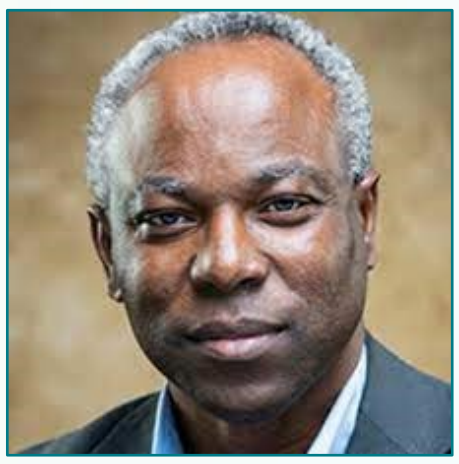
C²QA
Co-design Center for Quantum Advantage

Quantum Thursdays



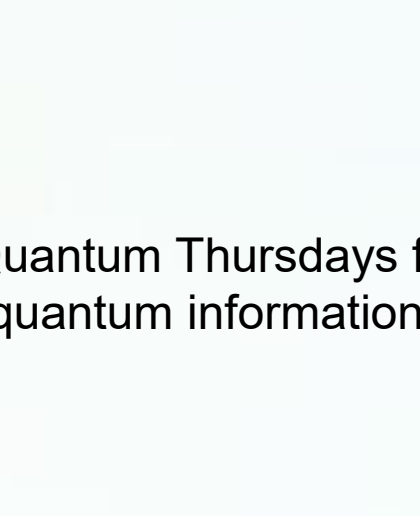
Fall 2023 Educational and Outreach Series
12:00 – 1:00 p.m. ET
Moderator Raymond E. Samuel, M.D., Ph.D.
North Carolina Agricultural & Technical State University
(C²QA Affiliate Member)

Featuring the U.S. Department of Energy Quantum Information Science (QIS) Centers

Quantum Thursdays focuses on bringing awareness to the undergraduate and graduate communities about quantum information science, the research being done in the five U.S. Dept. of Energy Quantum Centers, and the different career paths available in this field.

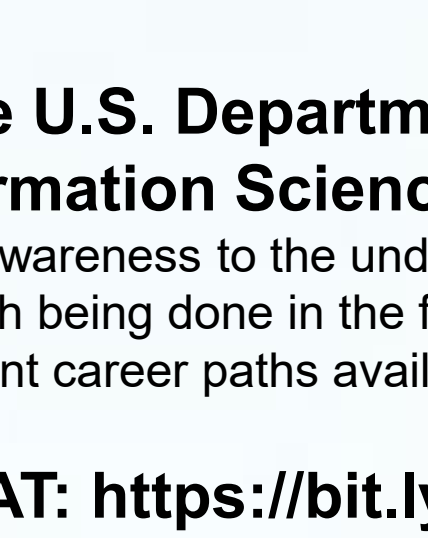
REGISTER AT: https://bit.ly/QuantThurs

Oct 26, 2023



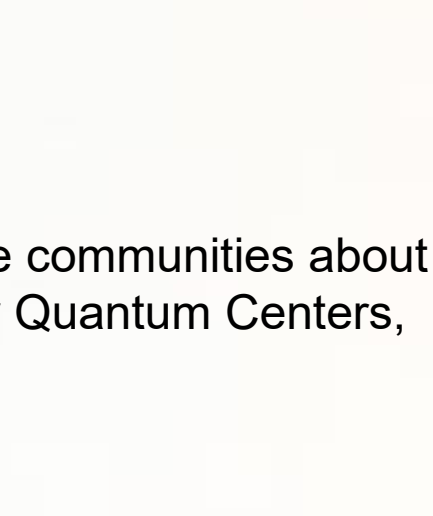
Jonathan Marcks
Q-NEXT
Interfacing with Solid State Qubits

Nov 2, 2023



Silvia Zorzetti
SQMS
Research advances & opportunities in the National Quantum Information Science Research Centers

Nov 9, 2023



Huo Chen
QSA
Adaptive variational simulation for open quantum systems

Nov 30, 2023

Vahagn Mkhitaryan
QSC
Quantum phases of Shastry-Sutherland lattice of Rydberg Atoms

Dec 7, 2023

Łukasz Dusanowski
C²QA
Individual Erbium Ions in Nanophotonic Structures for Quantum Networks Applications

U.S. DEPARTMENT OF ENERGY

C²QA Co-design Center for Quantum Advantage | Quantum Thursdays

Jonathan Marcks

Postdoctoral Researcher with Q-NEXT led by Argonne National Laboratory

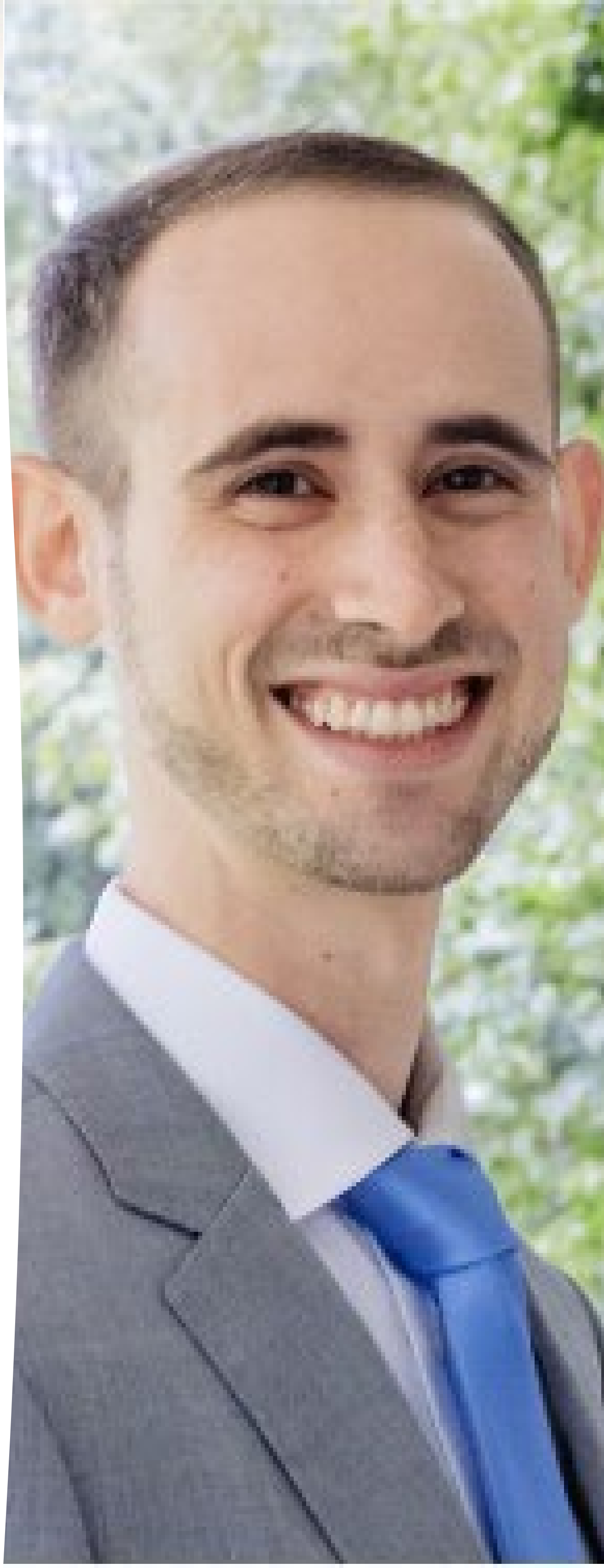
Interfacing with Solid State Qubits

Date: Oct. 26, 2023 @ 12-1pm ET

Register at: https://bit.ly/QuantThurs

Abstract Defect center-based spin qubits in solid-state materials show great promise as quantum sensors and nodes in quantum networks. However, there is a disconnect between the need for isolated qubits with long memory times and the need to couple qubits to other excitations, whether they are sensing targets, photons, or each other. I will tell three stories of our efforts to engineer, measure, and control interactions between the nitrogen vacancy (NV) center in diamond, a promising solid state qubit, and other systems. After discussing why we work with NV centers and how we grow diamond for quantum applications, I will discuss how we fabricate diamond thin films for device integration. Then I will describe NV center measurements that illuminate our understanding of nearby crystal defects in diamond and probe entangling interactions with magnetic materials.

Bio Jonathan Marcks is a postdoc at Argonne National Lab and recent graduate of the Pritzker School of Molecular Engineering at the University of Chicago. He enjoys studying spin qubits in semiconductors and living in Chicago.



C²QA Co-design Center for Quantum Advantage | Quantum Thursdays

Silvia Zorzetti

Deputy Head, Quantum Computing Co-design Department, Fermilab and Ecosystem Thrust Leader with SQMS led by Fermilab

Research advances & opportunities in the National Quantum Information Science Research Centers

Date: Nov. 2, 2023 @ 12-1pm ET

Register at: https://bit.ly/QuantThurs

Abstract Quantum Information Science (QIS) is a rapidly emerging field of study that holds immense importance for research. The National Quantum Information Science Research Centers (NQISRCs) bring together national laboratories, educational institutions, and industry players to drive groundbreaking advancements in quantum computing and sensing. The technologies developed will have far-reaching effects on both fundamental science and our daily lives. Among the others, the Superconducting Quantum Materials and Systems (SQMS) Center is committed to achieving significant breakthroughs in superconducting quantum systems, mediating QIS and High Energy Physics (HEP)-based material science. Beyond its technical objectives, the SQMS research center is dedicated to empowering the upcoming generation of quantum scientists and engineers. It offers distinctive opportunities such as internships, externships, and hands-on research experiences, engaging hundreds of students. These initiatives expose students to a diverse range of impactful careers within the expanding and innovative realm of QIS. Through these efforts, SQMS and the NQISRCs actively contribute to the growth of the quantum ecosystem while fostering the development of young talents who will shape the future of the field.

Bio Silvia Zorzetti is a senior engineer at the Fermi National Accelerator Laboratory. She is currently deputy head for the co-design department at the National Quantum Information Science Research Center SQMS Division. She also co-leads the ecosystem and workforce development thrust for the SQMS Center. She joined Fermilab in 2017 as a Bardeen Fellow. While earning her Ph.D. in electronics engineering and information technology from the University of Pisa, she was a Marie Skłodowska-Curie Fellow at the European Council for Nuclear Research (CERN). She is focusing on quantum systems to enabling applications on long-coherence quantum devices. She is also spinning off a new research project on microwave-optical quantum transduction. In 2023 she has been awarded the DOE Early Career Award.

C²QA Co-design Center for Quantum Advantage | Quantum Thursdays

Huo Chen

Postdoctoral Scholar with
QSA led by Lawrence Berkeley National Laboratory

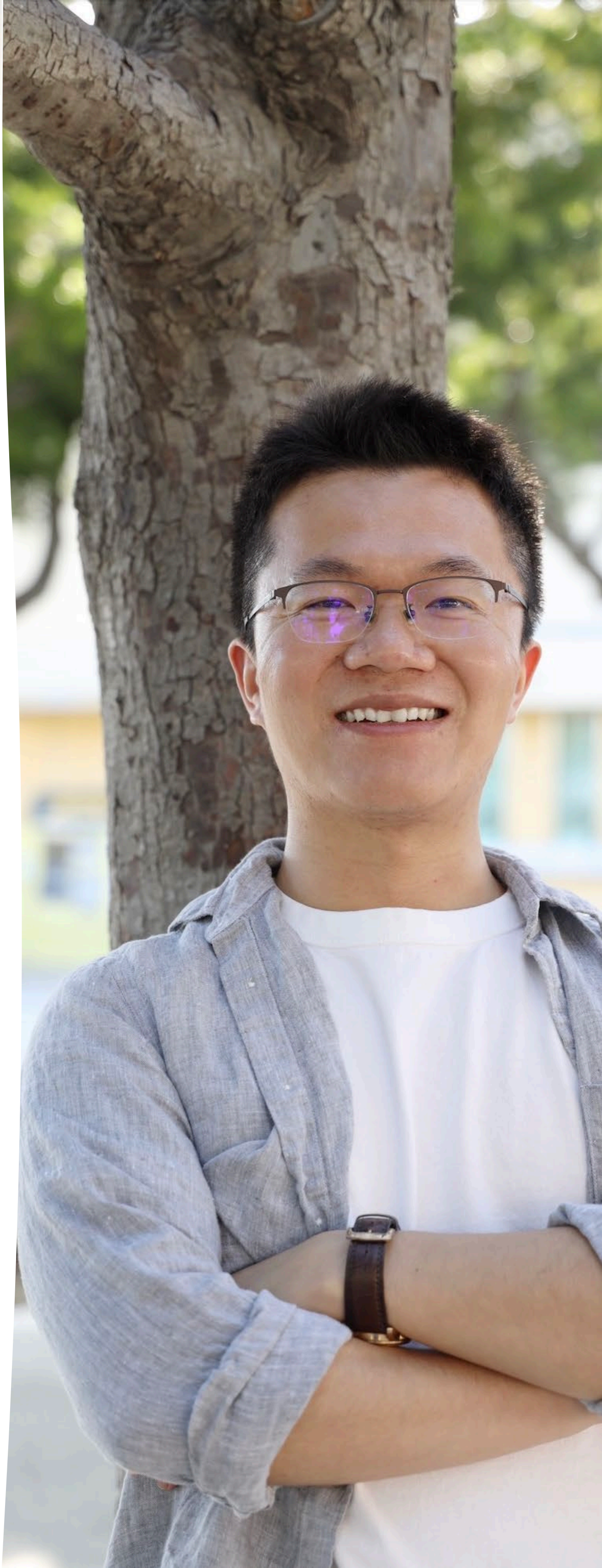
Adaptive variational simulation for open quantum systems

Date: Nov. 9, 2023 @ 12-1pm ET

Register at: https://bit.ly/QuantThurs

Abstract Emerging quantum hardware provides new possibilities for quantum simulation. While much of the research has focused on simulating isolated quantum systems, the real-world quantum systems constantly interact with external environment, which is referred to as an open quantum system. To better understand the real-world scenarios, it is essential to develop quantum algorithms that can effectively simulate open quantum systems. Here we present an adaptive variational quantum algorithm for simulating open quantum system dynamics. The algorithm is designed to build resource-efficient ansatze through the dynamical addition of operators by maintaining the simulation accuracy. We validate the effectiveness of our algorithm on both noiseless simulators and IBM quantum processors and observe good quantitative and qualitative agreement with the exact solution. Our results demonstrate that near-future quantum processors are capable of simulating open quantum systems.

Bio Huo Chen is a postdoctoral scholar at the Lawrence Berkeley National Laboratory, working in the Applied Computing for Scientific Discovery Group of the Applied Mathematics and Computational Research Division within the Computing Sciences Directorate. His primary research focus is on the theories and numerical methods of open quantum systems. In his previous work, he developed state-of-the-art models for open quantum systems that are applicable to current quantum devices. Currently, he is engaged in developing innovative quantum algorithms to accurately simulate the dynamics of open quantum systems.



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Vahagn Mkhitaryan
Postdoctoral Research Assistant at
QSC led by Oak Ridge National Lab

Quantum phases of Shastry-Sutherland lattice of Rydberg atoms

Date: Nov. 30, 2023 @ 12-1pm ET

Register at: https://bit.ly/QuantThurs

Abstract In this talk I will be presenting our recent studies of the phase diagram of Rydberg atoms on a frustrated Shastry-Sutherland lattice. Using the density matrix renormalization group, we map out a rich phase diagram in a three-dimensional parameter space that is naturally realizable in current Rydberg atom platforms. Besides a plethora of classical phases, we show the presence of phases stabilized exclusively by quantum fluctuations. We employ order parameter symmetry analysis to show the presence of novel quantum critical points. Lastly, we test the experimental feasibility of quantum phase preparation by employing the time-dependent variational principle in a system with open boundary conditions.

Bio Vahagn Mkhitaryan embarked on a doctoral journey in Spain, pursuing a PhD from 2013 to 2017 at ICFO – The Institute of Photonic Science. He obtained his PhD (Cum Laude) from UPC - Universitat Politècnica de Catalunya in Barcelona, Spain, with which ICFO was associated. Currently, he is a Postdoctoral Research Assistant at Purdue University, in the group of Prof. Vladimir Shalaev. In this capacity, he contributes to research initiatives in the fields of light-matter interaction and condensed matter physics, combining both experiments and theory. Recently,
he developed strong interests towards the fields of topological quantum materials and quantum simulations.

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Łukasz Dusanowski
Associate Research Scholar with C²QA
led by Brookhaven National Laboratory

Individual Erbium Ions in Nanophotonic Structures for Quantum Networks Applications

Date: Dec. 7, 2023 @ 12-1pm ET

Register at: https://bit.ly/QuantThurs

Abstract Single erbium ions in crystalline hosts are attractive candidates for solid-state spin-photon interfaces thanks to long-lived ground spin states and optical transitions in the telecom band, promising a clear advantage for long-distance quantum network applications. These ions can be incorporated into a wide range of host materials, which influence their spin and optical coherence properties through the concentration of other magnetic spins and the erbium site symmetry. In this work, we present a study of the spin and optical coherence properties of erbium ions implanted into CaWO4. Using silicon photonic crystal cavities, we isolate single erbium ions and investigate their optical and spin properties using resonance fluorescence and optically detected magnetic resonance. We investigate the effects of correlated environment noise by means of dynamical decoupling and photon correlation spectroscopy. In particular, we show the high indistinguishability of subsequently emitted photons in the Hong-Ou-Mandel experiment, promising a realistic pathway for generating spin-photon and spin-spin entanglement with the current device architecture.

Bio Łukasz Dusanowski is currently an Associate Research Scholar at Princeton University, where he is working in the laboratory of Jeff Thompson. His primary focus is on utilizing nanophotonic circuits to isolate and address individual rare earth ion dopants in crystalline hosts, for the purposes of using them as both single photon sources and quantum memories. Prior to joining Princeton, Łukasz worked on the optical spectroscopy of various semiconductor nanostructures, including quantum dots and quantum wells.