

# Atul Singh Arora

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## Objective

- short term Get a PhD position to explore Quantum Theory.
- general Contribute to expanding our knowledge of nature.

## Education

- 2016 **BS-MS Dual Degree**, *Indian Institute of Science Education and Research*, Mohali, CPI: 9.4/10.
  - Semester I:** (8.5/10) Mechanics, Chemistry of elements and chemical transformations, Cellular basis of life, Symmetry, Language Skills B, Introduction to Computers, Physics Lab I, Chem Lab I, Bio Lab I
  - Semester II:** (8.6/10) Electromagnetism, Atoms Molecules and Symmetry, Gene expression and development, Analysis in one variable, Hands-on electronics, History of science, Physics Lab II, Chemistry Lab II, Biology Lab II
  - Semester III:** (8.8/10) Waves and optics, Spectroscopic and other physical methods, Genetics and evolution, Curves and surfaces, Introduction to Astrophysics, Workshop Training, Physics Lab III, Chemistry Lab III, Biology Lab III
  - Semester IV:** (9.7/10) Thermodynamics and statistical physics, Energetics and dynamics of chemical reactions, Behaviour and ecology, Probability and statistics, Introduction to Quantum Physics, Philosophy of science, Physics Lab IV, Chemistry Lab IV, Biology Lab IV
  - Semester V:** (10/10) Classical Mechanics, Quantum Mechanics, Electrodynamics, Advanced Optics Lab, Reason and Rationality
  - Semester VI:** (9.6/10) Statistical Mechanics, Atomic and Molecular Physics, Quantum Computation, Advanced Electronics and Instrumentation Lab, Quantum Field Theory
  - Semester VII:** (9.4/10) Solid State Physics, Nuclear and Particle Physics, Nuclear Physics Lab, Physics of Fluids, Quantum Principles and Quantum Optics, Radiative Effects and Renormalization Group in Relativistic Quantum Field Theory
  - Semester VIII:** (9.5/10) Nonlinear Dynamics, Chaos and Complex Systems, Condensed matter Physics Lab, Computational Methods in Physics, Standard Model and beyond, Selected topics in classical and quantum mechanics
  - Semester IX:** (10/10): Ethics, MS Thesis - Research Project I
  - Semester X:** (10/10): Cosmology and Galaxy Formation, MS Thesis - Research Project II
- 2010 **CBSE 10+2**, *Sardar Patel Vidyalaya*, New Delhi, 80%.  
Physics, Chemistry, Math, Computer Science, English
- 2008 **CBSE X**, *Sardar Patel Vidyalaya*, New Delhi, 93%.  
Science, Maths, Social Science, English, Hindi, Information Technology

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## Experience (Academic)

- 2015-16 **Master's Thesis**, *Indian Institute of Science Education and Research*, Mohali.  
*Contextuality in a Deterministic Quantum Theory*. The thesis research was carried out under the guidance of Prof. Arvind where we reconsidered the no-go theorems on hidden variables and concluded that the notion of contextuality is not a necessary feature of quantum mechanics. We provided an alternative view, motivated by consistency requirements between Bohmian Mechanics and the said theorems. This was accomplished by identifying a new classical property, we call 'multiplicativity'. We proposed a non-contextual hidden variable model, consistent with all predictions of QM (for discrete spaces). Advantages of this view have been illuminated by discussion of implications of non-multiplicativity to non-locality and its relation to contextuality.
- Summer **Intern**, *University of Siegen*, Siegen, Germany.
- 2015 I had worked under the guidance of Dr. Ali Asadian and Prof. Otfried Guehne. We proposed a test of local realism based on correlation measurements of continuum valued functions of positions and momenta, known as modular variables. The Wigner representations of these observables are bounded in phase space and therefore, the associated inequality holds for any state described by a non-negative Wigner function. This agrees with Bell's remark that positive Wigner functions, serving as a valid probability distribution over local (hidden) phase space coordinates, do not reveal non-locality. We constructed a class of entangled states resulting in a violation of the inequality and thus truly demonstrate non-locality in phase space. These states were realized through grating techniques in space-like separated interferometric setups. The non-locality is verified from the spatial correlation data that is collected from the screens.
- Summer **Intern**, *Indian Institute of Science Education and Research*, Mohali.
- 2014 The objective was to devise ways of using a universal quantum computer to perform simulations of quantum phenomena itself, with 'practical' resource requirements. The project involved reading of books and papers, followed by reproducing the results of a paper using a quantum computer simulator, which was written from scratch and an independent discovery of a simple quantum algorithm to simulate mixed states (this result was however already known). I was guided by Prof. Arvind and had helpful discussions with Dr. Sudipta Sarkar and Dr. Abhishek Choudhury.
- Winter **Intern**, *Indian Institute of Science Education and Research*, Mohali.
- 2013 Studied Mechanics from Landau's first volume (excluding the last chapter) and covered parts of Mathematical Methods from a book on the said topic by Dennerly and Krzywicki. I was guided by Prof. Jasjeet Bagla and Prof. Sudeshna Sinha.
- Monsoon **School**, *National Centre for Biological Sciences*, Bangalore.
- 2013 Participated in a Monsoon School on Physics of Life where we treated selected biological phenomena with physical rigour, headed by Dr. Mukun Thattai
- Summer **Intern**, *National Physical Laboratory*, New Delhi.
- 2013 Worked on setting up an experiment to study dynamics of a two dimensional magnetic dipole lattice, with Dr. Ravi Mehrotra.
- Winter **Intern**, *Indian Institute of Science Education and Research*, Mohali.
- 2012 Studied Quantum Mechanics from J.J. Sakurai, under the guidance of Prof. Jasjeet Bagla and created a corresponding report.
- Summer **Intern**, *Indian Institute of Science Education and Research*, Mohali.
- 2012 Studied Group Theory and Linear Algebra for understanding Symmetry, under Prof. Kapil Hari Paranjape.  
A brief introductory understanding of the Knot Theory was also undertaken. LaTeX was learnt during this period, to be able to efficiently communicate via the internet.

Summer **Intern**, *Indian Institute of Technology*, Bombay.

2011 Worked on Image Recognition techniques using OpenCV, for Yarn Fault detection under the supervision of Prof. Anirban Guha.

This was an extension to an IIT alumni's Masters thesis. The work was done using Visual Studio, C++ and involved understanding of OpenCV and the idea behind various algorithms, to be able to solve the problem at hand.

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## Publication (Academic)

2015 A. S. A, A. Asadian. *Proposal for a macroscopic test of local realism with phase-space measurements*. *Phys. Rev. A* **92**, 062107

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## Teaching

2015 **TA**, Teaching Assistant. Classical Mechanics for undergraduates.

2016 **TA**, Teaching Assistant. Thermodynamics for undergraduates.

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## Recognition

2016 Graduated with rank two in the Physics Department from IISER in 2016

2016 Top 5% percent in the Graduate Aptitude Test in Engineering (GATE) for Physics

2016 Obtained a 92.3 percentile in the national graduate physics exam, Joint Entrance Screening Test (JEST)

2015-16 Amongst the highest scorers in both semesters of the academic session 2015-16

2015 Awarded the Junior Research Fellowship from the Council of Scientific and Industrial Research, India (JRF-NET)

2015 Awarded a Certificate of Merit for the best academic performance in the second semester of the academic session 2014-15

2015 Was awarded the DAAD WISE fellowship for a summer internship in Germany

2015 Amongst the highest scorers in the first semester of the academic session 2014-15

2014 Amongst the highest scorers in the second semester of the academic session 2013-14

2014 Awarded a Certificate of Merit for the best academic performance in the first semester of the academic session 2013-14

2012 Capacitive touch won the Best Physics Demonstration, at the Science Day 2012, organized by IISER Mohali

2011 Was awarded the KVPY fellowship for my work on Stepper Motor control, Chatur Chaalak

2010 Was awarded the First position in Senior programming, with my Team member, in an inter-school programming competition, a part of Access, an annual Computer Symposium, Access, organized by Modern School

2010 Was selected as one of the participants for attending the Bright Green Youth, Denmark, an international climate summit for the youth, on the basis of my performance in the National Science Fair and a personal interview. In DK, our team made it to the top 14 projects

2009 The Robotic Rescue Vehicle was awarded the first position in the Delhi region and second position in the Northern region, at the National Science Fair, held at the National Science Centre, New Delhi

- 2005 ALive City won the first place in the open Software Display, at an inter-school Computer Symposium, Access, an annual event organized by Modern School, Barakhamba Road, New Delhi
- 2004 ALive City qualified the open Software Display, at the inter-school Computer Symposium, Access
- 2004 Displayed the Robotic Rescue Vehicle at an interschool competition and secured the third position, even though due to a component failure, the robot failed to work when it was judged
- 2003 Displayed the School Bell Scheduler at the National Convention 2003, Computer Society of India, IIT-Delhi

## Positions of Responsibility

- 2012-13 **CR**, Class Representative. Was responsible for setting up various batch-activities, Tutorial Assistance, Summer Project Talks, Origami Meets, The MS11 digest, to name a few. Various other student responsibilities, such as infrastructure feedback, mess issues, meeting with the dean etc., were simultaneously executed.
- 2012-13 **WD**, Web Designer. Was responsible for developing and maintaining the Opportunity Cell website, a link to which was added in IISER's official web page.

## Languages

Native **Punjabi**

Fluent **English**

*Formally studied till Sem I, BS-MS*

Fluent **Hindi**

*Formally studied till class X*

## Computer Skills

- Familiar OSs Windows: XP, Vista, 7, 8, 10; Linux: Ubuntu, Debian, OpenSuse, Slackware
- Languages Basic, C, C++, C#, Fortran, Python, Javascript, SQL, HTML, PHP, LaTeX, Octave/Matlab, Mathematica
- Applications Visual Studio, Emacs, Sublime Text, Microsoft Office (Word, Powerpoint, Outlook, OneNote, Excel), CorelDraw, Inkscape, Git, Sony Vegas, Autodesk Maya, GNU plot, SolidWorks, FL Studio, Sony Sound Forge, Cinelerra

## Projects

- Sem VI **Drawdio**, What is Drawdio: "Imagine you could draw musical instruments on normal paper with any pencil (cheap circuit thumb-tacked on) and then play them with your finger. The Drawdio circuit-craft lets you MacGuyver your everyday objects into musical instruments: paintbrushes, macaroni, trees, grandpa, even the kitchen sink...". This project was originally created at the MIT Media Lab; I simply reproduced a version of this for the National Science Day, 2014.
- Summer **Nazar Band**, A face recognition system built using OpenCV with the aim of automating the locking and unlocking of doors, eliminating the need of keys.
- 2013
- Sem III **Opportunity Cell Website**, Team Project, A centralized web portal for the Opportunity Cell of IISER Mohali.
- 2012

- Sem III 2012 **Fly Count Assister**, For easing the task of counting flies (Biology experiment), this application was written in Python and used extensively. With just two buttons on the keyboard, and the voice support, the counting process was made much more efficient.
- Sem III 2012 **NaveenTantra**, Team Project, An Online Election system, based on a novel fraud prevention technique, created using Javascript, PHP and MySQL.
- Summer 2012 **Telescope**, Team Project, Newtonian Reflection Telescope for observing Transit of Venus.
- Sem II 2012 **Capacitive Touch Sensor**, Sensitive enough to measure changes in PicoFarads, developed for the Science Day.
- 2010-11 **Chatur Chaalak**, Developed with the aim of application in robotics, this project was designed to control the torque and speed of stepper motors, with precision, independently. This was implemented using C as the language and Atmel AVR as the platform.
- 2010 **Live GSM**, This was an attempt at controlling a phone using a microcontroller, to be able to remotely control devices, using DTMF communication protocol over voice calls.
- Class XII 2010 **3D Modelling and Animation**, Imitated the '21st Century FOX' animation and customized it to read 'XII class presents', for a class presentation, using the popular 3D cinema creation software, Maya.
- Class XI-XII 2009-10 **Space Race**, This game was developed using OpenGL to ensure cross-platform support and as a transition to the open world. Apart from the 3D-graphics, this game had Newtonian physics implemented using a point particle approach, derived from an open-source game.
- Class XI 2009 **Robotic Rescue Vehicle (RRV)**, It was designed using auto-mobile parts such as bicycle chains and sprockets, wiper motors, car batteries, a web-camera, and an ordinary PC, which gave it a unique look. It could be moved around wirelessly using a laptop which gave a live video feed from the robot, ideal for rescue operations.
- Class X 2008 **Math Project**, A calculator built using micro-controllers, to verify the property  $(a + b)(a - b) = a^2 - b^2$ . It was a battery operated device, with an LCD screen and used an 89S52 to process.
- Class IX 2006 **ALive City 2 - DirectX 9.0**, My second attempt at game making; this was developed without using any game engines, while the game itself was controlled using a USB steering wheel, built by me, based on an open-source application.
- Class VIII 2005 **Motion Detection - Image Processing**, This program was developed to save frames of a video feed, only when motion is detected, ideal for surveillance.
- Class VIII 2005 **ALive City - DirectX 8.0**, My first computer graphics 3D project, a simple racing game where the player could put his/her own picture, right on the car.
- Class VII 2004 **Edge Detecting Robot**, Built using stepper motors and a microprocessor, this vehicle was programmed to detect edges of a table using infra red sensors and turn to avoid falling.
- Class VII 2004 **AT Keyboard Interface**, Built using the 8051 series of Microcontrollers and an LCD, this device was developed to serve as a low cost portable typing tutor for kids. It was programmed using Bascom, a basic compiler.

Class VII **School Bell Scheduler 2**, This application was re-written in Visual Basic.NET to  
2004 automate ringing of school bells, given the schedule, like it's first version. It used  
UART for securer communication and was installed in Srijan School, Model Town,  
New Delhi.

Class VI **School Bell Scheduler**, A program, written in Visual Basic 6, for automating the  
2003 ringing of school bells. The user simply needs to specify the schedule.

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### Extra-Curricular Activities

2015 Tug of War: IISER M, Boys Tug of War Champions.

2013 Debating: Participated in the debating event of the in-house fest, Insomnia. The home  
team wasn't allowed to compete beyond a stage.

2012 Music Performance: Played the Guitar and composed the percussion electronically,  
with two friends, at the Cultural Evening of IISER.

Current Playing the Guitar, Tabla; Programming, Electronics, Robotics, Physical Fitness, Krav  
Interests Maga, Taekwondo (Red I)