra Research Institute (HRI),Allahabad during Mar 4 – Mar 8, 2016.

Arvind, V.

Visited IIT, Rourkee during Apr 14 – Apr 18, 2015. Gave two seminar talks

Visited Humboldt University, Berlin, during Aug 31 – Sep 12, 2015. Research. Visit supported by a joint project funded by the Humboldt Foundation

Ashok, Sujay K.

Visited Department of Physics, INFN, Torino during May 4 – Jun 15, 2015. Collaboration

Participated in *Indo-Israel conference on String Theory* held at Goa, India during Dec 21 – Dec 26, 2015. Invited speaker

Bagchi, Manjari

Visited Institute of Space Sciences (IEEC-CSIC), Barcelona, Spain during Dec 1, 2014 – May 29, 2015. Performing collaborative research activities.

Visited Jodrell Bank Centre for Astrophysics, University of Manchester, UK during Apr 27 – May 1, 2015. Deliverd a seminar: Binary radio pulsars with ultra-compact companions on April 30, 2015.

Visited School of Physics and Astronomy, The University of Birmingham, Birmingham, UK during May 4 – May 5, 2015. Gave a seminar: Use of binary radio pulsars with ultra-compact companions to understand basic physics on May 5, 2015.

Visited Department of Physics, Oxford University, Oxford, UK during May 6 – May 8, 2015. Gave a seminar: Use of binary radio pulsars with ultra-compact companions to understand basic physics - a seminar given on May 6, 2015.

Visited Department of Mathematics, The University of Southampton, Southampton, UK during May 11 – May 15, 2015. Gave a seminar: Use of binary radio pulsars with ultra-compact companions to understand basic physics on May 14, 2015.

Participated in *6th Indo-American Frontiers of Science Symposium* held at Arnold and Mabel Beckman Center, Irvine, California, USA during Aug 9 – Aug 12, 2015. A poster presentation: Use of binary radio pulsars with compact companions to understand basic physics.

Participated in *International Conference on Gravitation and Cosmology (ICGC)* held at Indian Institute of Science Education and Research Mohali, Mohali during Dec 14 – Dec 18, 2015. An oral presentation: Use of binary radio pulsars with compact companions to understand gravity.

Bakshi, Keshab Chandra

Participated in *Planar algebras, C^*-tensor categories and approximation properties of subfactors.* held at Indian Statistical Institute, Kolkata during Jan 18 – Jan 22, 2016. Presentation: On Pimsner Popa bases

Participated in *Advanced Instructional School in operator theory/algebras* held at Imsc during Feb 1 – Feb 20, 2016.

Balasubramanian, R.

Participated in *Elliptic curve cryptology 2015* held at University of bordeaux , France during Oct 23 – Oct 30, 2015. As a participant

Visited Indian Statistical institute on Mar 1, 2016. Delivered the S.K.Banerjee memorial lecture on Pell Brahmagupta equation

Participated in *Triveni :Number theory meet @HRI* held at HRI , Allahabad during Mar 4 – Mar 8, 2016. Delivered a lecture on Shifted sums and Elliptic curves

Participated in *current trends in cryptography and cyber security* held at Coimbatore institute of Engineering and Technology during Mar 18 – Mar 19, 2016. Delivered a lecture on the above topic The conference is sponsored by the Academy of Sciences India

Banerjee, Pinaki

Participated in *Spring School on Superstring Theory and Related Topics* held at International Centre for Theoretical Physics, Trieste, Italy during Mar 25 – Apr 2, 2015.

Participated in *Advanced Strings School 2015* held at International Centre for Theoretical Sciences, Bangaluru,India during Jun 11 – Jun 18, 2015.

Participated in *Strings 2015* held at International Centre for Theoretical Sciences, Bangaluru,India during Jun 22 – Jun 26, 2015.

Participated in *Spring School on Superstring Theory and Related Topics* held at International Centre for Theoretical Physics, Trieste, Italy during Mar 10 – Mar 18, 2016.

Participated in *Workshop on Topics in Three Dimensional Gravity* held at International

Centre for Theoretical Physics, Trieste, Italy during Mar 21 – Mar 24, 2016.

Visited University of Santiago de Compostela, Spain during Mar 27 – Mar 31, 2016. Gave a talk on “Conformal blocks, Heavy States and Entanglement Entropy”.

Chakraborty, Abhijit

Participated in *Indo-US Workshop on Time Series Analysis* held at IISER, Pune during May 25 – May 30, 2015. Presented a poster

Visited IISER Kolkata during Oct 26 – Nov 13, 2015.

Participated in *International workshop on Econophysics Sociophysics* held at JNU DU, Delhi during Nov 27 – Dec 1, 2015. Presented a poster

Chakraborty, Sankardeep

Participated in *COCOON 2015* held at Beijing, China during Aug 4 – Aug 6, 2015.

Chandrashekar, C. M.

Participated in *American Mathematical Society -Joint Mathematics Meeting 2016* held at Washington State Convention Center, Seattle, WA, USA during Jan 6 – Jan 9, 2016. To deliver invited talk in “AMS Special Session on Quantum Walks, Quantum Markov Chains, Quantum Computation and Related Topics”

Participated in *International School and Conference on Quantum Information (ISCQI) - 2016* held at Institute of Physics (IOP), Bhubaneswar, Orissa, India during Feb 14 – Feb 19, 2016. To deliver an invited talk in the conference

Chaudhuri, Pinaki P.

Participated in *Discussion meeting on “The Nonlinear Physics of Complex Flows and Amorphous Solids”* held at TIFR-ICTS, Bangalore during Apr 6 – Apr 8, 2015. Discussant and Session chair

Visited Institut fr Theoretische Physik II, Heinrich-Heine-Universitt Dsseldorf during Jun 16 – Jul 31, 2015.

Participated in *Length Scale Phenomena in Condensed Matter Physics* held at JNCASR, Bangalore on Oct 8, 2015. Talk on “Cavitation in amorphous solids”

Participated in *3rd Soft Matter Young Investigators’ Meeting* held at Hotel Atithi, Pondicherry during Dec 17 – Dec 20, 2015. Convenor, Organising Committee

Participated in *Compflu 2016* held at IISER, Pune during Jan 2 – Jan 4, 2016. Session organiser and chair - "Glass forming liquids and amorphous solids"

Participated in *Emergent Phenomena in Soft And Active Matter* held at JNCASR, Bangalore during Jan 5 – Jan 6, 2016. Talk on "Interplay of slow dynamics and coarsening in glassy systems"

Visited Indian Institute of Science, Bangalore during Feb 10 – Feb 11, 2016.

Participated in *3rd Indian Statistical Physics Community Meeting* held at ICTS, Bangalore during Feb 12 – Feb 14, 2016. Talk on "Anomalous dynamics during gel coarsening"

Date, G.

Participated in *International Conference on Gravitation and Cosmology* held at IISER Mohali during Dec 14 – Dec 18, 2015. Participated as the President of the IAGRG and also gave a talk on *Quadrupole field of compact sources in de Sitter background.*

Participated in *100 Years of General Relativity: Where do we stand?* held at Dept. of Physics, IIT Guwahati on Feb 13, 2016. Gave a colloquium on *Loop Quantization and Implications for Cosmology.*

Devanand, T.

Participated in *3rd Workshop and Conference on Modeling Infectious Diseases* held at IMSc, Chennai during Nov 23 – Dec 1, 2015.

Participated in *Winter School on Quantitative Systems Biology 2015* held at ICTS, Bangalore during Dec 5 – Dec 19, 2015.

Dutta, Arghya

Participated in *Fluctuation driven phenomena in non-equilibrium statistical mechanics* held at Mathematics Institute, University of Warwick, England during Sep 21 – Sep 25, 2015. Gave a talk

Participated in *Programme on Non-equilibrium statistical physics* held at ICTS, Bangalore during Oct 26 – Nov 20, 2015.

Participated in *Fracmeet 2016* held at IMSc, Chennai during Feb 1 – Feb 4, 2016.

Participated in *Indian Statistical Physics Community Meeting 2016* held at ICTS, Bangalore during Feb 12 – Feb 14, 2016. Presented a poster

Participated in *Avalanches, plasticity, and nonlinear response in nonequilibrium solids* held at YITP, University of Kyoto, Japan during Mar 7 – Mar 9, 2016. Presented a poster

Visited Earthquake research institute, University of Tokyo during Mar 10 – Mar 12, 2016.

Ghosh, Ria

Participated in *Santa Fe Institute Complex Systems Winter School* held at IISER Mohali during Dec 7 – Dec 21, 2015.

Participated in *Complex System Approach to Self-Organization* held at IIT Madras during Feb 1 – Feb 5, 2016. Presented a poster at the conference.

Ghosh, Sibasish

Participated in *Summer School on Quantum Correlation: Foundation, Information Processing and Various Applications* held at Physics and Applied Mathematics Unit, Indian Statistical Institute, Kolkata during Jun 22 – Jul 3, 2015. Gave a series of invited lectures in the School.

Participated in *Discussion Meeting on Quantum Information Processing* held at CHEP, IISc, Bangalore during Jun 29 – Jun 30, 2015. Gave an invited talk at the Meeting.

Participated in *Quantum Information Processing and Applications (QIPA-2015)* held at HRI–Allahabad during Dec 7 – Dec 13, 2015. Gave an invited talk at QIPA-2015

Participated in *International Conference on Light Quanta: Modern Perspectives and Applications (ICLQMPA-2015)* held at Physics Department, University of Allahabad during Dec 14 – Dec 16, 2015. Gave an invited talk at ICLQMPA-2015

Participated in *International Workshop on Quantum Physics: Foundations and Applications* held at CHEP, IISc, Bangalore during Jan 31 – Feb 13, 2016. Gave an invited talk in the Workshop.

Participated in *International School and Conference on Quantum Information-2016* held at IOP–Bhubaneswar during Feb 9 – Feb 18, 2016. Gave a series of invited lectures in the School part as well as an invited talk in the Conference part.

Visited Indian Statistical Institute, Kolkata during Mar 18 – Mar 28, 2016. Visited the Physics and Applied Mathematics Unit (PAMU) of ISI-Kolkata, interacted with the members in the group of Prof. Guruprasad Kar there at PAMU on some of our ongoing research projects, and also gave two seminars.

Gopalakrishna, Shrihari

Gave *Invited Talks, Seminars, Lecture Series* as listed below:

- "Theoretical Aspects of Dark Matter and Dark Energy." Tamilnadu Science and Technology Centre, Chennai, Oct 2015.
- "Current Status of Extra Dimension (inspired) Models." Workshop on High Energy Physics Phenomenology XIV, IIT-Kanpur, Dec 2015.
- "Dark Matter: Evidence, Theory and Detection Prospects." Current Issues in Cosmology, Astrophysics and High Energy Physics, Dibrugarh University, Nov 2015.
- "Phenomenology of vector-like fermions and new scalars." HEP seminar, California Institute of Technology, USA, Aug 2015.
- "Particle Physics at the Energy and Intensity Frontiers." Sixth Indo-American Frontiers of Science Symposium, Irvine, CA, Aug 2015.

Gun, S.

Visited University of Bordeaux during Mar 20 – Apr 17, 2015. Research Collaboration

Visited University of Paris VI during Apr 17 – Jun 5, 2015. Research Collaboration

Participated in *Arithmetique et autres Mathematiques* held at Institut Henri Poincare, Paris, France during Jun 2 – Jun 3, 2015. Invited Speaker

Visited Kerala School of Mathematics during Feb 10 – Feb 13, 2016. Lectured in a Workshop on Automorphic forms

Participated in *Workshop on Automorphic Forms* held at Kerala School of Mathematics during Feb 10 – Feb 13, 2016. Invited Speaker

Visited Harish-Chandra Research Institute during Feb 26 – Mar 5, 2016. Academic Visit

Krishna, M.

Visited Indian Statistical Institute, Bengaluru during Jun 18 – Jun 19, 2015. Gave a talk on 'Eigenvalue statistics of random operators' in honour of Prof Pl Muthuramalingam, on the eve of his superannuation.

Visited Indian Institute of Science, Department of Mathematics during Aug 1, 2015 – Mar 31, 2016. Visiting on Sabbatical Leave from IMSc and continuing research. Teaching a course on Quantum Mechanics

Visited Indian Institute of Technology, Kanpur during Nov 4 – Nov 6, 2015. Gave Colloquium talk on "Eigenvalue statistics for Random Operators"

Participated in *Operator Theory* held at Indian Statistical Institute, Bengaluru during Dec 1 – Dec 3, 2015. Gave a talk on 'Some consequences of Inverse Spectral Theory'.

Participated in *Indo - French Conference* held at Institute of Mathematical Sciences, Chennai during Jan 18 – Jan 19, 2016. Gave a talk on 'Eigenvalue statistics for random operators'.

Visited Tata Institute of Fundamental Research - Center for Applicable Mathematics, Bengaluru on Mar 1, 2016. Gave a colloquium talk on 'Eigenvalue statistics of Random Operators'

Lodaya, Kamal

Visited TIFR Mumbai during May 4 – Jun 19, 2015. Gave a talk on "Axiomatizing regular expressions" on 18 June.

Participated in *14th Formal Methods update* held at IISc, Bangalore during Jul 16 – Jul 17, 2015. Gave a talk on "Regular expressions, sequents and cut".

Participated in *Automata, graphs and logic* held at Madras Christian College during Aug 7 – Aug 8, 2015. Gave a talk on "Relating logic to formal languages".

Participated in *Workshop on Circuits, logic and games* held at Schloss Dagstuhl, Germany during Sep 27 – Oct 2, 2015. Gave a talk on "Unary temporal and two-variable logics with threshold".

Visited BITS (Goa campus) during Nov 3 – Nov 6, 2015. Gave lectures on "Using formal logic in programming", "Model checking", "Automata, concurrency and communication". Also a general talk on "Death and life at comets".

Participated in *Calcutta Logic Circle annual meeting* held at IBRAD, Kolkata during Nov 6 – Nov 8, 2015. Gave a talk on "Reducing probability to satisfiability".

Participated in *Workshop on Algorithmic verification of real-time systems* held at IISc, Bangalore on Dec 19, 2015.

Visited Université de La Réunion during Jan 6 – Jan 10, 2016. Lectured on "Automata, nets and models for concurrency".

Participated in *Trends and challenges in quantitative verification* held at Infosys campus, Mysore Park during Feb 1 – Feb 4, 2016.

Participated in *6th Indian School on Logic and Applications* held at PSG College of Technology, Coimbatore during Mar 21 – Mar 26, 2016.

Mahajan, Meena

Participated in *National Conference on Automata, Graphs and Logic* held at MCC, Chennai during Aug 7 – Aug 8, 2015. Gave an invited talk titled "Connections between Automata Theory and Computational Complexity".

Visited University of Tübingen, Germany during Sep 23 – Sep 26, 2015. Gave a talk titled "The Shifted Partial Derivative Complexity of Elementary Symmetric Polynomials".

Participated in *Dagstuhl Seminar on Circuits, Logic, and Games* held at Leibniz Centre for Informatics, Dagstuhl, Germany during Sep 27 – Oct 2, 2015. Was one of the scientific organisers of the seminar.

Participated in *The Classification Program of Counting Complexity* held at Simons Institute for the Theory of Computing, Berkeley, California, U.S.A. during Mar 28 – Mar 31, 2016. Gave a talk titled "Enumerator polynomials: Completeness and Intermediate Complexity"

Majumdar, Diptapriyo

Visited University of Bergen, Norway during Sep 1 – Oct 5, 2015. Research Collaboration in Algorithms Group at the Department of Informatics in University of Bergen

Participated in *23rd European Symposium of Algorithms 2015* held at University of Patras, Greece during Sep 14 – Sep 16, 2015.

Participated in *10th International Symposium of Parameterized and Exact Computation 2015* held at University of Patras, Greece during Sep 16 – Sep 18, 2015. Presented a paper

Participated in *35th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science 2015* held at Indian Institute of Science, Bangalore during Dec 16 – Dec 18, 2015.

Mallick, Anish

Visited University of California, Irvine on Nov 5, 2015. Presentation: Jakšić-Last theorem for higher rank perturbation

Participated in *TexAMP 2015* held at University of Texas, Dallas during Nov 6 – Nov 8, 2015. Poster presentation: Jakšić-Last theorem for higher rank perturbation

Meesum, Syed M.

Participated in *Computing and Combinatorics: 21st International Conference, COCOON 2015* held at Beijing, China during Aug 4 – Aug 6, 2015. Presented the paper titled

"Reducing Rank of the Adjacency Matrix by Graph Modification".

Mehta, Jay

Visited Graduate School of Advanced Technology, Kinki University during Oct 15 – Oct 24, 2015. Academic Visit (Research collaboration)

Participated in *A conference in Number Theory* held at Institute of Mathematical Sciences, Chennai during Dec 14 – Dec 18, 2015.

Participated in *Indo-French Conference* held at Institute of Mathematical Sciences during Jan 11 – Jan 24, 2016.

Menon, Gautam I.

Participated in *Mathematics for Health and Disease* held at ICMS, Edinburgh during Apr 13 – Apr 17, 2015. Gave an invited talk on "A Computational Model for Chromosome Positioning". Was also an organizer of this meeting

Participated in *40th Anniversary Institute Colloquium Series, Institute of Physics, Bhubaneswar* held at Institute of Physics, Bhubaneswar on Apr 23, 2015. Presented an invited talk on "Active Matter and Nuclear Physics"

Participated in *Mechanical manipulations and responses at the scale of the cell and beyond* held at Raman Research Institute, Bengaluru during Apr 24 – Apr 26, 2015. Gave an invited talk on "Simple Models for Stem Cell Mechanics"

Participated in *Mechanical manipulations and responses at the scale of the cell and beyond: Advanced School* held at NCBS, Bengaluru during Apr 27 – Apr 30, 2015. Gave a set of two invited lectures on "Introduction to Biophysics"

Participated in *FACETS-2015* held at IMSc, Chennai on Jun 29, 2015. Gave an invited public talk on "Contagion: Modelling Infectious Diseases"

Visited Pacific Mathematics Institute, University of British Columbia and Simon Fraser University, Vancover, Canada during Sep 3 – Sep 10, 2015. Gave three lectures across these two institutions, on "A computational model for chromosome positioning: and "Some Benefits of Crowding". Explored various collaborative interactions in infectious disease modeling with applied mathematicians at UBC.

Visited TIFR, Mumbai during Oct 19 – Oct 23, 2015. Collaborative Discussions with the group of Sandhya Koushika

Visited Department of Chemical Engineering, IISC, Bengaluru on Oct 29, 2015. Delivered a Colloquium on "Chromosome Positioning and Active Matter"

Visited Centre for Human Genomics, Bengaluru on Oct 30, 2015. Gave an invited talk on "Nuclear Architecture"

Participated in *DST-INSPIRE program* held at JNNCE, Shimoga during Dec 27 – Dec 28, 2015. Invited lectures on (1) Orders of Magnitude (2) Dimensional Analysis

Visited IISER-Pune during Jan 1 – Jan 4, 2016. Attended the Conference on Soft Matter

Participated in *Information Processing in Biological Systems* held at ICTS, Bengaluru during Jan 4 – Jan 8, 2016. Invited talk on "The Wisdom of Crowding"

Visited TIFR, Mumbai during Jan 15 – Jan 18, 2016. Visit for collaborations with the group of Prof. Sandhya Koushika

Visited Human Frontier Science Program, Strasbourg, France during Jan 24 – Jan 28, 2016. Attended the reviewing session of the HFSP Program

Participated in *Complex Systems Approach to Self-Organization* held at IITM, Chennai during Feb 1 – Feb 5, 2016. Presented an invited talk on "Robust Transport in Crowded Biological Environments"

Participated in *International Symposium on Health Analytics and Disease Management,* held at IIPH, Hyderabad during Feb 29 – Mar 1, 2016. Gave an invited talk on "Modeling Infectious Diseases in Space and Time"

Visited Institute of Physics, Bhubaneswar during Mar 21 – Mar 22, 2016. Gave a Colloqium on "Modeling Infectious Diseases" as part of the seminar series on complex systems

Menon, Shakti N.

Participated in *Indo-US Workshop on Time Series Analysis* held at IISER Pune during May 25 – May 30, 2015.

Participated in *6th Bangalore school on Statistical Physics* held at Raman Research Institute during Jul 2 – Jul 18, 2015.

Participated in *Infectious Disease Modelling Workshop* held at IMSc during Nov 23 – Dec 1, 2015.

Participated in *CompFlu 2016* held at IISER Pune during Jan 2 – Jan 4, 2016.

Mukhopadhyay, Anirban

Participated in *Conference in number theory* held at IMSC, Chennai during Dec 14 – Dec 18, 2015. Gave a talk on "Erdos-Falconer Distance problem"

Participated in *Indo-French conference* held at IMSc, Chennai during Jan 11 – Jan 24, 2016.

Participated in *Triveni lectures in Number theory* held at HRI, Allahabad during Mar 4 – Mar 8, 2016. Gave a talk on " Measuring fluctuations of error terms"

Mukhopadhyay, Partha

Visited Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Russia during Jul 29 – Aug 8, 2015. Discussed with colleagues on overlapping research interests. Delivered talk: Loop Space Quantum Mechanics

Participated in *Supersymmetries and Quantum Symmetries (SQS'2015)* held at Bogoliubov Laboratory of Theoretical Physics, Dubna, Russia during Aug 3 – Aug 8, 2015. Presented contributory talk: Tubular geometry in loop space and nonlinear sigma model

Participated in *Workshop on String Perturbation Theory* held at Harish Chandra Research Institute, Allahabad, India during Feb 1 – Feb 13, 2016. Presented invited talk: Towards a theory of conformal string bits

Visited The Indian Association for the Cultivation of Science during Mar 28 – Mar 31, 2016. Discussed with colleagues on overlapping research interests. Delivered talk: Towards a theory of conformal string bits

Murthy, M.V.N.

Visited Indian Association of Chemists and Allied Scientists (IANAS), Southern Chapter on Apr 20, 2015. Glen Seaborg Memorial Lecture on "The Big World of Small Neutrinos" at IGCAR Auditorium

Visited Department of Physics Kuriakose Elias College Mannanam, Kottayam

during Sep 29 – Sep 30, 2015. International Conference on Nuclear, High Energy and Astrop Physics: Delivered three lectures on 1. The Big World of Small Neutrinos, 2. The Mysterious Dark Matter, 3. Remembering Hiroshima after 60 years.

Nagaraj, D. S.

Visited University D'Artois during May 1 – May 31, 2015. To collaborate for research in Mathematics with Prof. A. El. Mazouni.

Visited University of Lille during Aug 23 – Sep 24, 2015. To collaborate to do research in mathematics with Prof. F. Laytimi

Participated in *50 year of Narasimhan-Seshadri Theorem* held at CMI Chennai during Oct 5 – Oct 16, 2015. Member of the Organizing committee. Gave a survey talk titled "Parabolic

Bundles and Parabolic Higgs bundles”

Participated in *Algebraic Surfaces and Related Topics* held at ICTS Bangalore during Nov 21 – Nov 30, 2015. Gave a invited talk “Tangent bundle of $mathbbP^2$ and morphism to Gr$(2, 4)$”.

Participated in *Grothendick Reimann-Roch Theorem* held at Hyderabad University, Hyderabad during Dec 1 – Dec 18, 2015. Gave five 1:30hrs talk on “cycle class and intersection Theory”

Participated in *3rd Indo-French conference in Mathematics* held at IMSc, Chennai during Jan 11 – Jan 24, 2016. Member of the organizing committee.

Visited J.S.S. College, Mysore on Feb 18, 2016. Participated in the conference “Recent advances in Mathematics” and gave a talk titled “in the world of Numbers”

Visited Hyderabad University during Feb 28 – Mar 3, 2016. Gave a talk on my research work, for the faculty and research students, titled “morphism from projective plane to Grassmannian”. Gave a popular talk for mathematics students titled “Algebraic Varieties over complex numbers”

Niyogi, Saurabh

Visited University of Delhi during Oct 4 – Oct 9, 2015. Meeting with Collaborators

Prabhakar, Varuni

Visited Tata Insititute for Fundamental Research, Mumbai during Jul 5 – Jul 14, 2015. Collaborative work with Prof. Sandhya Koushika

Prasad, Amritanshu

Participated in *Fourth India-Taiwan Conference on Discrete Mathematics* held at IIT Madras during Jul 10 – Jul 13, 2015. Invited Talk.

Participated in *Influence of Srinivasa Ramanujan's contributions in mathematics* held at Ramanujan Institute of Advanced Study in Mathematics, The University of Madras. on Feb 17, 2016. Gave a talk titled: Pingala's Meru Prastaara, Integer Partitions, and Young's lattice.

Participated in *NCM Workshop on Probability and Representation Theory* held at IMSc, Chennai during Mar 7 – Mar 12, 2016. Conducted sessions on the use of Sage to explore Markov chains and representations.

Participated in *Workshop on Group Theory organized by the Mathematical Society of St. Stephen's College* held at St. Stephen's College, Delhi during Mar 28 – Mar 29, 2016. Gave a lecture titled "Group Theory, the Language of Symmetry."

Raghavan, K. N.

Participated in *Advanced Training in Mathematics Workshop on Representation Theory of Semisimple Lie Groups* held at Indian Institute of Technology, Bombay during Apr 6 – Apr 11, 2015.

Participated in *Seventh Summer Training Programme at RIASM* held at Ramanujan Institute for Advanced Study in Mathematics, Madras University, Chennai during May 19 – May 21, 2015. Conducted sessions (lectures and tutorials) on group theory to masters students

Visited Vel Tech University, Avadi, Chennai on Jul 12, 2015. Evaluation of R & D project proposals by mathematics faculty

Participated in *Workshop on Algbera* held at Mathematics Department, University of Mysore during Aug 22 – Aug 23, 2015. Gave a lecture on Mutually Unbiased Bases.

Participated in *Refresher Course for College Teachers* held at Kerala School of Mathematics, Kozhikkode during Nov 12 – Nov 15, 2015. Participated as sole resource person for course with title "Filters, uniformities, and topological groups".

Participated in *AIS on Commutative Algebra* held at Chennai Mathematical Institute during Dec 21, 2015 – Jan 1, 2016. Delivered six lectures and conducted tutorials as a resource person.

Participated in *CBSE Regional Science Exhibition* held at Vidya Mandir Senior Secondary School, Mylapore, Chennai during Jan 4 – Jan 5, 2016. Judge of exhibits.

Participated in *UGC Sponsored National Seminar on "Recent Advances in Mathematics and its Applications"* held at JSS College of Arts, Commerce and Science, Mysore during Feb 18 – Feb 19, 2016. Gave a lecture with title "A theorem about linear inequalities with an application"

Visited IISER, Bhopal during Mar 17 – Mar 18, 2016. Attended meeting and interacted with faculty.

Rai, Ashutosh

Participated in *Mathematical Foundations of Computer Science (MFCS), 2015* held at The University of Milan, Milan, Italy during Aug 24 – Aug 28, 2015. Presented a paper titled "Generalized Pseudoforest Deletion: Algorithms and Uniform Kernel".

Visited Vienna Institute of Technology, Vienna, Austria during Aug 30 – Sep 8, 2015. Visited Dr. M. S. Ramanujan for research collaboration.

Rajasekaran, G.

Participated in *INO Collaboration Meeting* held at IIT, Chennai during Apr 1 – Apr 4, 2015.

Visited Institute of Physics, Bhubaneswar during Apr 15 – Apr 16, 2015. Gave a Colloquium "Hundred years of Fundamental Physics and a Crisis" on 15 April.

Visited IISER-Thiruvananthapuram during May 3 – May 16, 2015. Gave a course of about 25 lectures on High Energy Physics

Participated in *Science Academies' Refresher Course in Quantum Mechanics* held at Loyola College, Chennai during May 11 – May 23, 2015. Helped in the Organization of the Course and taught a part of the Course on Quantum Mechanics

Visited University of California, Riverside during Jul 10 – Aug 4, 2015. Pursued collaborative research with Ernest Ma and Bipin Desai

Visited Raja Ramanna Centre for Advanced Technology, Indore during Sep 20 – Sep 23, 2015. Discussed the possibility of Laser-Plasma Research leading to Laser Plasma Accelerator and gave a Colloquium "Hundred Years of Fundamental Research and a Crisis".

Participated in *Physics Training and Talent Search (PTTS) Workshop* held at Kuvempu University, Karnataka during Dec 27 – Dec 30, 2015. Participated for 3 days. Interacted with the teachers and students of this program and gave a talk "Hundred Years of Fundamental Physics and its Future".

Visited Institute of Physics, Bhubaneswar during Jan 5 – Jan 6, 2016. Was a Member of a Panel to discuss the Future of IOP and ways to bring it to the top level as originally envisaged by the Founder and the Government.

Visited Madurai Kamaraj University during Feb 14 – Feb 20, 2016. Gave lectures on High Energy Physics

Participated in *Science Academies' Refresher Course on Quantum Mechanics* held at Government College, Melur, near Madurai during Feb 14 – Feb 20, 2016. Gave a part of the Course on Quantum Mechanics

Participated in *Frontiers in High Energy physics -III* held at IMSc, Chennai during Mar 22 – Mar 25, 2016. Gave a talk "Past, Present and Future of HEP".

Raman, Venkatesh

Participated in *SS Pillai Endownment Lecture* held at Manonmaniam Sundaranar University, Tirunelveli on Apr 10, 2015. Gave a talk on 'Turan's theorem: proofs and an algorithmic application'

Participated in *Workshop on Design and Analysis of Algorithms* held at Indian Institute of Information Technology and Management (IIITM-K) Trivandrum during Apr 24 – Apr 29, 2015. Coordinated the academic program and gave several lectures in advanced topic in algorithms.

Participated in *11th Conference on Academy of Discrete Mathematics and Applications* held at B. S. Abdur Rahman University, Chennai during Jun 10 – Jun 12, 2015. Gave an invited talk on 'Turan's theorem: proofs and an algorithmic application'

Participated in *National Conference on Discrete Mathematics and its applications* held at Manonmaniam Sundaranar University, Tirunelveli during Jul 15 – Jul 17, 2015. Gave a talk on 'Algorithms on Tournament Digraphs'

Participated in *A school on Algorithms and Techniques* held at B.S. Abdur Rahman University, Chennai during Jul 22 – Jul 28, 2015. Coordinated the academic program and gave a few lectures.

Visited Indian Institute of Technology, Jodhpur during Nov 16 – Dec 7, 2015. Taught a course, Design and Analysis of Algorithms to third year undergraduates; participated in the BTech project evaluations and PhD thesis seminars

Visited National Institute of Education, Nanyang Technological University, Singapore on Jan 8, 2016. Gave a talk on 'Turan's theorem: proofs and an algorithmic application'

Visited Singapore University of Technology and Design, Singapore on Jan 11, 2016. Gave a talk on 25 years of vertex cover parameterization

Visited National University of Singapore, Singapore on Jan 12, 2016. Gave a talk on 25 years of vertex cover parameterization

Participated in *Faculty Development Programme on Design and Analysis of Algorithms* held at SSN College of Engineering, Chennai during Jan 25 – Jan 29, 2016. Gave a lecture on Dynamic Programming and one on NP-completeness.

Participated in *ACM-MSR Academic Research Summit* held at Pune during Jan 29 – Jan 30, 2016.

Ramanujam, R.

Visited IIT-Madras during Sep 3 – Sep 16, 2015. Gave a mini-course of lectures on "Infinite games in formal verification".

Ray, Purusattam

Participated in *Growing Length Scale Phenomena in Condensed Matter Physics* held at JNCASR, Bangalore during Nov 8 – Nov 10, 2015. Invited speaker

Visited Physics Department, Calcutta University during Dec 21 – Dec 30, 2015. Scientific collaboration and seminar presentation.

Visited Saha Institute of Nuclear Physics, Kolkata during Feb 23 – Feb 26, 2016. Scientific collaboration and seminar presentation.

Samal, Areejit

Participated in *DBT-BIF workshop: Systems biology approaches for pathway analysis* held at ICGEB, Delhi during Apr 9 – Apr 10, 2015. Invited talk

Visited Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany during Oct 10 – Nov 9, 2015. Invited talk and research collaboration

Visited University of Jena, Germany on Nov 5, 2015. Invited talk

Participated in *NNMCB National Meeting* held at IISER Pune and NCL Pune during Dec 27 – Dec 30, 2015. Invited talk

Visited Stella Maris College, Chennai on Jan 22, 2016. Invited talk in DBT star college scheme

Participated in *School on population genetics and evolution* held at ICTS Bangalore during Jan 25 – Feb 5, 2016. Research talk

Participated in *41st Indian Society of Human Genetics (ISHG) Conference 2016: Celebrating Genetics - The Human Way* held at Lady Andal auditorium, Chetpet, Chennai during Mar 3 – Mar 5, 2016. Invited talk

Visited IISc, Bangalore during Mar 14 – Mar 15, 2016. Research collaboration

Sankaran, Parameswaran

Participated in *Thirtieth Annual Meeting of the Ramanujan Mathematical Society* held at IISER, Mohali during May 15 – May 17, 2015. Gave a plenary talk on 'Twisted conjugacy in certain homeomorphism groups'.

Participated in *Summer School for MSc Students* held at Ramanujan Institute for Advanced Studies in Mathematics, University of Madras during Jun 1 – Jun 2, 2015. Gave four lectures on topology.

Participated in *Topology and Groups* held at Goa University, Goa during Oct 17 – Oct 20, 2015. Gave a talk on 'Twisted conjugacy in PL-homeomorphism groups'

Participated in *Teacher Enrichment Workshop* held at IMSc, Chennai during Nov 23 – Nov 28, 2015. Gave six lectures on multivariate calculus.

Participated in *Vijyoshi–National Science Camp* held at IISc, Bangalore during Dec 18 – Dec 19, 2015. Gave a talk on 'Geometry–from Euclid to Bolyai and Lobachevsky'.

Participated in *Annual Meeting, Indian Mathematical Society* held at VNIT, Nagpur during Dec 28 – Dec 30, 2015. Gave the Ramanujan Lecture on 'Twisted conjugacy in PL-homeomorphism groups'.

Participated in *Refresher course in complex analysis* held at Kerala School of Mathematics, Kozhikode during Feb 18 – Feb 21, 2016. Gave eight lectures on 'Infinite series and products'.

Sathiapalan, Balachandran

Visited Kobe University during Oct 14 – Oct 28, 2015. Collaboration with Dr. Hidenori Sonoda

Saurabh, Saket

Visited Indian Institute of Technology, Gandhinagar during Jan 24 – Jan 31, 2016. Visited Dr. Neeldhara Misra for research purposes. Also, gave a talk there.

Sharma, Vikram

Visited Max Planck Institute for Informatics (MPII) during Jun 2 – Jun 25, 2015.

Participated in *International Symposium on Symbolic and Algebraic Computation (ISSAC)* held at University of Bath, UK during Jul 6 – Jul 9, 2015. Presented a paper

Participated in *Computability and Complexity in Analysis* held at Meiji University, Japan during Jul 12 – Jul 17, 2015. Gave an invited talk

Visited Tokyo University during Jul 18 – Jul 25, 2015.

Visited University of Reunion, Reunion, France during Jan 6 – Jan 11, 2016. Attended PANO meeting

Participated in *Triveni: Number Theory Meet* held at HRI, Allahabad during Mar 4 – Mar 8, 2016. Gave an invited talk

Sinha, Sitabhra

Participated in *Workshop on Mathematics for Health and Disease* held at International Centre for Mathematical Sciences, Edinburgh during Apr 13 – Apr 17, 2015. Gave invited talk on "Learning and Memory in the Eukaryotic Cell: Emergence of sensitization and adaptation in intra-cellular signaling"

Visited Dhirubhai Ambani Institute of Information and Communication Technology (DAI-ICT), Gandhinagar on Jun 26, 2015. Expert in Faculty Selection Interviews

Visited Saha Institute of Nuclear Physics, Kolkata during Oct 5 – Nov 13, 2015. Gave Institute colloquium talk on "Resolving social dilemmas using symmetry: The co-action solution for non-cooperative games"

Visited Indian Institute of Science Education and Research (IISER) Kolkata on Oct 14, 2015. Gave invited talk on "Why Mr Spock would be nice to strangers: The co-action solution framework for non-cooperative games resolves social dilemmas"

Participated in *Santa Fe Institute - IISER Mohali Complex Systems Winter School* held at Indian Institute of Science Education and Research (IISER) Mohali during Dec 6 – Dec 21, 2015. Gave two invited lectures on "Complexity in physiological systems"

Participated in *Second Workshop on Intelligent Transportation Systems, COMSNETS 2016* held at Chancery Pavilion Hotel, Bangalore on Jan 5, 2016. Gave invited talk on "Dynamics of Urban Traffic Congestion"

Visited National Institute of Technology (NIT), Agartala during Jan 29 – Jan 31, 2016. Gave three lectures on "Modeling biological systems using mathematics"

Participated in *Conference on Complex Systems Approach to Self-organization (CSAS 2016)* held at Indian Institute of Technology (IIT) Madras, Chennai during Feb 1 – Feb 5, 2016. Gave invited talk on "Imposing order by inducing chaotic traps: A new paradigm for controlling driven dynamical systems"

Participated in *4th International Conference on Complex Dynamical Systems and Applications (CDSA 2016)* held at National Institute of Technology (NIT), Durgapur during Feb 15 – Feb 17, 2016. Gave invited talk on "Why Networks Matter in the Brain: Symmetry exchange transitions, Coupling induced activity and Chaos-order coexistence in mesoscopic models of the nervous system"

Participated in *National Conference on Computational Mathematics and Nonlinear Dynamics (CMND 2016)* held at Department of Mathematics, Visva Bharati University, Santi Niketan during Feb 19 – Feb 21, 2016. Gave invited talk on "How networks enhance robustness in complex systems: Optimal interdependence and extreme multistability"

Participated in *International Symposium on Health Analytics and Disease Modeling (HADM-2106)* held at Indian Institute of Public Health, Hyderabad during Feb 29 – Mar 1, 2016. Gave invited talk on "Strong community organization of populations can promote long-term recurrence of epidemic diseases"

Srinivas, K.

Participated in *Elliptic Curves and Attacks on ECC based Schemes* held at ISI Delhi during Apr 6 – Apr 8, 2015. Delivered three talks on special attacks on ECC.

Participated in *30th Annual Conference of the Ramanujan mathematical Society* held at IISER, Mohali during May 15 – May 17, 2015. Delivered an invited talk.

Participated in *Lectures in Number Theory* held at Department of Mathematics, University of Pune, Pune. during Aug 5 – Aug 12, 2015. Delivered a course of 10 lectures on analytic number theory. About 50 people attended it. They included doctoral and master students, some UG students, many UG-faculty including some from engineering colleges, and some from the National Defense Academy.

Visited IISER, Pune on Aug 7, 2015. Delivered a colloquium talk on the zeros of the zeta functions.

Participated in *Teacher's Enrichment Workshop* held at IMSc, Chennai during Nov 23 – Nov 28, 2015. Delivered a course of six lectures on Complex analysis, Fourier transforms and Laplace transforms.

Visited IISER, Trivandrum during Feb 8 – Feb 12, 2016. Pursued collaborative work, delivered a colloquium talk.

Subramanian, C. R.

Participated in *National Workshop on Cryptography, Applications and Foundations of Data Science* held at National Institute of Technology, Goa during Oct 26 – Oct 30, 2015. Was a Resource Person and gave three lectures on Pseudorandomness and Cryptography

Participated in *Faculty Development Workshop on "Algorithms Analysis and Design"* held at National Institute of Technology, Warangal during Feb 29 – Mar 9, 2016. Was a Guest Speaker at the workshop and gave six lectures on NP-completeness and Approximation Algorithms.

Visited National Institute of Warangal during Mar 4 – Mar 6, 2016. Was a Guest Speaker at a Faculty Development Workshop.

Visited Indian Institute of Technology, Guwahati during Mar 11 – Mar 14, 2016. Visited and had interactions with faculty of the departments of Mathematics and Computer Science & Engineering

Sunder, V. S.

Visited ISI, Kolkata during Sep 6 – Sep 12, 2015. Delivered the Third SCB Memorial Lecture on 11/09/2015.

Participated in *Indo-Freach Cconference* held at IMSc during Jan 11 – Jan 23, 2016. Gave a lecture titled 'From Graphs to Free Probability' on 18/01/2016.

Visited IIT, Kanpur during Mar 3 – Mar 4, 2016. Delivered a colloquium lecture titled *Functional calculii: a pedagogical re-take on the spectral theorem.*

Vijayakumar, Sasidevan

Participated in *Indo-US Workshop on Time-Series Analysis* held at IISER, Pune during May 25 – May 30, 2015.

Participated in *European meeting on Game Theory* held at St. Petersburg University, Russia. during Jul 8 – Jul 10, 2015. Gave a talk titled "Symmetry warrants rational cooperation in social dilemmas"

Participated in *School on Non equilibrium Statistical Physics* held at Raman Research Institute, Bangalore during Jul 14 – Jul 18, 2015.

Participated in *Econophysics-Delhi* held at JNU, New Delhi during Nov 26 – Nov 30, 2015. Presented a poster

Participated in *Santa Fe Institute Indian Complex Systems Winter School* held at IISER, Mohali during Dec 6 – Dec 21, 2015.

Viswanadham, G. K.

Visited Harish Chandra Research institute, Allahabad during Jun 29 – Jul 29, 2015. Tutor for complex analysis, Annual Foundation School-3.

Participated in *AIS on Analytic Number theory* held at IMSc, Chennai during Oct 19 – Oct 24, 2015. Partcicipated in AIS on Analytic Number theory held at IMSc, Chennai

Participated in *Conference in Number Theory* held at IMSc, Chennai during Dec 14 – Dec 18, 2015.

Participated in *Indo-French Conference* held at IMSc, Chennai during Jan 11 – Jan 24, 2016.

Viswanath, Sankaran

Visited IIT Kanpur during Apr 8 – Apr 10, 2015. Delivered a Colloquium talk.

5.4 Visitors from Other Institutions

Bertin	01.04.15 - 05.04.15	ERIC, France
Martens Kirsten	01.04.15 - 05.04.15	France
Malay Banerjee	01.04.15 - 04.04.15	IIT, Kanpur
Bhaskaran Muralidharan	08.04.15 - 08-04-15	IIT, Bombay
Reji Kumar K	21.04.15 - 31.05.15	NSS College
Padha R	09.04.15 - 09.04.15	VIT, Vellore
Stephan Baien	20.04.15 - 03.05.15	TIFR, Bombay
Jitendra Kumar Parranaik	30.04.15 - 31.07.15	IISER, Kolkata
Prasad Perlekar	05.05.15 -07.05.15	TCIS, Hyderabad
Naveen Surevdran	08.05.15 - 12.05.15	IIST, Trivandram
Gopal Chandra Shit	11.05.15 - 05.06.15	Dept.of Mathematic, Jadavpur, Kolkata
Vineeta Bac	13.05.15 - 15.05.15	NII, New Delhi
Adhkar S. R	18.05.15 - 04.06.15	HRD, Allahabad
Sandhua Koushika	01.05.15 - 30.05.15	TIFR, Mumbai
Narayana Murhy C. S	22.05.15 - 23.05.15	IIST, Trivandram
Deepak Dhar	17.05.15 - 28.05.15	TIFR, Mumbai
Thomas Konrad	24.05.15 - 05.06.15	UKZN, South Africa
Syed Mohammed Kamic	15.05.15 - 31.05.15	Shivanadar University

Kebar Damle	27.05.15 - 28.05.15	TIFR, Mumbai
Sansale Vsha Keshav	19.05.15 - 30.05.15	School of Mathematical Science
Sivakumar	25.05.15 - 29.05.15	School pf Phy, University of Hyderabad
Ramij Rahaman	24.05.15 - 12.06.15	University of Allahabad
Samir Kunkra	26.05.15 - 15.06.15	Kolkata
Mahendra Khankar	01.06.15 - 08.06.15	Pillai Institute of Technology
Tanusree khandat	31.05.15 - 06.06.15	NISER, Bhubaneswar
Paul Raja P	07.08.15 - 09.06.15	Kalasalingam University, Krishnankoil
Bul Bul Chakraborty	09.06.15 - 11.06.15	Brandeis University, USA
Monowar Hossein	21.05.15 - 13.06.15	Aligarh Muslim University, Uttar Pradesh
Neha Gupta	14.06.15 - 21.06.15	Shiv Nadar University, Uttar Pradesh
Pushkar Joglekar	01.06.15 - 20.06.15	IIT, Jodhpur
Depajyoti Choudhuri	02.06.15 - 20.06.15	University of Delhi
Sunitha V	12.05.15 - 20.06.15	Gandhi Nagar, Gujarat
Jagan Pongubala	18.06.15 - 19.06.15	University of Hyderabad
Ivonne Zauala	28.06.15 - 30.06.15	Swansea University
Bikash Chandrapaul	21.06.15 - 05.07.15	University of North Begal
Dibyenda Das	02.07.15 - 03.07.15	IIT, Bombay

Sugata Gango Padhuay	04.07.15 - 12.07.15	IIT, Roorkee
Vijayalakshmi M	17.07.15 - 17.07.15	Sartra University
David Sinnoy	15.07.15 - 29.08.15	University of Paris
Shiv Chaitanya K. V. S	20.07.15 - 24.07.15	BITS, Hyderabad
Pruisker A. M. M	01.07.15 - 28.07.15	University of Amsterdam, Netherland
Sanjay Kumar Singh	16.07.15 - 16.08.15	Institute of Mathematics
Satti Srinivasa Rao	22.07.15 - 28.07.15	Seoul National University
Paritosh Pandya	30.07.15 - 03.08.15	TIFR, Bombay
Rao B. J	02.08.15 - 05.08.15	TIFR, Bombay
Loic Merel	01.08.15 - 30.08.15	University of Paris VII
Arup Bose	16.08.15 - 17.08.15	ISI, Kolkata
Ngangkham Nimai Singh	17.08.15 - 18.08.15	Manipur University, Impal
Debargha Banerjee	14.08.15 - 23.08.15	IISER, Pune
Rejikumar K	10.08.15 - 04.09.15	NSS College
Rao S. J	18.08.15 - 18.08.15	TIFR, Mumbai
Basant K Tivari	26.08.15 - 26.08.15	Pondicherry University
Diceep Jatkar	19.08.15 - 01.09.15	HRI, Allahabad
Sunitha V	10.08.15 - 29.08.15	DAIICT, Gandhinagar

Sengupta J	01.09.15 - 11.09.15	TIFR, Mumbai
Pranay Goel	07.09.15 - 09.09.15	IISER, Pune
Subinay Dasgupta	06.09.15 - 12.09.15	University of Calcutta
Mukunda N	10.09.15 - 13.09.15	C. V. Raman Research Institute, Bangalore
Chaturevedi S	10.09.15 - 13.09.15	University of Hyderabad
Bhaskar Saha	13.09.15 - 17.09.15	St. Xavier College, Mumbai
Umesh V. Dubey	09.09.15 - 16.09.15	IISC, Bangalore
Anindya S. Chakrabarti	15.09.15 - 25.09.15	Boston University, US
Prahladh Harsh	16.09.15 - 24.09.15	TIFR, Mumbai
Prasanna Venkataraman	06.1.015 - 07.10.15	TMH, Mumbai
Oesterle Joseph	03.10.15 - 06.02.16	University of Paris
Hari Dass N D	25.09.15 - 10.10.15	TIFR-TCIS
Pazuki Mehdi Fabien	09.10.15 - 26.10.15	University of Copenhagen
Gopal Chandra Shit	11.05.15 - 31.10.15	Jadavpur University, Kolkata
Mehedi Kalam M D	15.10.15 - 05.11.15	University of Kolkata
Zbigniew Beaszczyk	21.10.15 - 25.10.15	Adam Mickiewicz University, Poland
Stevan Spallone	17.10.15 - 25.10.15	TIFR, Mumbai
Stephan Baier	18.10.15 - 23.10.15	IISER, Trivandram
Samir Kunkri	24.10.15 - 11.11.15	Mahadevananda Mahavidyalaya, West Bengal

Ramakrishnan B	02.11.15 - 15.11.15	HRI, Allahabad
Subenoy Chakraburty	03.11.15 - 06.11.15	Jadavpur University, Kolkata
Bikas Chandrapaul	03.11.15 - 17.11.15	North Bengal University
Shiraz Minwalla	07.11.15 - 14.11.15	TIFR, Mumbai
Dileep Jatkar	09.11.15 - 14.11.15	HRI, Allahabad
Subhro Bhattacharjee	10.11.15 - 14.11.15	TIFR, Bangalore
Sandhya Koushika	11.11.15 - 19.11.15	TIFR, Mumbai
Gunter M. Schuetz	12.11.15 - 16.11.15	Forschungszentrum Jlich, GMBH
Maharana J	14.11.15 - 17.11.15	I. O. P, Bhuvaneshwar
Steven Spallone	17.11.15 - 21.11.15	IISER, Pune
Krishna S	17.11.15 - 21.11.15	Madurai Kamaraj University
Sarbeswaradal	21.11.15 - 28.11.15	IISER, Trivandram
Thelma. B. K	16.11.15 - 18.11.15	University of Delhi
Parimala Raman	19.11.15 - 15.01.16	Emory University
Claus Kostler	19.11.15 - 30.11.15	University College Cork, Ireland
Gerardo Adesso	29.11.15 - 06.12.15	University of Nottingham, UK
Raghu Murtugudde	20.12.15 - 22.12.15	University of Maryland, US
Sachin Gautam	21.12.15 - 01.01.16	PITP, Canada

Maria Aneelka Cueto	21.12.15 - 01.01.16	USA
Sourav	21.12.15 - 23.12.15	ISI, Kolkata
Ram Murthy	21.12.15 - 25.12.15	University of Toronto, Canada
Indranil	04.01.16 - 06.01.16	TIFR, Mumbai
Jean Baptiste	04.01.16 - 08.01.16	University of Namibia
Swarup Poria	22.12.16 - 11.01.16	University of Calcutta
Gautam Sekar	01.01.16 - 04.01.16	ISI, Chennai
Xavier Viennot	04.01.16 - 06.03.16	LABRI, France
Christopher Woodward	02.01.16 - 15.01.16	Rutgers University, USA
Preena Samuel	11.01.16 - 21.01.16	IIT, Kanpur
Juergen Horbach	21.01.16 - 26.01.16	University of Dsseldorf, Germany
Prusiken	15.01.16 - 15.03.16	University of Amsterdam, Netherlands
Teodor Knapik	16.01.16 - 17.01.17	University of New Caledonia
Krishnaswamy S	07.01.16 - 21.01.16	Madurai Kamaraj University
Manvel Asorey	27.01.16 - 30.01.16	University of Zargon
Sandip Pakavasa	27.01.16 - 03.02.16	University of Hawai
Nilendra Ganesh Desh	27.01.16 - 03.02.16	University of Oregon, US
Rao. B. J	07.02.16 - 14.02.16	TIFR, Mumbai
Benois	26.01.16 - 24.03.16	University of Bordeaux, France

Rajabhaduri	14.02.16 - 04.03.16	McMaster University, Canada
Prashant Batra	09.02.16 - 23.02.16	Hamburg University of Technology, Germany
Subhashish Banerjee	23.02.16 - 27.02.16	IIT, Jodhpur
Nikolai Tyurin	22.02.16 - 03.03.16	BLTP Russia
Gopakumar A	06.03.16 - 09.03.16	TIFR, Mumbai
Vasudharani Devanathan	29.02.16 - 07.03.16	IISER, Tirupati
Sreenivasulu K	14.03.16 -16.03.16	University of Hyderabad
Aleksy Tralle	11.03.16 - 21.03.16	University of Warmia and Mazury, Poland
Sudipta Mukherji	14.03.16 - 21.03.16	I. O. P, Bhuvaneshwar
Ranjan Kumar Jana	14.03.16 - 01.04.16	SVNIT, Gujarat
Reji Kumar	11.11.15 - 30.12.15	NSS College
Shiv Chaitanya K. V. S	04.01.16 - 09.01.16	BITS, Hyderabad
Subinay Dasgupta	06.03.16 - 12.03.16	University of Calcutta
Dileep Jatkar	14.03.16 - 18.03.16	HRI, Allahabad
Krishnaswamy S	24.03.16 - 01.04.16	Madurai Kamaraj University
Stefan Schuster	20.03.16 - 22.03.16	University of Jena, Germany
Prahladh harsah	19.03.16 - 28.03.16	TIFR, Mumbai
Manickam M	24.03.16 - 31.03.16	KSOM, Kozhikode

Satti Srinivasa Rao	31.03.16 - 28.05.16	SNU, South Korea
Naresh Dadhich	24.03.16 - 07.04.16	IUCAA, Pune

Chapter 6

Infrastructure

6.1 Computer Facilities

Enhancement of Computer Facility during 2015-16

- The imsc.res.in domain renewed upto 29.04.2024
- The new Laptops were issued to newly joined faculty and those faculty requested for replacement of laptops which are older than 5 years. The following Macbook pro(Dr.Ganesan Ramachandran and Dr. Ghanashyam Date), Toshiba Portege R30(Dr. Chandrasekar), Lenovo yoga 300 laptop(Dr. R. Ramanujam), Lenovo Thinkpad Yoga(Dr. Rahul Siddharthan and Dr. Manjari Bagchi) laptops are distributed.
- 3 BENQ projectors and 5 Ricoh projectors replaced with the obsolete and older projectors in the locations of Chandrasekar Hall, Alladi Ramakrishna Hall, Lecture halls 117,123,217,326 and 327.
- New storage of 25TB LFS and 80TB backup solutions were installed in the HPC datacenter.
- 70 Acer Veriton desktops replaced with the desktops of obsolete and older than 7 years.
- Dell 27" monitor was purchased and installed for Dr. Pinaki Chaudhuri for his visualising large scale data works and graphical analysis.
- Internet bandwidth upgraded from 32 Mbps to 34 Mbps
- Comodo SSL Certificate renewed
- Network facilities installed in the Guest house and Hostel after renovation
- 6 Ricoh laser printers replaced with the obsolete and old printers
- Integrated Media Room setup with matrix video switcher, professional PTZ video cameras, Video Conference codec, short through projector, motarised screen, LED lights, spring pull screens, rolling chairs with collapsible table for class room and meeting room activity was established. An Apple iMac was installed for video editing using FCP at IMSc Media Room.

Activities :

Dr.G.Subramoniam, Scientific Officer-F participated in the 4th Annual Workshop on NKN held at Jawaharlal Nehru Technological University, Kukatpally, Hyderabad during Jan 21-22, 2016 organised by NIC,

Mr.B.Raveendra Reddy, Scientific Officer-F attended the meetings on CISAG, DAE, Mumbai during 2015

6.2 The Library

The Institute Library holds a total collection of 72100 books and bound periodicals as on March 31, 2016. This includes an addition of 498 volumes during the current year April 2015 - March 2016. The NBHM has recognized this Institute library as the Regional Library for Mathematics. An average of about 4000 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, Computational Biology, Mathematics and Theoretical Computer Science. The library subscribes to over 350 national and international journals.

The library has access to over 3500+ 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 contents from Volume 1 from some of the major publishers like Elesevier under DAE consortium, Springer, World Scientific, Wiley, deGruyter, Cambridge University Press, Turpion, IOP Publishing and Annual Reviews Electronic Backvolume collection.

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 participating institutions in the southern region.

Library is an institutional member of AMS, MALIBNET, CURRENT SCIENCE Association, and IAPT.

Acknowledgment

The Library gratefully acknowledges the donation of valuable books, journals and other reading materials received during the current year from the persons and organizations mentioned below:

Ankit Agrawal, IMSc
Issan Patri, IMSc
Purusattam Ray, IMSc
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Balasubramanian, R., IMSc
Kamal Lodaya, IMSc
Prafulla Kumar Tale, IMSc
Shankar, R., IMSc
Sunder, V.S., IMSc

Balaji, K.
Pierre & Sophie Fima
Gayathree Mohan, Loyola College
Vimala Ramani

NBHM
Ramakrishna Math
Nuclear Power Corporation
Tamil Nadu Forest Department

6.3 Hostel, Guest House, Recreation Facilities

The students hostel has 90 rooms(including a few double occupancy rooms) and can accommodate 97 students and currently operates to its full capacity. The rest of the students are accommodated in off campus hostel leased by the institute. The hostel building is equipped with TV halls, music room, laundry zones and news paper reading lounges on each floor. Currently the guest house has a total of 47 fully furnished units of rooms including 24 units of flat-lets (with Kitchen, refrigerator and cooking stove etc). A few students including married students, Post-doctoral fellows(married & single) and academic visitors of the institute are accommodated in the flat-lets of the guest house.

The Institute has two well equipped Canteens one each for general use and students mess where breakfast, lunch and dinner including the evening snacks are served on all the days of week.

The Institute has a large sports complex with modern gymnasium, Indoor badminton court, table-tennis tables and other Indoor games. The Institute also has a mini football ground and tennis court for the use of members of the institute.

Management's love of nature and aesthetics is reflected in the pleasant greenery and harmonious landscaping of the institute campus.