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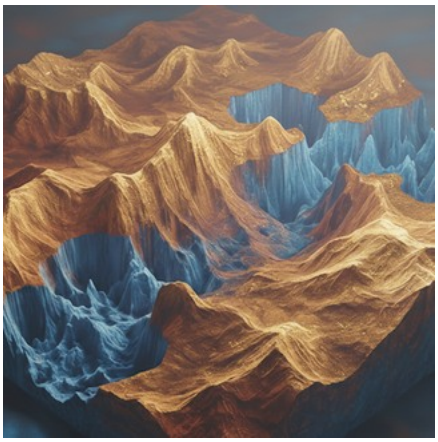
The Quantum Monte Carlo Sign Problem: Structure, Complexity, and New Directions

JANUARY 25 - 29, 2027



Scientific Overview

The Monte Carlo sign problem remains a central obstruction to scalable simulation of interacting quantum many-body systems. By undermining reliable importance sampling in quantum Monte Carlo—the primary practical framework for large-scale quantum simulation—it renders wide classes of physically relevant models computationally intractable. Despite significant conceptual advances and model-specific breakthroughs, no general resolution is known, and the boundary between tractable and intractable regimes remains poorly understood.

This workshop will bring together researchers from physics, applied mathematics, quantum information, and theoretical computer science to critically examine the current landscape of sign-problem mitigation. The goal is not merely to survey existing approaches, but to clarify structural principles underlying sign-free formulations, identify new algorithmic and complexity-theoretic perspectives, and foster cross-disciplinary collaborations. Through lectures, tutorials, focused discussions, and problem-driven sessions, the workshop aims both to accelerate conceptual progress and to train early-career researchers entering this rapidly evolving field.

This workshop will include a poster session; a request for posters will be sent to registered participants in advance of the workshop.

Organizers

Bryan Clark
University of Illinois at Urbana-Champaign

Itay Hen
University of Southern California (USC)

Emilie Huffman
Wake Forest University

Jianfeng Lu
Duke University Medical Center

Nikolay Prokof'ev
University of Massachusetts Amherst

Invited Speakers

Erez Berg (University of California, Santa Barbara (UCSB)), **Juan Carrasquilla** (ETH Zürich), **Shailesh Chandrasekharan** (Duke University), **Bryan Clark** (University of Illinois at Urbana-Champaign), **Guy Cohen** (Tel Aviv University), **Itay Hen** (University of Southern California (USC)), **Johannes S. Hofmann** (Max Planck Institute for the Physics of Complex Systems), **Emilie Huffman** (Wake Forest University), **Michael Jarret** (George Mason University), **Armen Karakashian** (Stony Brook University), **Yuehaw Khoo** (University of Chicago), **Eun-Ah Kim** (Cornell University), **Lin Lin** (California Institute of Technology), **Jianfeng Lu** (Duke University Medical Center), **Milad Marvian** (University of New Mexico), **Anders Sandvik** (Boston University), **Leyna Shackleton** (Massachusetts Institute of Technology), **Boris Svistunov** (University of Massachusetts Amherst), **Yu Tong** (Duke University), **Kris Van Houcke** (Ecole Normale Supérieure), **Lei Wang** (Chinese Academy of Sciences), **Robert Webber** (University of California, San Diego (UCSD)), **Stefan Wessel** (RWTH Aachen University), **Shiwei Zhang** (Flatiron Institute)

NSF UCLA

For program details and registration:

Scan the QR code or visit ipam.ucla.edu/QMS2027