

Pranjal Bordia

CONTACT INFORMATION

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RESEARCH INTERESTS

Atomic, Molecular, Optical & Laser Physics, Quantum Optics, Precision Measurements

EDUCATION

Bachelor of Technology in Engineering Physics with Honours
Indian Institute of Technology Bombay (IITB), Mumbai, India
Cumulative Performance Index (CPI) : **9.25** on a scale of 10
CPI in Physics core courses over **9.5**. Department Rank 2 out of 21

LABORATORY RESEARCH EXPERIENCE

Summer Internship : Experimental Setup for Raman Cooling of Atoms

Building Semiconductor lasers, Phase Lock Loop, and Optics

Guide: Prof. Immanuel Bloch, MPI for Quantum Optics

May 2010 - July 2010

Co-Guide: Dr. Stefan Kuhr

The aim of the project was to build a setup for Raman Cooling of atoms. Initially I built two semiconductor lasers. After making the laser cavity, the reflecting mirror was adjusted to get maximum feedback. By using thermopiles and peltier elements, it was temperature stabilised. Further, coarse tuning was done with an etalon. Fine tuning was done using a peizo and using external voltage. Finally, I was able to achieve a FWHM of about 10MHz for 100THz laser.

After that, I designed, built and implemented a Phase Locked Loop (PLL) for them. The two 100 THz lasers were locked with an accuracy of 100Hz. As a final task, a compact optical arrangement was made, and using AcoustoOptic Modulators (AOMs), a very fast switch was made for them. The beams were then superposed and were available for cold atom experiments for the group. The PLL was also developed into a convenient box for any experiment which needs it.

THEORY AND SIMULATION RESEARCH EXPERIENCE

Senior Thesis: High Intensity Light Effects on Matter

Guide: Prof. K C Rustagi

August 2010 - Ongoing

I am studying Light Matter Interactions (LMI) in regimes where conventional perturbation theory fails. Through literature survey, I have learned about high intensity light producing techniques such as Chirped Pulse Amplification, Q- Switching. I've also studied effects such as High Harmonic Generation (HHG), Above Threshold Ionization (ATI). Currently, I am looking at effect of spatial dependence of the field and we aim to introduce relativistic dynamics next in our work.

Neutrino Phenomenology and simulations for India based Neutrino Detector

Neutrino Phenomenology, Mass Hierarchy, INO simulations

Guide: Prof. Uma Sankar

July 2008 - July 2009

We worked on neutrino oscillations in vacuum and matter. Current limits on neutrino parameters were laid down and we wanted to study the hierarchy problem from point of view of INO (India based Neutrino Observatory, an upcoming detector). Using ROOT(CERN) computing software and Nuance, a neutrino detector software, simulations were done to estimate the error in reconstructing the parameters.

COMPUTATIONAL RESEARCH EXPERIENCE

Summer Internship: Numerical Methods in Quantum Many body systems

Computational Techniques for Differential Equations, Parallel Processing

Guide: Prof. Alok Shukla

May 2009 - June 2009

I did a project in quantum many-body systems where I computed the ground state energy of dilute gas (Fermi and Bose). I solved for the Hartree Fock equation using numerical methods. Further, using OpenMPI, I implemented a simple code on 80 computer nodes, to demonstrate the computation time reduction by using parallel processing methods.

TEST SCORES

- GRE:- **Physics: 990/990** Verbal: 530/800, Quantitative: 800/800, Writing: 4.0/6.0
- TOEFL:- Reading 29/30 Listening 29/30 Speaking 26/30 Writing 29/30 Total 113/120

SCHOLASTIC ACHIEVEMENTS	<ul style="list-style-type: none"> • Institute Academic Prizes: Awarded scholarship for Ranking 1st in my second year. • Awarded AP grade¹ in Differential Equations II. • Got a perfect SPI of 10.0 in Semester IV at IIT Bombay. • Secured a place in top 250 nationwide out of 43000 in Indian National Physics Olympiad. • Awarded HBCSE MERIT in International Astronomy Olympiad selection camp for securing a place in TOP 10 nationwide out of 15000 students. • Deutscher Akademischer Austausch Dienst (DAAD) WISE Scholarship: Received scholarship covering full expenses for 3 months summer internship in Germany. • Awarded certificate of Merit by CBSE for outstanding performance in Science and Hindi Language in the 10th Board Examination. (Given to top 0.1%)
WORKSHOPS AND SCHOOLS	<p>Study of Solar Winds Using Single Station Inter-Planetary Scintillation Measurements <i>Astronomy Nurture Camp at Ooty Radio Telescope</i> <i>December 2008</i> Guide: Prof. P. K. Manoharan We worked on determination of the solar wind velocity pattern in the solar system for distances less than 1 A.U. by measuring the scintillations caused by interplanetary density irregularities on radio waves at 92cm. Using a model and our own codes, solar wind velocity pattern was found (as a function of heliographic latitude).</p> <p>Measuring the 5 and 3 minute Solar Oscillation mode <i>A CUREA Summer program at Mt. Wilson Observatory, Pasadena, USA</i> <i>22 June-6 July 2008</i> Guide: Prof James Charles LoPresto, Edinboro University We worked on the SOLAR telescope, Mt Wilson Observatory, Pasadena, CA and then obtained the data from it. For detecting oscillation modes, spectroscopic data was processed using AutoStar IP package. After data reduction, the power spectrum was computed and analyzed. The 3 and 5 minute solar oscillation modes were clearly shown.</p>
TEACHING EXPERIENCE	<p>Teaching Assistant for PH103 Electricity and Megnetism <i>Autumn 2010</i> Tutor for 1st Year undergradutes across all discliplines. Duties included solving theory doubts, developing problem solving skills and grading examination papers.</p>
KEY COURSE PROJECTS	<p>Chaotic Oscillations of a Double Pendulum <i>Aim: To see sensitive dependence on initial conditions</i> Guide: Prof. Punit Parmananda (Course Project - Non-Linear Dynamics) <i>Spring 2009</i> I derived the governing partial differential equation. I then solved the it using RK-4 (Runge Kutta Method) to understand the sensitive dependence in initial conditions. (The Butterfly Effect).</p> <p>FEM Solver for a Arbitrary Shaped 2-D Homogeneous Waveguide <i>Aim: To understand and implement a FEM based Eigen Mode Solver</i> Guide: Prof. S V Kulkarni (Course Project - Computational Electromagnetics) <i>Autumn 2009</i> I developed a code to solve for eigen-modes of a constant dielectric waveguide of arbitrary shape based on Finite Element Technique. Comparison with analytical solutions or commercial software showed over 99% accuracy.</p> <p>TouchScreen <i>Development of a Touchscreen using Microprocessor control system</i> Guide: Prof. Pradeep Sarin (Course Project - Microprocessors Lab) <i>Autumn 2009</i> A touch-sensitive panel made with recycled ESD protective sheets . These sheets have very high point-to-point resistance. So we apply a potential drop across it, and some raster scanning at high frequency to get high resolution from a 10 inch square sheet. To connect the Atmega microcontroller to computer an user interface was written in Flash.</p>
TECHNICAL SKILLS	<p>Programmming Lanugages: Excellent in C/C++, Fortran, MATLAB Used L^AT_EX 2_ε, Mathematica, ROOT(CERN) Parallel Processing: Open MPI Microprocessor Control System : AtMega Series, IDE : Arduino, PCB Software: Eagle</p>
CONFERENCES	<p>Conference on Research Frontiers in Ultra-Cold Atomic and Molecular Gases organised by ICTP Trieste, Italy, Goa - India, 10 - 14 January 2011</p>

¹AP is awarded for outstanding performance in institute core courses

REFERENCES

- **Prof. Immanuel Bloch** (Summer Internship Mentor)
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- **Dr. Stefan Kuhr** (Project Guide)
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- **Prof. S Uma Sankar** (Year-long Project Guide)
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- **Prof. Alok Shukla** (Project Guide, Course Instructor)
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- **Prof. Kailash Rustagi** (Senior Thesis Guide, Course Instructor))
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