

CONTACT INFORMATION	<p>University of Cambridge Cavendish Laboratory, TCM Group 19 JJ Thomson Avenue Cambridge, CB3 0HE, UK</p>	<p>Website: https://shovandutta.org/ Email: sd632@cornell.edu, sd843@cam.ac.uk</p>
ACADEMIC POSITION	<p>Postdoctoral Research Associate Darwin College, Cambridge Supervisor: Prof. Nigel Cooper</p>	September 2018 - present
EDUCATION	<p>Cornell University, Ithaca, USA Ph.D. in Physics, 2018 M.S. in Physics, 2015 Advisor: Prof. Erich Mueller Dissertation: Collective phenomena in quantum gases</p> <p>Jadavpur University, Kolkata, India B.E. in Electronics and Tele-Communication Engineering 1st class with Honours, CGPA: 9.42/10</p> <p>Howrah Zilla School, Howrah, India Passed Higher Secondary Exam in 2008 with 96.33% in Science</p>	<p>2012 - 2018</p> <p>2008 - 2012</p> <p>1998 - 2008</p>
AWARDS AND ACADEMIC ACHIEVEMENTS	<p>DAMOP Travel Award from the American Physical Society, 2017 and 2018</p> <p>Postdoctoral Fellowship at the Max Planck-Harvard Center for Quantum optics, 2018 (declined)</p> <p>Dr. V. Ramachandra Rao Summer Fellowship, Cornell University, 2013</p> <p>Hartmann Memorial Teaching Award, Cornell University, 2012-2013</p> <p>Dr. Shyama Prasad Mukherjee (SPM) Fellowship from the Council of Scientific and Industrial Research (CSIR), India, 2012 (declined)</p> <p>1st all over India in CSIR National Eligibility Test (NET) in the Physical Sciences, 2012, for award of Junior Research Fellowships and eligibility for lecturership</p> <p>1st all over India in Joint Entrance Screening Test (JEST) in Physics, 2012, organized by premier research institutes in India</p> <p>Within top 50 in Physics Nationwide Entrance Examination (TIFR GS), 2012, organized by the Tata Institute of Fundamental Research, India</p> <p>1st all over India in Graduate Aptitude Test in Engineering (GATE) Physics 2011, organized by the Indian Institute of Science (IISc) and the Indian Institutes of Technology (IITs)</p> <p>Best paper award in National Students Paper and Circuit Design Contest (NSPCDC) 2011, organized by IEEE Jadavpur University Students' Branch and IEEE Calcutta Section</p> <p>Late Supriya Basu Scholarship from Jadavpur University Alumni Association (Mumbai Branch), 2010, for securing the highest grade in all engineering departments</p> <p>1st among 67,655 students in the West Bengal Joint Entrance Examination (WBJEE) in engineering, 2008 [news article in The Telegraph] – Gold medal from Howrah Zilla School</p>	

Within top 50 among $\sim 4 \times 10^5$ students in the West Bengal Higher Secondary Examination, 2008 – Government of India, Ministry of Human Resource Development (MHRD) Scholarship

2nd in the Achievement-cum-Diagnostic Test in Mathematics (ADTM) 2007, organized by the Centre for Pedagogical Studies in Mathematics, West Bengal

RESEARCH
DURING PHD

Theoretical study of ultracold quantum gases: As matter is cooled to very low temperatures, strange quantum-mechanical properties emerge. My research consisted of analyzing mathematical models of such quantum gases of atoms and photons using a blend of analytical and numerical techniques. The projects I worked on fall under the following broad research areas:

- **Superfluidity in ultracold gases of fermions and bosons:** kinetics of Bose condensation, spread of impurities, stability and dynamics of collective excitations such as domain walls, vortices, and polarons, experimental signatures of different superfluid states.
- **Quantum phase transitions and crossovers:** Characterizing quantum phase transitions and crossovers by studying the variation of physical properties, e.g., the Superfluid-Mott transition in Bose gases, BEC-BCS crossover in Fermi gases, and dimensional crossovers.
- **Nonequilibrium dynamics:** Spread of impurities, condensate formation, thermalization, soliton dynamics, collective oscillations and waves, driven optical cavities. Different theoretical tools – rate equations, Fermi's golden rule, Heisenberg/Schrodinger equations, Bogoliubov-de Gennes equations, Lindblad type master equations, and variational ansatz.
- **Exotic many-body quantum states:** Proposing experimental protocols to prepare, detect, and manipulate quantum states with exotic features, such as FFLO (Fulde-Ferrell-Larkin-Ovchinnikov) and breached-pair superfluidity in spin-imbalanced Fermi gases, and photonic Laughlin states and anyons in specially designed optical cavities.
- **Emergent macroscopic structures:** Stability and dynamics of persistent nonlinear waves or solitons and quasiparticle excitations such as polarons and bipolarons in superfluids.
- **Open quantum systems:** Modeling driven dissipative quantum systems to study the formation and detection of novel many-body states, such as those accessible through strong light-matter coupling in a cavity. Examples include the study of fractional quantum Hall states of polaritons and anyonic quasiparticles in a driven optical cavity.

RESEARCH AS
AN UNDERGRAD

Bifurcation in dynamical systems: Analyzing equations of motion of simple nonlinear systems with feature-rich bifurcation diagrams, coming up with theoretical techniques to characterize borderline cases where linear stability analysis fails, and proposing tunable electronic circuits which will possess a given set of bifurcations.

Random walks: Using probability arguments to construct and solve integro-differential equations describing the dynamics of a particle executing a continuous-time random walk under an arbitrary time-varying external field, leading to subdiffusive transport seen in disordered media.

Photoemission from thin films: Analyzing quantum Boltzmann rate equations to study the photocurrent from a semiconductor film as a function of the film thickness and the frequency and polarization of the incident light.

PT-symmetric quantum mechanics: Exploring the mathematical properties of a class of non-Hermitian Hamiltonians that are symmetric under spacetime reflection, and showing how they are physically equivalent to Hermitian Hamiltonians used in ordinary quantum mechanics.

Liquid-gas phase transition of cold nuclear matter: Using the Bethe-Peierls approximation of quantum statistical mechanics to model the liquid-gas phase transition in a cubic lattice gas model of cold nuclear matter.

JOURNAL
PUBLICATIONS

[Summary with illustrations available at shovandutta.org/research/]

1. **Shovan Dutta** and Erich J. Mueller, “Coherent generation of photonic fractional quantum Hall states in a cavity and the search for anyonic quasiparticles,” *Phys. Rev. A* **97**, 033825 (2018) [[pdf](#)] [[supplement](#)] [[arXiv](#)] [[news story](#)].
2. **Shovan Dutta** and Erich J. Mueller, “Protocol to engineer Fulde-Ferrell-Larkin-Ovchinnikov states in a cold Fermi gas,” *Phys. Rev. A* **96**, 023612 (2017) [[pdf](#)] [[arXiv](#)].
3. **Shovan Dutta** and Erich J. Mueller, “Collective modes of a soliton train in a Fermi superfluid,” *Phys. Rev. Lett.* **118**, 260402 (2017) [[pdf](#)] [[arXiv](#)] [[news story](#)].
4. **Shovan Dutta** and Erich J. Mueller, “Dimensional crossover in a spin-imbalanced Fermi gas,” *Phys. Rev. A* **94**, 063627 (2016) [[pdf](#)] [[arXiv](#)].
5. **Shovan Dutta** and Erich J. Mueller, “Kinetics of Bose-Einstein condensation in a dimple potential,” *Phys. Rev. A* **91**, 013601 (2015) [[pdf](#)] [[arXiv](#)].
6. **Shovan Dutta** and Erich J. Mueller, “Variational study of polarons and bipolarons in a one-dimensional Bose lattice gas in both the superfluid and the Mott-insulator regimes,” *Phys. Rev. A* **88**, 053601 (2013) [[pdf](#)] [[arXiv](#)].

UNPUBLISHED
RESEARCH

1. Thermalization in a quasi-one-dimensional quantum gas [A-exam problem – manuscript and slides available in shovandutta.org/research/#unpublished].
2. 1D-to-3D crossover in a spin-imbalanced Fermi gas in an array of coupled tubes [extension of work on dimensional crossover in a single tube].
3. Understanding the nucleation of the superfluid B phase in ^3He as it is supercooled below the A-B transition temperature [unresolved].
4. Developing a generalized Density-Matrix-Renormalization-Group (DMRG) technique for modeling continuum systems [work in progress].

CONFERENCE
POSTERS

1. Shovan Dutta and Erich Mueller, “Creating Laughlin states and braiding anyons in an optical cavity.”
 - 49th Annual Meeting of APS DAMOP, May 30, 2018, Ft. Lauderdale, FL [[poster](#)]
 - CCMR Symposium on Photonics & Quantum Optics, May 23, 2018, Ithaca, NY [[poster](#)]
 - ITAMP workshop on Many-Body Cavity QED, Oct 10, 2017, Boston, MA [[poster](#)]
 - ARO AFOSR Quantum Matter MURI review, Oct 12, 2017, Gaithersburg, MD
2. Shovan Dutta and Erich Mueller, “Collective modes of a soliton train in a Fermi superfluid.”
 - 48th Annual Meeting of APS DAMOP, Jun 6, 2017, Sacramento, CA [[poster](#)]
 - ARO AFOSR MURI Program Review, Sep 27, 2016, Chicago, IL [[poster](#)]

UNDERGRAD
RESEARCH
PAPERS

1. **Shovan Dutta** and **Subhankar Ray**, “Damped bead on a rotating circular hoop - a bifurcation zoo,” [arXiv:1201.1218](#) (2012) .
2. **Shovan Dutta** and Subhankar Ray, “Bead on a rotating circular hoop: a simple yet feature-rich dynamical system,” [arXiv:1112.4697](#) (2011).
3. **Shovan Dutta**, Subhankar Ray, and **J. Shamanna**, “Continuous Time Random Walk with time-dependent jump probability: a direct probabilistic approach,” [arXiv:1112.3253](#) (2011).

4. **Shovan Dutta**, “A simple circuit model showing feature-rich Bogdanov-Takens bifurcation.” Selected as the best paper in the National Students Paper and Circuit Design Contest (NSPCDC) 2011.
Available at http://ewh.ieee.org/sb/calcutta/jadavpur/Papers/Circuit_Model_for_Bogdanov-Takens_Bifurcation.pdf.

REFEREED FOR	Physical Review Letters, Physical Review A
TEACHING EXPERIENCE	Teaching Assistant at Cornell University [evaluations available at shovandutta.org/teaching/]
	<ol style="list-style-type: none"> 1. PHYS 3327: Advanced Electricity and Magnetism Fall 2016 Instructed discussion section, designed numerical problems in Mathematica Course instructor: Prof. Itai Cohen [course website] 2. PHYS 2216: Introduction to Special Relativity Fall 2016 Prepared clicker questions, quiz and exam problems, graded Course instructor: Prof. Michelle Wang 3. PHYS 1116: Mechanics and Special Relativity Spring 2016 Instructed discussion and lab sections, prepared quizzes, graded Course instructor: Prof. Michael Niemack 4. PHYS 2213: Electromagnetism Fall 2015 Instructed two discussion sections and one lab section, graded, created new demos, managed discussion forum in Piazza Course instructor: Prof. Kyle Shen 5. PHYS 1203: Physics of the Heavens and the Earth Spring 2015 Instructed discussion section, supervised projects, graded Course instructor: Prof. David A. Kronreich 6. PHYS 2208: Fundamentals of Physics II Spring 2014, Spring 2013 Instructed three discussion sections, prepared quizzes, graded Course instructor: Prof. Matthias Liepe 7. PHYS 2207: Fundamentals of Physics I Fall 2012 Instructed two discussion and one lab sections, prepared quizzes, graded Course instructor: Dr. Kathy Selby
LANGUAGES	English (fluent), Bengali (native), Hindi (working knowledge), Sanskrit (beginner)
EXTRA-CURRICULAR ACTIVITIES	<p>Music – learned Indian raagas and Bengali music for ten years, won singing competitions!</p> <p>Reading non-fiction, watching documentaries, movies, interviews, and comedy</p> <p>Walking through the woods, boating on lakes</p> <p>Playing cricket, tennis, and the harmonium</p>