USHNISH RAY

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EDUCATION

- *Ph.D.* in Physics, University of Illinois at Urbana-Champaign, September 2008 – May 2015
- *B.A.* s*umma cum laude* with *High Honors* in Physics & *High Honors* in Computer Science, Colgate University, September 2004 – May 2008

CORE COMPETENCIES

Quantum and Non-equilibrium Modeling, Optimization & Algorithms: Monte-Carlo strategies (**DMC, VMC**, **SSE & PIMC**) for local and global optimization of stochastic models; Tensor network approach (**DMRG, PEPS)** to optimization; Embedding techniques (**CMFT & DMET**); Ab initio & active space techniques (**HF**, **MCSCF**, **MRCI, DFT & MD**); Machine Learning strategies and Quantum Computing.

Domain Knowledge: Condensed Matter Physics, Atomic-Molecular Optical Physics, Nonequilibrium Statistical Mechanics, Physical Chemistry, Computer Science

Programming Languages & Parallel Frameworks: C/C++, Python, Java, Fortran, MATLAB, Visual Studio, Objective C, OpenMP, POSIX, MPI, CUDA.

Research Libraries, Frameworks & Others: CANSS, CSSER, LAPACK, BOOST, QMCPACK, ITENSOR, MOLPRO, PYSCF, BLOCK, CERES, Linux, Windows, MacOS, Git, SVN, SQL, Oracle, UML.

Soft Skills: Leadership, Communication, Teamwork, Adaptability, Problem Solving, People Skills.

EXPERIENCE

California Institute of Technology
July 2016 - July 2020
Postdoctoral Research Scholar
- Extended Large Deviation Theory by identifying a connection with quantum mechanics leading to the development of novel solutions with unprecedented accuracies for non-equilibrium systems.
- Devised importance sampling strategy to mitigate exponential growth of variance in Monte-Carlo estimators leading to orders of magnitude improvement and ability to access extremely rare events.
- Designed and implemented HPC Diffusion Monte-Carlo framework to simulate realistic driven systems (such as heat flow in carbon nanotubes).

Princeton University
September 2015 - July 2016
Postdoctoral Research Scholar
- Extended Density Matrix Embedding Theory to handle superconducting and symmetry protected topological systems via large-scale simulations with Python and C++ based framework.
- Identified symmetries to improve efficiency (x20 times or more) of tensor-network based strategies.
- Participated in large benchmarking collaboration (20 researchers) with the Simons Foundation to study properties of a chain of Hydrogen atoms with extreme (sub milli-Hartree) accuracy.

University of Illinois at Urbana-Champaign
September 2010 - May 2015
Research Assistant
- Solved 20-year old outstanding problem leading to the discovery of the quantum Bose-glass phase in real systems via the largest quantum disordered calculation done to date via C++ based framework. Published as front-cover article in the preeminent journal Nature Physics.
- Pioneered studies of quantum disordered systems providing insights into their elusive properties that are pertinent for adiabatic quantum computing and related technologies.

- Undertook collaborative effort with experiments to understand properties of real quantum systems and associated exotic phases, effects of realistic protocols such as quenches, TOF and relaxation, which are critical for quantum control and metrology.

SELECTED AWARDS & ACHIEVEMENTS

- Published 17 peer-reviewed articles in leading journals such as Nature Physics, Physical Review Letters and Journal of Chemical Physics. (https://ushnishray.me/publications)
- Referee for top journals: Physical Review Letters, Physical Review A, B & E, and J. Chem. Phys.
- *University of Illinois at Urbana-Champaign Fellowship*, September 2008
- *Physics and Astronomy Alumni Award*: Colgate, April 2008
- *Award* for Academic Excellence in Computer Science: Colgate, April 2008
- *Phi Beta Kappa*: Colgate, September 2007
- *Extraordinary Talent in Computing*: State-wide Telegraph School Awards, Calcutta 2003, from among over 100,000 high-school students in West Bengal.

SELECT PUBLICATIONS & CONFERENCES

JOURNALS (* indicates co-first authorship, names arranged alphabetically.):
- **Ushnish Ray** and Garnet Kin-Lic Chan, "Constructing Auxiliary Dynamics for Nonequilibrium Stationary States by Variance Minimization", J. Chem. Phys., 152, 104107 (2020). (**Selected as Editor's Picks and website front-page article, 12 March 2020.**)
- **Ushnish Ray** and David T. Limmer, "Heat current fluctuations and anomalous transport in low-dimensional carbon lattices", *Phys. Rev. B* 100, 241409(R) (2019). (**Selected as Rapid Communications.**)
- Phillip Helms, **Ushnish Ray**, and Garnet Kin-Lic Chan, "Dynamic phase behavior of the single- and multi-lane asymmetric simple exclusion process via matrix product states", *Phys. Rev. E* 100, 022101 (2019).
- Bruno R. de Abreu, **Ushnish Ray**, Silvio A. Vitiello, David Ceperley, "Properties of the Superfluid in the Disordered Bose-Hubbard Model", *Phys. Rev. A* 98, 023628 (2018).
- **Ushnish Ray**, Garnet Kin-Lic Chan, David T. Limmer, "Exact Fluctuations of Nonequilibrium Steady States from Approximate Auxiliary Dynamics", *Phys. Rev. Lett.* 120, 210602 (2018).
- **Ushnish Ray**, Garnet Kin-Lic Chan and David Limmer, "Importance Sampling Large Deviations in Non-equilibrium Steady States: Part 1", *J. Chem. Phys.*, 148 (12), 124120 (2018). (**Selected as Editors' picks and website front-page article, March 29, 2018.**)
- Carolyn Meldgin[*], **Ushnish Ray**[*], Phillip Russ, David Chen, David Ceperley and Brian DeMarco, "Probing the Superfluid to Bose-glass Transition using Quantum Quenches of Disorder", *Nature Phys.*, 12, 10.1038 (2016). (**Selected as front cover of Nature Physics July 2016.**)
- David McKay[*], **Ushnish Ray**[*], Stefan Natu, Phillip Russ, David Ceperley and Brian DeMarco, "Metastable Bose-Einstein Condensation in a Strongly Correlated Optical Lattice", *Phys. Rev. A* A 91, 023625 (2015). (**Selected as Editors' Suggestion.**)
- **Ushnish Ray** and David Ceperley, "Revealing the Condensate and Non-condensate Distributions in the Inhomogeneous Bose-Hubbard Model", *Phys. Rev. A* 87, 051603R (2013). (**Selected for Rapid Communication.**)

CONFERENCES:
- Constructing approximate Auxiliary Dynamics for Non-equilibrium Stationary States, MoISSI workshop, Caltech (2018).
- Exploring the Superfluid-Bose-glass transition and their properties with SSE, Workshop on Understanding Quantum Phenomena with Path Integrals: From Chemical Systems to Quantum Fluids and Solids, The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy (2017).
- Efficient Strategies to Access Large Deviation Functions of Stationary Non-equilibrium States, UC Berkeley Statistical Mechanics Meeting, (2017). (**Received 1st Prize for the Poster Presentation.**)
- Dirty Bosons in Disordered Optical Lattices, APS March Meeting (2016).