

Divya Rana

Curriculum Vitæ

National Institute of Science Education and Research
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Education

In Progress

2013

Integrated Master of Science (Physics), *National Institute of Science Education and Research (NISER)*, Bhubaneswar, India.

Grade: 7.16/10

Completed

2011
2013

Higher Secondary Examination (standard 12th), *Vivekanand School, Delhi*, India, Grade: 90.4%.

2009
2011

Secondary School Certificate (standard 10th), *Air Force School, Ghaziabad*, India, Grade: 8.8/10.

Master Thesis

Title *Search for similarities between large scale structure formation and freely cooling granular gases*
[\[View Thesis\]](#)

Supervisor Dr Nishikanta Khandai, Dr Anamitra Mukherjee

Description We began our study by understanding the mechanisms responsible for structure formation in cosmology and granular gases, during which we derived an analytical expression for self-scaling behaviour in energy decay in granular systems. This indicated that we can always map one system to other regardless of their configurations. In order to search for similarities on a higher level, we began to quantify structures in granular systems using two-point correlation functions, and power spectra which qualitatively have similar behaviour as one would expect in gravity N -body simulations. Finally, I used Friends of Friends algorithm to identify these structures in the form of probability distribution functions. My next step will be to use TreePM algorithm for N -body simulation in two dimensions so that we can do a clear comparison among these systems. If we are able to succeed in finding similarities on some level, it will give us an idea of a possible map between long-ranged gravitational forces and short-ranged collisions. In order to visualize the evolution of matter distribution in granular systems, I made an [animation](#) by taking snapshots at equal time steps with labelled density contrast.

Academic Merits

2017

JRF, Qualified as a Junior Research Fellow in Council of Scientific & Industrial Research (CSIR)-National Eligibility Test (NET) (Phd admission test for Indian Universities), Government of India.

2013

INSPIRE, Recipient of Innovation in Science Pursuit for Inspired Research (INSPIRE) scholarship by Department of Science and Technology, Government of India.

- Selected for Summer Program at **Bhabha Atomic Research Centre (BARC)**, Mumbai, **Department of Atomic Energy, Government of India**. 2015
- Ranked 247 among 100,000 candidates in **National Entrance Screening Test (NEST) for admission in National Institute of Science Education and Research Bhubaneswar (NISER)**, Department of Atomic Energy, Government of India. 2013.

- Got 98 percentile (among 15 lakh candidates) in all India, **Indian Institute of Technology (IIT) Joint Entrance Examination(JEE) mains examination**, 2013.
- Got achievement award from school for excellent performance in Higher Secondary Examination, 2013.

Experience

2016

Summer Project, *National Institute of Science Education and Research (NISER) Bhubaneswar*, Odisha, **Dr Nishikanta Khandai, May - July.**

Dynamics of Colliding Balls: Our aim was to develop an algorithm for solving the equations of motion for a system having a large number of particles (hard spheres) with no long-range interactions. We counter this problem with an approach of event-driven algorithm. For the correctness of our algorithm, we did a test run for thermalisation of the system which was initially homogeneous having flat velocity distribution with elastic collisions, which showed promising results for velocity distribution with a perfect fit for Maxwell distribution at a certain temperature. We also ran some simulations for dissipative systems (inelastically colliding) gas which is also known as granular gas. The findings were astonishing because this system shows a web-like structures in later stages of evolution which greatly resembles structures in gravity N -body simulations. [\[report\]](#)

2015

Summer Project, *Bhabha Atomic Research Center (BARC) Mumbai*, Maharashtra, **Prof Sudhir R Jain, May - July.**

Classical Dynamics underlying Quantum Hall Effect: We worked on the problem of "trapping of electron using localised repulsive potential". By using Moser's theorem, we showed the existence of invariant curves (trapped orbits) in the phase portrait for an electron in quantum Hall setup with a hard disc representing repulsive potential. We showed this analytically as well as computationally for a special case in which the cyclotron radius is very large compared to disc radius. [\[report\]](#)

2014

Summer Project, *Center for Excellence in Basic Sciences (CEBS), University of Mumbai*, Maharashtra, **Prof Shashikanta C Phatak, May - July.**

A Brief Study on Relativity, Quantum mechanics and Chaos Theory: In this project we did a review of concepts in Quantum Mechanics, Chaos Theory and Theory of Relativity. In Quantum Mechanics we first developed the mathematical tools required then we went on to study the finite, infinite square well potentials, the Harmonic Oscillator and the Dirac Delta Potential. We also learned the Transfer Matrix Method to solve Schrödinger equation for the Dirac Comb potential and apply it to studying Electronic Band Structure Model. In Theory of Relativity we began with the developments of the Lorentz Transformations and then went onto formulating Relativistic Dynamics and Relativistic Electrodynamics. In Chaos Theory we developed the basics of studying dynamical systems and went on to study three maps namely the logistic, sine and tent map. [\[report\]](#)

Academic Projects

- **Solving Schrodinger equation for a Dirac comb potential with Dr Sanjay K Swain:** Numerically solved Schrodinger Equation in one dimension for a potential with n delta functions. I found energy bands and wave functions, which gives a idea for band theory in metals, semiconductors and insulators. I also presented my work in Science Activity Club at NISER. [\[presentation\]](#)
- **Demonstration of negative group delay in an electronic circuit with Dr Ashok K Mohapatra:** A simple electronic circuit is made where if an input pulse is given then the output with similar waveform is shifted forward in time compared to input. At first, one may get confused as this seems to be violation of causality. In view of this, some additional experiments are done to repudiate this intuition. [\[report\]](#)
- **Geometric Phase in Quantum Mechanics with Dr Yogesh Kumar Srivastava:** We used Differential Geometry as a tool to understand Berry phase, Aharonov-Bohm effect, Pancharatanam phase and integral quantum Hall effect. We also did a brief study on two dimensional identical particle systems using anyons and coherent states of harmonic oscillator. I also presented a poster on this topic at *NISER* bhubaneswar. [\[report\]](#) [\[poster\]](#)

Extra-curricular activities

- Workshop on Linux Operating System, 2017 at NISER.
- National Strings Meeting 2017 at NISER.
- Active member of Football Club at NISER.
- Member of Science Activities Club at NISER.
- Active participant in Science Open Day.

Computer Skills

Programming Languages	Python, C, C++, Mathematica
Markup Languages	L ^A T _E X
Operating Systems	Linux(Ubuntu, Fedora), Mac, Windows

Relevant Coursework

Core Courses[\[view UG core courses\]](#)

Physics I (Mechanics and Thermodynamics)	Mathematics I (Linear Algebra)
Physics II (Electricity, Magnetism and Optics)	Mathematics II (Real Analysis)
Mathematical Methods I & II	Electronics
Electromagnetism I & II	Statistical Mechanics
Quantum Mechanics I & II	Special Theory of Relativity
Atoms, Molecules and Radiation	Introduction to Condensed Matter Physics
Nuclei and Particle	Classical Mechanics I & II

Advanced Courses [\[view elective courses\]](#)

Phase Transitions and Critical Phenomena	Quantum Field Theory I
General Relativity and Cosmology	Plasma Physics and Magnetohydrodynamics
Particle Physics	Magnetism and Superconductivity

Elective Mathematics Courses [\[view maths courses\]](#)

Algebra I (Group Theory)	Differential Equations
Abstract Linear Algebra	Differential Geometry

Languages

Hindi	Native
English	Fluent

Interests

Research Interest	Cosmology, General Relativity, Galaxy Evolution, Structure Formation in the Universe
Others	Craft making, Music enthusiast, watching anime, computer gaming

References

Dr Nishikanta Khandai

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Prof Sudhir R Jain

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Dr Anamitra Mukherjee

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Prof Shashikant C Phatak

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