The Institute of Mathematical Sciences, Chennai

Quarterly Report

April - June 2021

Highlights: research and events

Quantum condensed matter : Low energy physics

Prof. Mukul Laad of IMSc, has developed a new ladder-mean field theory, together with his student, Soumya Sur to investigate quantum phase transitions in the square lattice quantum compass model. This model is widely used in various contexts:

(1) As a model for orbital ordered and liquid states in two-dimensional Mott insulators with orbital degeneracy

(2) Arrays of Josephson junctions and

(3) As Bacon-Shor codes for quantum error correction in quantum information.

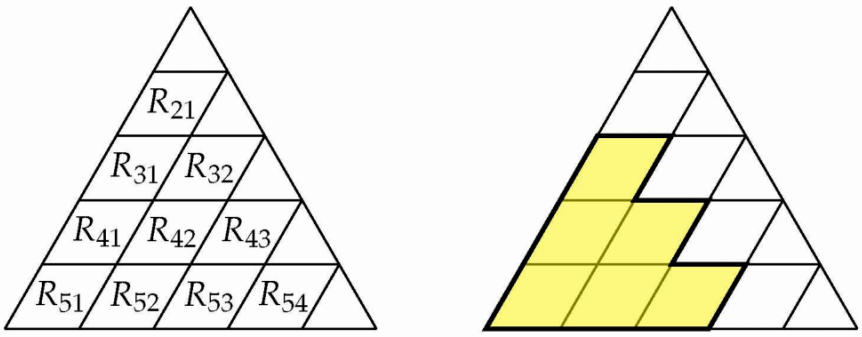
They found an excellent quantitative accord with a range of state-of-the-art numerical methods and based upon to describe an explicit scenario for a novel phenomenon of orbital-spin-charge separation in multi-orbital Mott insulators.

Presently, extension of the above work involving emulation of a range of topological quantum phase transitions in various systems as well as a new proposal for a scalable quantum computing platform is in progress.

DOI:https://doi.org/10.1103/PhysRevB.103.144419

Saturation theorem for Littlewood-Richardson coefficients

Mrigendra Singh Kushwaha, K.N. Raghavan and Sankaran Viswanath of IMSc obtained a refined version of Knutson-Tao's celebrated saturation theorem for Littlewood-Richardson coefficients. An extended abstract titled "The saturation Problem for Refined Littlewood Richardson Coefficients" has been accepted as a talk at the FPSAC 2021 conference.



(a) Labelling of North-East slanted rhombi (shown for $n = 5$). (b) A typical configuration of rhombi in F_w.

During the reporting period April to June 2021, there were 55 publications(Source: Web of Science & IMSc annual report software) by the members of the Institute.

Sanoli Gun of IMSc along with Motoko Kotani from Japan, Kyewon Park from South Korea, Polly Sy from Philippines and Dongmei Xiao from China have organized 'The first meeting of CWM ambassadors' for Asia-Pacific region. The objective of this meeting was to form a mathematical association for Asia-Pacific region to facilitate exchange of mathematical ideas, foster collaboration and extend support to women in these mathematical communities.

Conference Participation:

Coimbatore Balram, Ajit

Participated in Virtual Workshop Quantum Hall Effect: Status Report held Online. Hosted by the Simons Center for Geometry and Physics. during May 3 – May 7, 2021. Participant in the workshop. http://scgp.stonybrook.edu/archives/29732

Participated in The 8th International Workshop on Emergent Phenomena in Quantum Hall Systems (EPQHS-8) held Online. Hosted by Princeton University, during May 17 – May 21, 2021. Participant in the workshop. https://epqhs-8.princeton.edu/

Mahajan, Meena B.

Participated in Satisfiability: Theory, Practice and Beyond held online during Jan 12 – May 14, 2021. Semester-long program of the Simons Institute for the Theory of Computing, Berkeley,

USA. Conducted fully online, with multiple workshops and seminars. Gave a talk titled ”Refuting false QBFs with Merge Resolution” on 19 Apr 2021.

Online Worldwide Seminar on Logic and Semantics OWLS. https://www.cl.cam.ac.uk/events/owls/ on Jun 2, 2021. Gave a talk titled ”Refuting false QBFs with Merge Resolution”.

Viswanath, Sankaran

Participated in Workshop on Macdonald polynomials held at IISc Bangalore (online) during Apr 5 – Jun 30, 2021. Gave 4 lectures.

Honours and Awards:

Sinha, Sitabhra of IMSc, was awarded **P. C. Mahalanobis National Award** for the year 2021, for 2021, by the Government of India’s Ministry of Statistics Programme Implementation.

Gun, Sanoli of IMSc, is an elected member of the Asia-Pacific association for women in Mathematics. This association is created under the supervision of the Committee for Women in Mathematics (CWM) of the International Mathematical Union (IMU).

Special Lecture & Public Talks (Conducted at IMSc as Webinar):

1. Friday, May 21 2021, 16:00 - 18:00 (IMSc Webinar-Public Talk)

Talking about ‘Cancer : Reducing Risk, Early Detection and Treatment’.

Speaker(s): Dr. R. A. Badwe, Dr. Pankaj Chaturvedi, Dr. S.D. Banavali, TMC, Mumbai

www.imsc.res.in/~semadm/webinars/HBNI-lecture-talking-about-cancer.pdf

(On Webex): ***hbni.webex.com/hbni/j.php?MTID=m67f63d0660a8cdf05bfba98ad138b99a***

Youtube Live: ***youtu.be/eZHWoxIEvbI***

2. Thursday, June 3 2021, 14:00 - 16:30 (IMSc Webinar-Public Talk)

Steps towards Life: Chemistry

Speaker: Prof Jean-Marie Lehn, Nobel Laureate, University of Strasbourg, France.

HBNI Foundation Day: J. B. Joshi Research Foundation Endowment Lecture

3. Wednesday, April 21 2021, 17:30 - 18:30 (IMSc Webinar-Special Lecture)

Recent Developments in the Mathematics of Neural Nets

Speaker: Anirbit Mukherjee University of Pennsylvania

zoom.us/j/91782375389?pwd=aUo4UWZKZjh1SlBYWkV2QlBnY3VyZz09

4. Friday, June 18 2021, 16:30 - 18:30 (IMSc Webinar-Physics Colloquium)

The hadronic vacuum polarization from lattice QCD: contributions to the muon anomalous magnetic moment and to the running of electroweak couplings

Speaker: Marco Ce, CERN

The recent Fermilab experimental result, combined with the previous BNL one, confirms the ongoing four-sigma tension between the SM theory prediction of the anomalous magnetic moment (g-2) of the muon and the experimental value.

However, some lattice QCD calculations have produced results for the hadronic vacuum polarization (HVP) contribution to the muon g-2 that solve the discrepancy with the experiments without the need of BSM physics. If this is confirmed, a new tension would arise either with the hadronic cross-section at low energies or with global electroweak fits. Lattice QCD results for the HVP contribution to the running of the electroweak couplings can shed light on this possible tension.

Threads on Twitter:

Some of our events / research activities that received many likes from the public via twitter. Few are listed as below:

1. https://twitter.com/IMScChennai/status/1407222655812395013

Mini-symposium on "Looking back, looking forward", on the **Science of COVID19** (28th June, 2021).

IMSc has conducted mini-symposium "Looking back, looking forward", on 28th June 2021, presenting short talks and discussion on the science of **COVID19**, zoonotic diseases and

spillover, immune response, epidemiology, and variant tracking etc., Prof. Gautam I Menon, Ashoka University Sonipat[NCR]/IMSc Chennai, was the Moderator for this symposium.

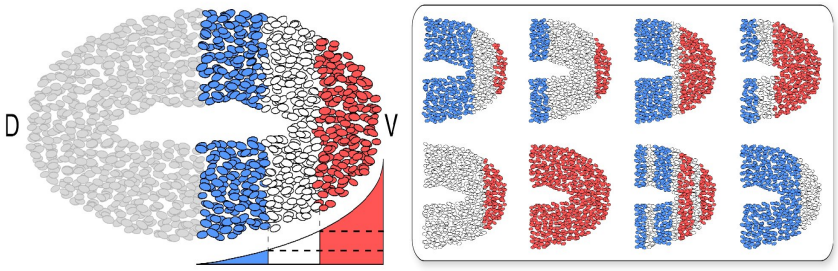
Speakers: Uma Ramakrishnan (NCBS Bengaluru), Vineeta Bal (IISER Pune), Rajesh Sundaresan(IISc Bengaluru), Dhiraj Hazra(IMSc Chennai)Chitra Pattabiraman (NIMHANS Bengaluru) and Vinod Scaria(CSIR-IGIB Delhi).

2. https://twitter.com/IMScChennai/status/1408034688241836033

Intercellular signaling:

One of the publications by our member has received a tweet.
DOI:https://doi.org/10.1103/PhysRevE.103.062409

Development in multicellular organisms is marked by a high degree of spatial organization of the cells attaining distinct fates in the embryo. Recent experiments showing that suppression of intercellular interactions can alter the spatial patterns arising during development suggest that cell fates cannot be determined by the exclusive regulation of differential gene expression by morphogen gradients (the conventional view encapsulated in the French flag model).
Using a mathematical model that describes the receptor-ligand interaction between cells in close physical proximity, we show that such intercellular signaling can regulate the process of selective gene expression within each cell, allowing information from the cellular neighborhood to influence the process by which the thresholds of morphogen concentration that dictate cell fates adaptively emerge. This results in local modulations of the positional cues provided by the global field set up by the morphogen, allowing interaction-mediated self-organized pattern formation to complement boundary-organized mechanisms in the context of development.



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