

The Institute of Mathematical Sciences, Chennai



Quarterly Report

January - March 2021



Highlights: research and events

Hon'ble Vice-President of India, Shri M. Venkaiah Naidu's Visit:

(5th Jan 2021)

The Hon'ble Vice-President of India, Shri M. Venkaiah Naidu, visited the Institute of Mathematical Sciences (IMSc) on 5th January 2021. He shared the stage with Thiru. K. P. Anbalagan, Hon'ble Minister for Higher Education and Agriculture, Government of Tamil Nadu; Selvi Apoorva IAS., Principal Secretary in the Higher Education Department, Government of Tamil Nadu; Dr. A. K. Bhaduri, Director, IGCAR, Kalpakkam; and Prof. V. Arvind, Director, IMSc.

Shri Naidu planted a sapling outside the Ramanujan Auditorium. He viewed the permanent exhibition on the history of IMSc and the temporary exhibits on INO and DAE Technologies. Inside the Auditorium, he listened with interest to a presentation by Prof. V. Arvind on the work done by IMSc scientists.

Thiru. Anbalagan addressed the gathering and spoke about the importance of science and mathematics education and research. He praised the role of IMSc in these fields over the years

During his speech to IMSc members, Shri Naidu spoke of the importance of the mathematical sciences in the development of the nation. He stressed the need for scientists to work towards improving the lives of ordinary people, and for society to live in harmony with nature. He highlighted the issues of gender equity in Science and of early learning being in one's mother tongue. He expressed the hope that the National Education Policy would lead to better educational outcomes for Indian children and youth.

The Vice President also inaugurated, remotely, the New Residential Wing of IMSc located at the DAE Nodal Centre, Pallavaram, Chennai

<https://vicepresidentofindia.nic.in/events>



Astrophysics and Cosmology

The Indian Pulsar Timing Array (InPTA) experiment started in 2015 using the upgraded Giant Metrewave Radio Telescope (uGMRT). IMSc members have been involved in this experiment since then. Like other Pulsar Timing Array (PTA) experiments, this experiment aims to detect nano-Hertz gravitational waves using radio pulsars as tools.

InPTA became an associate member of IPTA very soon and after continuing the experiment successfully for more than 5 years, became a full member of IPTA consortia in February 2021. InPTA data will now be pooled to International Pulsar Timing Array consortium database and will contribute to eventual detection of nano-Hertz gravitational waves.

InPTA experiment is a joint venture among various Indian institutes (IMSc, TIFR, NCRA-TIFR, IIT-Hyderabad, RRI, etc). Four IMSc members (one faculty, one student and two postdocs) are part of this experiment.

IMSc faculty member is also serving as a co-chair of the education and public outreach working group of International Pulsar Timing Array.

Coverage in News Paper:- Indian Express, March 21, 2021

<https://indianexpress.com/article/india/india-first-asian-country-to-join-international-pulsar-timing-array-with-ugmrt-7238173/>

“India joins the global hunt for Einstein's waves from monster black holes Last week, a consortium of mainly Indian researchers, that regularly employs the upgraded Giant Metrewave Radio Telescope (uGMRT), situated near Pune, became a full member of the international effort to discover and study very low-frequency gravitational waves from monster black holes going around each other in orbit. According to Einstein, gravitational waves (GWs) are ripples in the space-time fabric of our Universe. These ripples are created by celestial dance of black hole pairs. The 2016 discovery of short period GWs by the LIGO detectors was awarded the Nobel prize a year later. These detectors measure the tiny deformations of the Earth caused by passing GWs from black hole pairs that weigh many times our Sun. However, these longer period GWs, produced by black hole pairs, that weigh billions of times the mass of our Sun, are yet to be detected as these are not detectable with instruments such as LIGO. These long period waves, called nanohertz GWs, minutely deform the space and time near the Earth and this leaves an imprint in the measured ticks of Galactic clocks, called radio millisecond pulsars. The largest telescopes in the world are routinely being used by an international experiment, called International Pulsar Timing Array (IPTA), to precisely measure the clock periods of a collection of these radio pulsars. The unique frequency range of the uGMRT, which is the largest steerable radio telescope at low radio frequencies, is helping to improve the precision of IPTA to detect nanohertz GWs. When discovered, these waves will refine evolutionary models of our universe as well as masses and orbits of members of our own solar system and open a new window of GW astronomy. Last week, an Indian initiative, Indian Pulsar Timing Array (InPTA), formally joined IPTA as a full member. InPTA is a collaboration of currently about 25 research scientists and students from 15 institutions in India and abroad and uses the uGMRT, operated by National Centre for Radio Astrophysics of Tata Institute of Fundamental Research, for monitoring about 6 to 20 millisecond pulsars since 2015. These clocks are observed between 300 - 800 MHz with the uGMRT, which is not covered by other big IPTA telescopes. The inclusion of uGMRT will allow removing the delays introduced by the interstellar medium in the arrival of radio pulses from these Galactic clocks by a factor of 5 more precisely than before, which should be crucial to improve the precision of IPTA. Therefore, the InPTA and the uGMRT are likely to play significant roles in the detection of nanohertz GWs and gravitational astronomy with these waves in future.

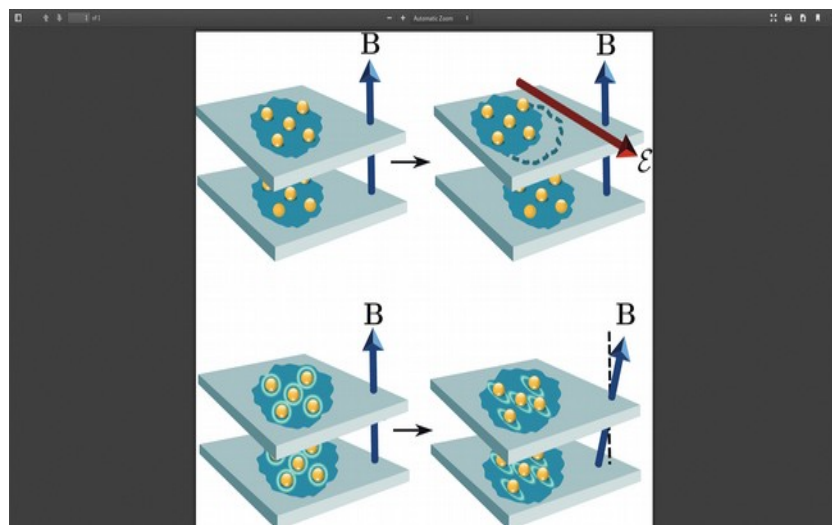
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Condensed Matter Physics

A collective mode is a paradigmatic property of physical systems ranging from liquid helium to frustrated magnets. Recent investigations of fractional quantum Hall states have revealed that their collective excitation forms an analog of the spin-2 graviton particle. We showed [C2] that a sudden change in the experimentally controllable parameters such as an in-plane magnetic field can serve as a dynamical probe of the graviton. These results demonstrate that the fractional quantum Hall effect provides an ideal platform to study the interplay of exotic collective excitations and emergent quantum geometry in topological phases of matter.



IGCI-2021

(International GeoGebra Conference, India) came out to be a highly successful online conference with over two thousand registered participants. More details can be found below:

<https://sites.google.com/view/igci2021>

Organizing Committee:

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- **Inder K. Rana** (Ex. IIT Bombay) [Convener]
 - **Makarand Sarnobat** (IISER Bhopal)
 - **Soumya Dey** (IMSc, Chennai)

Invited Speakers:

- **B. Surendranath Reddy** (SRTM University, Nanded)
- **Bed Prasad Dhakal** (Tribhuvan University, Nepal)
- **Christopher Brownell** (Fresno Pacific University, California)
- **Girish Belkar** (Shri Ram Centennial School, Indore)
- **Jonaki B. Ghosh** (Lady Shri Ram College for Women, New Delhi)
- **Julia Wolfinger** (GeoGebra Origin Lab, Linz, Austria)
- **Mikko Rahikka** (Helsingin yhteislyseo, Helsinki, Finland)
- **R. Ramanujam** (MNKM Govt. H. S. School, Pulapatta)
- **Sangeeta Gulati** (Sanskriti School, Delhi)
- **Thomas Lingefjärd** (University of Gothenburg, Sweden)

Transcendental number theory

Let $\Gamma \subset \overline{\mathbb{Q}}^\times$ be a finitely generated multiplicative group of algebraic numbers. Let $\delta, \beta \in \overline{\mathbb{Q}}^\times$ be algebraic numbers with β irrational. In this work, I prove that there exist only finitely many triples $(u, q, p) \in \Gamma \times \mathbb{Z}^2$ with $d = [\mathbb{Q}(u) : \mathbb{Q}]$ such that

$$0 < |\delta qu + \beta - p| < \frac{1}{H^\varepsilon(u)q^{d+\varepsilon}},$$

where $H(u)$ denotes the absolute Weil height. As an application of this result, we also prove a transcendence result, which states as follows: Let $\alpha > 1$ be a real number. Let β be an algebraic irrational and λ be a non-zero real algebraic number. For a given real number $\varepsilon > 0$, if there are infinitely many natural numbers n for which $|\lambda\alpha^n + \beta| < 2^{-\varepsilon n}$ holds true, then α is transcendental, where $||x||$ denotes the distance from its nearest integer. When α and β both are algebraic satisfying same conditions, then a particular result of Kulkarni, Mavraki and Nguyen asserts that α^d is a Pisot number. When β is algebraic irrational, our result implies that no algebraic number α satisfies the inequality for infinitely many natural numbers n . Also, our result strengthens a result of Wagner and Ziegler. The proof of our results uses the Subspace Theorem based on the idea of Corvaja and Zannier [?] together with various modification play a crucial role in the proof. This work has been proved in [Ku2].

Let $f(z) = \sum_{n=0}^{\infty} a_n z^n$ be a power series with integer coefficients and converging in the disc $D = \{z : |z| < R\}$ for some $R > 0$. In 1985, Laohakosol proved, using Ridout theorem, that the largest prime factors of partial sums of $f(b)$ for a rational number $0 < |b| < R$ is unbounded, if $f(b)$ is a non-zero algebraic number. In this article, we prove, using the subspace theorem, similar results for other approximation of $f(b)$. Moreover, we prove the number field analogue of Laohakosol's result. This work has been proved in [Ku1].

Honours and Awards:

Prof. Saket Saurabh, has been chosen as recipient of the 2020 ACM India Early Career Researcher (ECR) Award.

Prof. G. Rajasekaran, is a recipient of the Elavenil-ISTA Lifetime Achievement Award for the year 2020.

Prof. Sanoli Gun, has been elected as a fellow of the Indian Academy of Sciences.

