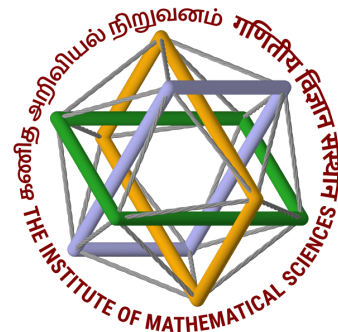


# The Institute of Mathematical Sciences, Chennai



## Quarterly Report

April - June 2019



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# Research Highlights

## Path models for Kostant-Kumar modules

Understanding the tensor product of two irreducible finite dimensional representations of a complex semisimple Lie algebras is a very important problem that has been studied intensely by mathematicians for the past 75 years. The celebrated conjecture of Parthasarathy-Ranga Rao-Varadarajan from the 1960s and its extensions by Kostant, Verma, Kumar and Montagard were the subject of recent research by members of the mathematics group at IMSc. Significant new results were obtained employing the “path model”, a powerful combinatorial tool first formulated by Littelmann in the 1990s. Using the decomposition rule, we establish a lower bound for multiplicities of PRV components in Kostant-Kumar modules, thereby generalising simultaneously the KPRV and the refined PRV theorems of Kumar.

## Annual Meeting of the IPTA

The *International Pulsar Timing Array* (IPTA) consortium consists of established Pulsar Timing Array (PTA) efforts, that include the European Pulsar Timing Array (EPTA), the North American Nanohertz Observatory for Gravitational Waves (NANOGrav), and the Parkes Pulsar Timing Array (PPTA) as well as the emerging efforts like the Indian Pulsar Timing Array (InPTA), South African Pulsar Timing Array and the Chinese Pulsar Timing Array. The IPTA consortium aims to detect gravitational waves using an ensemble of millisecond pulsars located in our Galaxy. To nurture the collaborative nature of the IPTA consortium, annual meeting is held in different continents. This year, the annual meeting of the IPTA was held in Pune, India between June 10 to 21, 2019. The first week (June 10 - 14, 2019) was a school for students, where lectures and hands on experiments by international experts were arranged. This part was hosted by NCRATIFR. The second week (June 17 - 21, 2019) was the conference week, and was held in the Orchid Hotel, Pune. It was a very successful meeting. The conference week was attended by 90 scientists throughout the globe (26 Indians working in India, 12 Indian students and post-docs abroad, and 52 foreign nationals). There were presentations by scientists on their research results as well as policy making discussions for the IPTA.

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There was a dedicated session on diversity and equity, lead by Prof. Ketki Ranade and Prof.



Shewli Kumar from Tata Institute of Social Sciences, Mumbai. IMSc members had pivotal roles in organising both of the weeks. Mr. Dhruv Pathak, Phd student in IMSc was part of the Scientific Organising Committee of the student workshop (the first week) and the Scientific Organising Committee of the conference week was chaired by Dr. Manjari Bagchi, faculty member of the theoretical physics group of IMSc. Additionally, Dr. Arpita Choudhury, DST-WOSA postdoctoral fellow at IMSc attended the meeting. Dr. Bagchi and Mr. Pathak presented their research work and Dr. Choudhury presented a collaborative work done by the InPTA team.

## **Game Theory Highlights Power of Local Reporting in Vaccine Decisions**

A recent article published by scientists from IMSc investigates how the social environment of an individual influences her decision to get vaccinated. This assumes importance in view of the recent dramatic increase in measles cases worldwide.

## **Systemic Risk: Frustration suggests imminent depression**

A recent article published by scientists at IMSc suggests that measuring the level of frustration, a concept central to the physics of disordered systems, in financial markets can give warning about the

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build-up of systemic risk, which, left unchecked can lead to a catastrophic failure of the economy. Unlike previous studies focusing on relatively short periods that possibly include only one extreme event, the article looks at the evolution of the largest financial market of the world for close to a century.

## **Explaining the ubiquity of complex patterns**

A recent paper published by scientists from IMSc shows that patterns seen in processes as diverse as chemical reactions, a cell undergoing division, and interactions between populations of predators and prey, can arise through the same fundamental mechanism. All of these systems (and more) consist of many oscillators, each trying to suppress the activity of its neighbors - a phenomenon that can be termed as lateral inhibition in analogy to the similar mechanism in operation in sensory systems. Although one may see a dazzling range of patterns that vary over space as well as in time, these can be traced to effectively two basic patterns - one which shows patterns frozen in time, and the other in which the oscillators are organized into clusters of synchronous activity.

# Highlights of Outreach Activities

## **TNSF Chithirai FEST-I : 6th - 8th May 2019**

This is part of the efforts to popularize science to the general public and students who are pursuing science as their career and to fill the gap between what students are acquiring through the curriculum and what it is required.

A Summer Camp was organised at Anna Centenary Library, Kotturpuram, Chennai, on June 15, 2019, hosting “Popular Science Lecture Series – VIII, LHC and Detection of Higgs Boson”.

The event was co-organised by The Institute of Mathematical Sciences, Indian Institute of Technology Madras, Anna Centenary Library & Tamil Nadu Science Forum.

## **Summer Camp for college students:**

About 50 students from various local colleges attend a 3 day science workshop including talks on a range of topics from physics to evolution.

(Co-organised by The Institute of Mathematical Sciences, Indian Institute of Technology Madras and Tamil Nadu Science Forum)



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Organizer: R Ramanujam

## Summer School Students Workshop: 14th - 22nd May 2019

Week-long summer science workshop for high school students IMSc students and post-docs ran a 9-day summer workshop for students from class XI. We designed and ran activity and interactive problem sessions for school students on various topics in mathematics and science. About 30 students attended the workshop.

Organizers: Sushmita V, Varuni P



## Teacher's Enrichment Workshop: 20th - 25th May 2019

Linear Algebra and Calculus on  $\mathbb{R}^n$

(A workshop for mathematics teachers of Arts and Science colleges)

**Organizer:** Sanoli Gun

## Exhibitions:

The "Indian Women in Science" exhibition was displayed at TCS Ignite and Periyar Science and Technology Center.

The "From Learning to Doing: Science, Education and Public Service in Chennai" exhibition was displayed at TCS Ignite and Chennai Mathematical Institute.

