

Sandesh Kalantre

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Research Interests

- Quantum Information and algorithms, Quantum cryptography
- Large scale structure, Cosmology, Radio Astronomy

Education

- 2014-2018 **Sophomore Undergraduate, B.Tech in Engineering Physics**,
Indian Institute of Technology, Bombay, CPI - 9.81/10.
Minor in Computer Science and Honours in Physics
- 2012-2014 **Intermediate/+2, S. P. College, Pune**, Percentage – 94.31.
Ranked 1st in the college among 800 students
- 2012 **Matriculation, Dyanmata High School, Amravati**, Percentage – 97.82.

Academic Achievements

- 2015 Ranked **2nd** in the Department and overall **10th** in the institute (out of 880)
- Sept 2011 **Gold Medal, 16th International Astronomy Olympiad**.
Kazakhstan, ranked 1st among participants from 21 countries
- Aug 2012 **Gold Medal, 6th International Olympiad on Astronomy and Astrophysics**.
Brazil, International Rank 18th
- Aug 2013 **Silver Medal, 7th International Olympiad on Astronomy and Astrophysics**.
Greece
- 2014 **All India Rank 335**, IIT-JEE among *121,000* overall participants for entrance to the IITs.
- 2013 Gold Medal and Certificate of Merit in Indian National Physics Olympiad (2013) for being among *national top 35 out of ≈ 10000 students*
- 2014 AP grade (given only to top 1%) for *exceptional performance* in Quantum Physics and Application, Complex Analysis, Computer Programming, Physical Chemistry and Introduction to Electronics at IIT Bombay
- 2015 **Institute Academic Award (2014-2015)**, IIT Bombay for being among the top 10 students on the basis of CPI
- 2009-2010 **All India Rank 4** in *4th* International Mathematics Olympiad and *12th* National Science Olympiad among $\approx 10,000$ participants.

Scholarships

- 2013 Kishore Vigyan Protsahan Yojana (**KVPY**) awarded by Department of Science and Technology, India for promotion of basic sciences among high school students to ≈ 250 students in the country
- 2011-2013 Infosys Award for International Olympiad medalists by HBCSE in association with the Infosys Foundation and TIFR Endowment Fund
- 2010 National Talent Search Scholarship (**NTSE**) awarded by the National Council for Educational Research and Training to ≈ 1000 students in the country

Experience: Quantum Computation and Computer Science

September **Quantum Teleportation with NV Centres,**

2015 Prof. Bhaskaran Muralidharan, Department of Electrical Engineering, IIT Bombay.

- Investigated a photonic channel mediated method to generate heralded entanglement between two distant ($\sim 3m$) NV electron spins
- Studied the use of *indirect* Bell measurements of NV electronic spin and N nuclear spin to accomplish teleportation of quantum states
- Working on designing a simulation to reproduce the teleportation scheme

August **Quantum Entanglement Entropy and Thermodynamics,**

2015 Prof. Bhaskaran Muralidharan, Department of Electrical Engineering, IIT Bombay.

- Studied the properties of von Neumann entropy in entangled quantum systems
- Examined the process of converting classical information to energy in nanoscale devices by means of a '*electronic*' *Maxwell's Demon*
- Investigated the nature of second law in the context of information driven current in nanoscale devices

June **Quantum Algorithms and Information,**

2015 Prof. P. K. Panigrahi, Department of Physics, IISER Kolkata.

- Examined the canonical quantum algorithms - Deutsch-Josza, Shor & Grover and studied their computational complexities
- Applied Grover's Search algorithm to search for the existence of an Eulerian circuit in a undirected graph given the adjacency list representation
- Worked on designing an efficient counter-factual quantum cryptography scheme based on Noh's protocol
- This project was supported under the National Initiative on Undergraduate Science (NIUS) Programme in Physics which is awarded to **top 20 students in the country**.

Autumn **NumCpp - arbitrary precision mathematical library in C++,**

2014 Prof. D. B. Pathak, Department of Computer Science and Engineering, IIT Bombay.

- Wrote a stack based parser using Djitstra's shunting yard algorithm to parse function definitions as well as mathematical equations
- Implemented routines for FFT, numerical integration and differentiation, root finding of a function with arbitrary precision support using the GNU MPFR Library

Experience: Astronomy and Astrophysics

August **Pair-production anomaly from propagation of VHE gamma-rays,**

2015 Prof. V. Rentala, Department of Physics, IIT Bombay.

- Investigated various components of Extra-galactic Background Light (EBL) at μm wavelengths and their relative contributions to the pair production process
- Explored a model of the optical depth for gamma-ray sources using EBL models and simulated the presence of a spectral-break in GeV and TeV spectra
- Working on Inter-Halo Light (light from stars outside galaxies) models to scrutinize its effect on VHE spectral indices and the spectral-break

December **Pulsar Observatory for Students (POS) - 2014,**

2014 K. Krishnakumar, Radio Astronomy Centre, Ooty - NCRA-TIFR.

- Studied the operation of the Ooty Radio Telescope (ORT), a 530-metre (1,740 ft) long and 30-metre (98 ft) wide Cylindrical Paraboloid telescope.
- Collected raw time-series data for pulsars using the ORT and analysed using Numpy/Scipy
- The processed data was used to explore various properties such as the Dispersion Measure(DM), modulation index and pulse broadening due to interstellar scattering for various pulsars.
- The slides of the final presentation are available at
http://home.iitb.ac.in/~sandeshkalantre/presentations/sandesh_pos2014.pdf

Positions of Responsibility

Autumn **Teaching Assistant**,

2015 *PH107 - Quantum Physics and Application*, IIT Bombay.

- Mentoring a batch of around 50 students in the course content
- Involved in evaluation of exams and quizzes

May 2015 **Resource Person**,

Indian Astronomy Olympiad Programme, HBCSE - TIFR, Mumbai.

- Involved in generation of problems for selection of the Indian Team to the International Olympiad on Astronomy and Astrophysics (IOAA)
- The team was awarded **3 Gold & 2 Silver medals** in the International Olympiad on Astronomy and Astrophysics (IOAA), Indonesia, 2015, which was India's best result in 9 years.

July 2015 **IPho-rum**,

Browser Application for International Physics Olympiad (IPhO), Mumbai.

- Worked in a team of 2 in development of IPho-rum — a browser based application for tasks such as voting, translation upload and feedback submission among *approx 100 users*
- Used *Node.js* as the server application and MongoDB as the primary database

2015-2016 **Convener**,

Maths and Physics Club, IIT Bombay.

- Organisation of events fostering to the enthusiasm of students in Physics and Mathematics catering to around *400-500 students on campus and having an outreach of around 4000 online*
- Worked on designing a *Homopolar Motor* for demonstration to freshmen

Computer skills

Programming C, C++, Fortran, Python, Haskell, HTML, CSS, Javascript, Perl, bash

Science NumPy, SciPy, Matplotlib, QuTip, Astropy, gnuplot, Octave, SPICE Circuit Simulation,
Packages GNU GMP/MPFR library

Softwares L^AT_EX, Git, InkScape, AutoCad, Pelican, Node.js, Wireshark

Key Courses

Physics Quantum Mechanics I**, Continuum Mechanics**, General Theory of Relativity**, Classical Mechanics*, Special Relativity, Non-Linear Dynamics*, Quantum Physics and Applications, Electricity and Magnetism, Physics lab

Mathematics Complex Analysis, Differential Equations*, Linear Algebra

Others Data Structures and Algorithms**, Computer Networks*, Electronics, Computer Programming and Utilization

(* and ** courses are will be completed by end of Autumn 2015 and Spring 2016 respectively.)

Extra-curricular activities

- Interested in abstract mathematics, teaching, literature, history and mythology
- Gave a talk on *Chaos in Celestial Mechanics* for Kritika, Astronomy Club of IIT Bombay
- Built a Kelvin Water Dropper and demonstrated build-up of a potential difference under Maths and Physics club, IIT Bombay.
- Secured 2nd position in the Bazinga Physics Quiz organised by Maths and Physics club, IIT Bombay.
- Associated with National Service Scheme, IIT Bombay under Educational Outreach program.
- Secured first prize in Debate competition held at Dynamata High School, Maharashtra.
- Secured first place in Inter-School Geography Quiz.