

The Institute of Mathematical Sciences, Chennai

Quarterly Report

October - December 2023



Highlights: research and events

Quantum Computations

Quantum Teleportation is a very useful scheme for transferring quantum information. Given that the quantum information is encoded in a state of a system of distinguishable particles, and given that the shared bi-partite entangled state is also that of a system of distinguishable particles, the optimal teleportation fidelity of the shared state is known to be $(F_{max} d + 1)/(d + 1)$ with F_{max} being the maximal singlet fraction of the shared state. In the present work, we address the question of optimal teleportation fidelity given that the quantum information to be teleported is encoded in Fermionic modes while a 2N-mode state of a system of Fermions (with maximum 2N no. of Fermions in the second quantization language) is shared between the sender and receiver with each party possessing N modes of the 2N-mode state. Parity Superselection Rule (PSSR) in Fermionic Quantum Theory (FQT) puts constraint on the allowed set of physical states and operations, and thereby, leads to a different notion of Quantum Teleportation. Due to PSSR, we introduce restricted Clifford twirl operations that constitute the Unitary 2-design in case of FQT, and show that the structure of the canonical form of Fermionic invariant shared state differs from that of the isotropic state the corresponding canonical invariant form for teleportation in Standard Quantum Theory (SQT). We provide a lower bound on the optimal teleportation fidelity in FQT and compare the result with teleportation in SQT. Surprisingly, we find that, under separable measurements on a bipartite Fermionic state, input and output states of the Fermionic teleportation channel cannot be distinguished operationally, even if a particular kind of resource state with maximal singlet fraction being less than unity is used.

Reference : Sanam Khan, R. Jehadeesan, and Sibasish Ghosh. General teleportation channel in fermionic quantum theory. 2023. (Preprint: arXiv:2312.04240 (quant-ph)).

Remembering Amal Kumar Raychaudhuri (AKR): the celebration of the centenary year (October 5 - October 7, 2023)

The three day long program discussed the works of Professor Amal Kumar Raychaudhuri. We remembered the scientist, the teacher, the visionary and the man from the memories of his students and eminent scientists working in the areas of gravitation and related subjects. The first 2 days we will have seminars at the technical level followed by discussions. The first two

days featured in-depth technical seminars followed by open discussions, while the final day was dedicated to engaging students (Outreach Program).

Organisers : Manjari Bagchi, Dhiraj Kumar Hazra, Arnab pal, V. Ravindran

Alladi Ramakrishnan Centenary conference during Dec 16 – Dec 18, 2023.

The birth centenary of Prof Alladi Ramakrishnan was celebrated via this conference. There were talks by institution builders and policy heads as well as technical talks by physicists and mathematicians.



Mr. N.R. Narayana Murhty (middle) unveiling bust of Prof. Alladi Ramakrishnan along with Prof. Krishnasamy Allai(Left) and Prof. Ravindran (right).

Awards and Honours

Grants, Awards and fellowships:

Arnab Pal was awarded SERB Start-Up Research Grant (2022-24) by DST SERB to work on applications of first passage processes in natural sciences.

Participation in conferences

Coimbatore Balram, Ajit

Participated in MRSI-Kalpakkam Chapter theme meeting on Recent Advances in Low-dimensional Quantum Systems held at Materials Science Group, IGCAR, Kalpakkam on Oct 6, 2023. invited speaker

Participated in Indian Academy of Sciences (IASc) annual meeting held at BITS Pilani Goa campus during Nov 3 – Nov 5, 2023. attending as an associate of IASc

Visited Raman Research Institute (RRI), Bengaluru during Nov 19 – Nov 23, 2023. invited seminar

Participated in Fractionalization and Emergent Gauge Fields in Quantum Matter held at International Centre for Theoretical Physics (ICTP), Trieste, Italy during Dec 4 – Dec 8, 2023. invited talk

Participated in Young Investigators Meet on Quantum Condensed Matter Theory 2023 held at IISER Bhopal during Dec 14 – Dec 17, 2023. invited speaker

Ghosh, Sibasish

Participated in MATHEMATICAL FOUNDATIONS OF QUANTUM INFORMATION THEORY held at IIT-Tirupati and IISER-Tirupati on Oct 7, 2023. This Meeting was jointly organized by IIT-Tirupati and IISER-Tirupati in memory of Prof. K. R. Parthasarathy. I gave an invited talk (entitled, "A glimpse of Gaussian quantum information theory") in the Meeting. "

Participated in Meeting on Quantum Information Processing and Applications (QIPA-2023) Harish-Chandra Research Institute, Prayagraj 04 - 10 December, 2023 held at Harish-Chandra Research Institute, Prayagraj during Dec 4 – Dec 10, 2023. I gave an invited talk there in QIPA-2023

Kodiyalam, Vijay

Participated in 89th Annual Meeting of the Indian Academy of Sciences held at BITS Pilani, Goa Campus during Nov 3 – Nov 5, 2023. Gave a talk on "Infinitely many quantum solutions

to Euler's 36 officers problem" Participated in Refresher course on mathematics held at RIASM, Chennai on Nov 29, 2023. Gave a talk on "Grobner Bases"

Madanagopalan, Padmanath

Participated in Hunting for the charming beauty tetraquark Tbc: LHCb meets theory held at CERN, Switzerland on Oct 5, 2023. Gave an online talk on "Search for isoscalar bcu⁻d tetraquarks using lattice QCD". Link to the workshop: https://indico.cern.ch/event/1324964/overview

Mahajan, Meena B.

Participated in Foundations of Software Technology and Theoretical Computer Science held at IIIT Hyderabad during Dec 18 – Dec 20, 2023.

Mukhopadhyay, Partha

Visited Department of Physics and Astronomy, University of Kentucky during Oct 23 – Dec 22, 2023. Academic exchange. Research seminar: Construction of Poincare invariant theories on a lattice

IMSc Outreach

Facets: 9 Oct 2023

One-day Mathematics program for advanced college students

kaNita-kAnakam: 12 Oct 2023

Mathematics program in Tamil for school students

Mathematics Toy Development workshop: 13 Oct 2023

A workshop to develop Mathematics related toys

Vigyan Pratibha Teachers Workshop (TN govt schools Chennai region): 17-20 Oct 2023

Regional workshop for teachers in the Vigyan Pratibha program in Tamil

TNSF Lecture series: Nobel Prize in Physics: 4 Nov 2023

Conceiving and developing Attosecond optical pulses, Sivarama Krishnan, IITM

Women, Science and Media: 6-8 Nov 2023

A series of sessions highlighting Women in Science and Science Journalism

Vigyan Pratibha Regional Workshop (KVS & JNV): 20-23 Nov 2023

Teacher workshop for Kendriya Vidyalaya and Jawahar Navodaya Vidyalaya teachers from the southern region.