Dr. Dipanjan Ray, PhD

Computational Physics
High-performance Computing
Soft & Hard Condensed Matter
Material Science

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Education:
Ph.D, Physics, University of Notre Dame, Indiana, 2014
M.Sc, Physics, University of Notre Dame, Indiana, 2011
B.Sc., Physics, University of California, Berkeley, 1996

Computing Skills:
Wide array of language proficiency on Unix/Linux, MacOS, and Windows platforms, including
- C/C++, Python, Fortran, shell scripting
- Open MPI
- experience with GPU programming (CUDA platforms)

Diverse previous research areas in computational physics: including
- Superconductivity, particularly behavior of magnetic vortices (pinning and flow)
- Atomistic and Molecular Systems: rare-event dynamics
- Novel collective behaviors of many-body ordered and disordered systems, such as:
  - superconducting vortices
  - active matter and other biophysical systems
  - skyrmions (potential next-generation high-density storage medium)

Analytical Skills and Knowledge Base:
Broad-based theoretical and computational physics, and mathematics background, including:
- Numerical Analysis / Computational Methods
- Quantum Mechanics and Quantum Field Theory
- Differential and Riemannian geometry, and Tensor Analysis

Patent:
US 9,082,923 B2: "Method and Apparatus for Enhancing Vortex Pinning by Conformal Crystal Arrays": B. Jankó, C. J. Olson Reichhardt, C. Reichhardt, and D. Ray (granted 7/14/2015)

Experience:

2020 – present: Independent researcher, Berkeley CA and Los Alamos, NM
Continuing research on postdoctoral project in collaboration with Dr. Arthur Voter (LANL). See also family / medical leave section, below.

Fall 2014 – Winter 2019: Los Alamos National Laboratory, Los Alamos, NM
(Theoretical Division, T-1 group: Physics of Materials)
Postdoctoral Research Associate (until Fall 2016);
Consultant and Guest Scientist (continuing).

Research in theoretical and computational condensed matter under Dr. Arthur Voter:
- Development of efficient algorithms for Langevin dynamics.
- Algorithms for rare-event dynamics, particularly in atomistic systems.
- Built, maintained, and administered an HPC cluster for our research group.

Research in computational condensed matter under Drs. Cynthia and Charles Reichhardt:
- Molecular dynamics; biophysics; soft condensed matter; superconductivity.

Summer 2012 – Fall 2014: Los Alamos National Laboratory, Los Alamos, NM
Student Research Associate
Conducted dissertation research under Drs. Cynthia and Charles Reichhardt in conjunction with Notre Dame Prof. Boldizsár Jankó.

Fall 2007 – Spring 2013: University of Notre Dame, Notre Dame, IN
Teaching Assistant and Grader
Graded homework and exams, and led help sessions, for graduate courses in quantum mechanics, general relativity, electrodynamics, and mathematical methods, as well as undergraduate courses in general physics and modern physics. For quantum mechanics and math methods courses, wrote up detailed homework solutions (100+ pages total) and gave fill-in lectures for professor.

Spring 2004 - Spring 2006: Lawrence Berkeley Laboratory, Berkeley, CA
Research Assistant
Assisted the KamLAND experiment, a multi-institutional collaboration attempting to observe neutrino oscillation and measure neutrino data parameters. Worked on the Monte Carlo simulation of the detector, stabilizing the program and tuning its output to reproduce actual physics data, making it a useful tool for the collaboration. The principal area of Monte Carlo research was a better understanding of the light production and transmission properties of the complicated liquid scintillator "cocktail" used by the KamLAND detector.

Winter 1998 - Spring 2000: PixelPro Technologies, San Francisco, CA
Head Programmer
Worked to develop a new proprietary video compression format to compete with QuickTime and Real, and a new still image compression format aiming to improve in efficiency upon the JPEG standard; I was the head programmer on this effort, and assisted with algorithmic research and development.

Summer 1998: Kamiya Consulting, Berkeley, CA
Consultant

Provided assistance in the design and implementation of a physics-based, generic video game engine written in the C++ programming language.

Spring 1996 - Spring 1998: Lawrence Berkeley Laboratory, Berkeley, CA
Research Technician

Worked under Dr. James Siegrist (PI) and Dr. Maurice Garcia-Sciveres as part of the CDF collaboration at Fermilab. Assisted with the development of the silicon vertex front-end electronics; my work included development of a software test suite and custom testing hardware for the silicon wafers, as well as wafer probing.

Family / medical leave:
(Beginning of 2022 – present)

During this period, I have been devoting part of my time helping my long-term partner deal with the effects of a serious illness which she has been experiencing. Details are available upon request.

Awards:

- Outstanding Graduate Student Teacher/TA Award for Excellence in Teaching, Kaneb Center for Teaching and Learning, University of Notre Dame, April 2011.
- Chancellor's Scholarship, University of California, 1991.

Publications:

1. D. Ray, C. J. Olson Reichhardt, B. Jankó, and C. Reichhardt, "Strongly Enhanced Vortex Pinning by Conformal Crystal Arrays", *Phys. Rev. Lett.*, **110**, 267001 (2013).
Editors' Choice selection of the journal.

2. D. Ray, C. Reichhardt, and C. J. Olson Reichhardt, "Vortex States in Archimedean Tiling Pinning Arrays", *Supercond. Sci. Tech.*, **27**, 075006 (2014).
Featured paper of the journal.

3. D. Ray, C. Reichhardt, and C. J. Olson Reichhardt, "Casimir Effect in Active Matter Systems", *Phys. Rev. E.*, **90**, 013019 (2014).

4. C. J. Olson Reichhardt, S.-Z. Lin, D. Ray, and C. Reichhardt, "Comparing the Dynamics of Skyrmions and Superconducting Vortices", *Physica C*, **503**, 52 (2014).

5. D. Ray, C. Reichhardt, C. J. Olson Reichhardt, and B. Jankó, "Vortex Transport and Pinning in Conformal Pinning Arrays", *Physica C*, **503**, 123 (2014).

6. D. Ray, C. J. Olson Reichhardt, and C. Reichhardt, "Pinning, Ordering, and Dynamics of Vortices in Conformal Crystal and Gradient Pinning Arrays", *Phys. Rev. B*, **90**, 094502 (2014).

7. C. Reichhardt, D. Ray, and C. J. Olson Reichhardt, "Quantized transport for a skyrmion moving on a two-dimensional periodic substrate", *Phys. Rev. B*, **91**, 104426 (2015).

8. C. Reichhardt, D. Ray, and C. J. Olson Reichhardt, "Reversible ratchet effects for vortices in conformal pinning arrays", *Phys. Rev. B*, **91**, 184502 (2015).

9. C. Reichhardt, D. Ray, and C. J. Olson Reichhardt, "Collective Transport Properties of Driven Skyrmions with Random Disorder", *Phys. Rev. Lett.*, **114**, 217202 (2015).

10. C. Reichhardt, D. Ray, and C. J. Olson Reichhardt, "Magnus-induced ratchet effects for skyrmions interacting with asymmetric substrates", *New. J. Phys*, **17**, 073034 (2015).

11. C. Reichhardt, D. Ray, and C. J. Olson Reichhardt, "Pattern formation for active particles on optically created ordered and disordered substrates", Proceedings of SPIE, **9548**, article 95481I (2015); doi 10.1117/12.2188586. [not peer-reviewed]

12. C. J. Olson Reichhardt, Y. L. Wang, Z. L. Xiao, W. K. Kwok, D. Ray, C. Reichhardt, and B. Jankó, "Pinning, flux diodes and ratchets for vortices interacting with conformal pinning arrays", *Physica C*, in press; arXiv:1602.03912

13. D. Ray, D. Perez, and A. Voter, "Highly Accurate Splitting Integrator for Langevin dynamics", in preparation.

14. D. Ray, D. Perez, and A. Voter, "Comparative Analysis of Available Methods for Integration of the Langevin equation", in preparation.

Contributed Talks:

1. CNLS, August 2016: "Highly Accurate Splitting Integrator for Langevin Dynamics".
2. APS March 2015: "Collective Transport Properties of Driven Skyrmions with Random Disorder."
3. CNLS, 2 July 2014: "Dynamics of vortices and active matter on structured substrates".
4. APS March 2014: "Casimir effect with active swimmers".
5. APS March 2014: "Enhanced vortex ratchet effect using a conformal pinning array".
6. APS March 2013: "Strongly enhanced vortex pinning by conformal crystal arrays".
7. Class presentation, April 2012: Lectured on and led student discussion of W. S. Bakr, et al. Science 329, 547 (2010): "Probing the Superfluid–to–Mott Insulator Transition at the Single-Atom Level".