Ranveer Kumar Singh

Mob – 8986355310

Alternate Mob – 7223821799

Updated: October 1, 2020

ranveer@iiserb.ac.in

ranveersfl@gmail.com

RESEARCH INTERESTS

- Mathematical physics : Applications of number theory in string theory
- Mathematics : Automorphic forms, number theory.
- Physics : Quantum field theory, string theory.

EDUCATION

- **Indian Institute of Science Education and Research Bhopal**,
  Degree - BS-MS (Integrated Bachelor of Science and Master of Science),
  Major - Mathematics, Minor - Physics
  Aug. 2015 - April, 2020
  CPI : 9.12/10.00
  Major CPI : 9.545/10.00

- **Nancy Convent Senior Secondary School**, Nainital, Uttarakhand
  Class XII (Senior Secondary Examination), CBSE
  July 2015   Aggregate 95.00%

- **Nancy Convent Senior Secondary School**, Nainital, Uttarakhand
  Class X (Secondary Examination), CBSE
  July 2013   CGPA: 10/10

PUBLICATIONS AND PREPRINTS

- A Converse Theorem for Harmonic Maass Forms and Harmonic Maass Jacobi Forms, [In Preparation].
- Details of proof of Zagier's mock modular forms, [In Preparation].
- Mock modular forms associated to generalised Cohen-Hurwitz-Kronecker class number, [In Preparation].
- Isomorphism of Skew-Holomorphic Harmonic Maass-Jacobi Forms and Certain Weak Harmonic Maass Forms, Ranveer Kumar Singh, Preprint: Link.
- Bhargava's Cube and Black Hole Charges, Nabamita Banerjee, Ajit Bhand, Suvankar Dutta, Ashoke sen, Ranveer Kumar Singh, Preprint : arXiv:2006.02494(2020).[Submitted]
- Demonstration of a general fault-tolerant quantum error detection code for $(2n+1)$-qubit entangled state on IBM 16-qubit quantum computer, Ranveer Kumar Singh, Bishvanwesha Panda, Bikash K. Behera, Prasanta K. Panigrahi, https://arxiv.org/abs/1807.02883, [Submitted].
- Getting Started With Quantum Computation: Experiencing The Quantum Experience, Ranveer Kumar Singh, Prathamesh Ratnaparkhi, Bikash K. Behera and Prasanta K. Panigrahi, *Student Journal of Physics*,**Vol. 7, No. 4, Oct-Dec**. 2018, https://www.iopb.res.in/~sjp/74final/3.pdf
- On the classical dynamics of charged particle in special class of spatially non-uniform magnetic field, Singh, R.K. *Indian J Phys* (2019) **93: 503**. https://doi.org/10.1007/s12648-018-1316-z

PROJECTS AND INTERNSHIPS

- May 2019 - April 2020
  MS Thesis Research - Applications of number theory in black hole physics.
  Supervisor - Dr. Ajit Bhand.
  The aim of the project was to study two recent papers . For the first paper, the goal was to study modular forms, Jacobi forms, Siegel modular forms, mock modular forms and understand the relation of mock modular forms to the statistical entropy of black hole in string theory (arXiv:1208.4074). In another project, I read a paper which relates the U-duality classes of black holes in string theory to class groups associated with binary quadratic forms (arXiv:1807.00797). We also attempted to answer the questions posed in this paper. This project was done in

collaboration with Dr. Nabamita Banerjee and Dr. Suvankar Dutta.

- Jan. 2019 - March 2019
  Introduction to Modular forms and Sphere Packing Problem.
  Supervisor - Dr. Ajit Bhand
  In this project, I studied the basics of modular forms. It included modular forms on $SL_2(\mathbf{Z})$ and its congruence subgroups, Eisenstein series, modular functions, Ramanujan cusp form, Hecke theory for modular forms of level 1. Finally, we studied the sphere packing problem and the recent breakthrough by Maryna Viazovska for packings in dimension 8 as an application.

- 21 May 2018 - 17 July 2018
  Indian Academy of Sciences Fellow - Demonstration of a general fault-tolerant quantum error detection code for $(2n+1)$-qubit entangled state on IBM 16-qubit quantum computer. Supervisor - Prof. P.K. Panigrahi
  In this project, we studied quantum error correction and several codes for fault-tolerant error detection and correction. We also proposed a code for fault tolerant quantum error detection for entangled states and demonstrated it on IBM quantum computer. We also studied coupled quantum systems and Rabi-oscillations. (Link to project report).

- 26 Nov. 2017 - 16 Dec. 2017
  Reading Project - Rademacher's series representation of partition function.
  Supervisor - Dr. Ajit Bhand
  The aim of this project was to understand the proof of the the convergent infinite series formula for partition function obtained by Hans Rademacher. We first studied the basic concepts of generating functions, Möbius transformations, Farey fractions and Ford circles. The main proof was then studied using these ideas and basic complex analysis. Thereafter a few auxiliary results like the asymptotic formula first presented by Hardy and Ramanujan were studied.

- 15 May 2017 - 30 June 2017
  Summer Internship - Supersymmetric Quantum mechanics and Solitons.
  Supervisor - Prof. C.N. Kumar
  The aim of the project was to study non-linear integrable systems like KdV equation, sine Gordan equation, nonlinear Schödinger equation etc. and analyse the properties of the soliton solutions. We also studied solitary wave behaviour of rogue waves and trapped Bose-Einstein condensate. The project also included study of isospectral partners of Hamiltonians and soliton wavefunctions arising in different Hamiltonians. The project ended with the study of negative index materials (Link to project report).

- 15 Oct 2016 - 20 Nov 2016
  Reading project - Quantum teleportation of an arbitrary two qubit state and its relation to multipartite entanglement.
  Supervisor - Dr. Auditya Sharma, IISER Bhopal
  In this project, I read a paper by Prof. Gustavo Rigolin which proposes a protocol to teleport an arbitrary two qubit entangled state and generalises it to n-qubit state (Link to paper). The paper also proposes a new measure of entanglement called "Entanglement of Teleportation".

- 15 May 2016 - 30 June 2016
  Summer Internship - Quantum Foundation, Quantum Information and Quantum Computation.
  Supervisor - Prof. Guru Prasad Kar, ISI Kolkata
  In this project, I studied EPR paradox and hidden variable theories, quantum teleportation, superdense coding, projective and POVM measurements, Krauss operators, measures of entanglement, quantum key distribution and other protocols in quantum cryptography. I also learned important concepts in quantum information theory like the Shannon entropy, Von Neumann entropy, the Holevo bounds etc.

COURSES TAKEN

- Mathematics
Calculus of One Variable, Linear Algebra, Multivariable Calculus, Probability and Statistics, Real Analysis I, Group Theory, Elementary Number Theory, Advanced Linear Algebra, Ordinary Differential Equations, Topology, Rings and Modules, Lie Groups and Lie Algebras, Fields and Galois Theory, Real Analysis II, Partial Differential Equations, Complex Analysis, Measure and Integration, Differential Geometry of Curves and Surfaces, Analytic Number Theory, Functional Analysis, Algebraic Topology.

- Physics
Mechanics, Electromagnetism, Modern Physics, Basic Electronics, Quantum Mechanics I, Classical Mechanics, Quantum Mechanics II, Statistical Mechanics, Quantum Field Theory I, Electrodynamics and Special Relativity, Decoherence and Open Quantum Systems, Quantum Field Theory II, General Theory of Relativity, Nuclear and Particle Physics.

TEST SCORES

- General GRE - 320/340
- Physics GRE - 780/990.
- TOEFL - 105/120
- Council for Scientific and Industrial Research, National Eligibility Test (CSIR Net) - 96th rank in Mathematics, December 2018, Roll no : 402010.

SEMINARS AND CONFERENCES

- 29 June 2020 - 3 July 2020
Strings 2020, Public Talk by Prof. Shamit Kachru – The hidden symmetries of spacetime.
- 24 Oct. 2019
The Gelfand-Kazhdan theorem for $GL_2(F)$ - IISER Bhopal, India
- 9 Jan 2017 to 11 Jan 2017
Nobel prize series via Ideathon contest - Ahmedabad, Gujrat, India
- 2 June 2017-15 June 2017
Partial diffrential equation - IISER Bhopal, India
- 6 May 2018 - 12 May 2018
Modern Physics and Ancient Indian Wisdom - NIAS Bangalore, India

TALKS AND PRESENTATIONS

- Quantum teleportation of an arbitrary two qubit state and its relation to multipartite entanglement - 24th Oct. 2016, Physics club, IISER Bhopal (Slides)
- Special to General Theory of Relativity, From Newton to Einstein - 28th Aug. 2017, Physics club, IISER Bhopal (Slides)
- The proof of Lindeman-Weirstrass theorem - 11th Sept. 2018, IISER Bhopal.
- Introduction to Modular forms [Modular forms and string theory reading group] - $1^{st} - 10^{th}$ May 2019, IISER Bhopal

REFERENCES

- Dr. Ajit Bhand
Assistant Professor
Department of Mathematics, IISER Bhopal
Email - abhand@iiserb.ac.in
Webpage - https://home.iiserb.ac.in/~abhand/
- Dr. Nabamita Banerjee
Assistant Professor
Department of Physics, IISER Bhopal
Email - nabamita@iiserb.ac.in
Webpage - http://www.iiserpune.ac.in/~nabamita/

- Dr. Karam Deo Shankhadhar
  Assistant Professor
  Department of Mathematics, IISER Bhopal
  Email - karamdeo@iiserb.ac.in
  Webpage - https://sites.google.com/view/karamhomepage

- Dr. Suvankar Dutta
  Associate Professor
  Department of Physics, IISER Bhopal
  Email - suvankar@iiserb.ac.in
  Webpage - https://home.iiserb.ac.in/~suvankar/

- Prof. Prasanta Kumar Panigrahi
  Professor
  Department of Physics, IISER Kolkata
  Email - pprasanta@iiserkol.ac.in
  Webpage - https://www3.iiserkol.ac.in/people/faculty/dps/pprasanta