QUIEST
Quantum Information, Engineering, Science and Technology
University of Pennsylvania

PENN FoQuS

Penn Forum on Quantum Systems

MAY 5-6, 2025

Welcome to the second annual Penn Forum on Quantum Systems: Penn FoQuS 2025, hosted by the Penn QUIEST Center.

Quantum information, engineering, science and technology (QUIEST) is a transdisciplinary field that draws from physics, materials science, electrical engineering and information science to transform the way we think about computation and information security.

The University of Pennsylvania's QUIEST Center brings together faculty and students from the School of Engineering and Applied Science (Penn Engineering) and the School of Arts and Sciences (Penn Arts & Sciences) to collaboratively advance this vision by coordinating activities across the university and in the greater Philadelphia region. Penn FoQuS is an exemplary culmination of this mission within the broader QUIEST community.

Building upon last year's inaugural event, Penn FoQuS 2025 features quantum experts from academia, industry and government who will highlight the latest innovations and questions driving research regionally, nationally and internationally.

We hope this event will provide scientists at all levels the opportunity to build connections across the quantum community, exchange ideas and explore new possibilities for the collaborative advancement of QUIEST.

Thank you for your attendance at Penn FoQuS 2025, and we look forward to your avid participation.

Lee Bassett

Associate Professor, Electrical and Systems Engineering,
QUIEST Director,
University of Pennsylvania

SYMPOSIUM SPEAKERS

Vijay Kumar

Nemirovsky Family Dean,
Penn Engineering,
University of Pennsylvania

Vijay Kumar is the Nemirovsky Family Dean of Penn Engineering with appointments in the Departments of Mechanical Engineering and Applied Mechanics, Computer and Information Science, and Electrical and Systems Engineering at the University of Pennsylvania. He received his Bachelor of Technology from the Indian Institute of Technology, Kanpur and his Ph.D. from The Ohio State University in 1987. He has been on the Faculty in the Department of Mechanical Engineering at the University of Pennsylvania since 1987.

In addition to holding many administrative positions at Penn, Kumar has served as the assistant director of robotics and cyber physical systems at the White House Office of Science and Technology Policy (2012 – 2013). His lab has spun off many startups in robotics, and he is the founder of Exyn Technologies. He is a Fellow of the American Society of Mechanical Engineers (ASME) and the Institute of Electrical and Electronic Engineers (IEEE).

He has served on the editorial boards of the IEEE Transactions on Robotics and Automation, IEEE Transactions on Automation Science and Engineering, ASME Journal of Mechanical Design, and the Springer Tract in Advanced Robotics (STAR), and was the chief editor for the ASME Journal of Mechanisms and Robotics. He has won best paper awards at DARS 2002, ICRA 2004, ICRA 2011, RSS 2011, RSS 2013, ICRA 2014, BICT 2015, and MARSS 2016 and has advised doctoral students who have won Best Student Paper Awards at ICRA 2008, RSS 2009, and DARS 2010. He is the recipient of the 2012 ASME Mechanisms and Robotics Award, the 2012 IEEE Robotics and Automation Society Distinguished Service Award, a 2012 World Technology Network (wtn.net) award, a 2013 Popular Mechanics Breakthrough Award, a 2014 Engelberger Robotics Award, the 2017 IEEE Robotics and Automation Society George Saridis Leadership Award, the 2017 ASME Robert E. Abbott Award, the 2018 IEEE Robotics and Automation Pioneer Award, and the 2020 IEEE Robotics and Automation Field Award. He was elected to the National Academy of Engineering in 2013, the American Philosophical Society in 2018, the American Academy of Arts and Sciences in 2022, and the National Academy of Inventors in 2023.

MODERATORS

Bo Zhen

Jin K. Lee Presidential Associate Professor,
Physics and Astronomy,
University of Pennsylvania

Anthony Sigillito

Assistant Professor, Electrical and Systems Engineering,
University of Pennsylvania

Steve Zdancewic

Schlein Family President's Distinguished Professor and Associate Chair,
Computer and Information Science,
University of Pennsylvania

Gushu Li

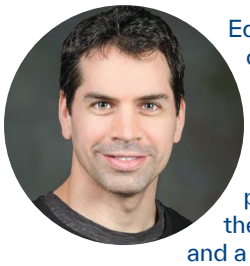
Assistant Professor, Computer and Information Science, Electrical and Systems Engineering,
University of Pennsylvania

Eric Schelter

Hirschmann-Makineni Professor of Chemistry,
University of Pennsylvania

Edwin Barnes

Professor of Physics, Roger H. Moore and Mojdeh Khatam-Moore Dean's Faculty Fellow,
Virginia Tech



Ed Barnes is a Professor of Physics and Moore Faculty Fellow at Virginia Tech, where he has been since 2015. Prior to that, he held a postdoctoral position at the University of Virginia and a senior research associate position in both the Joint Quantum Institute and the Condensed Matter Theory Center at the University of Maryland. He earned a doctoral degree in Physics from the University of California, San Diego in 2006.

Quantum control and error mitigation from geometric space curves

Future technologies such as quantum computing, sensing and communication demand the ability to control microscopic quantum systems with unprecedented accuracy. Control errors and environmental noise are among the primary obstacles to realizing these applications. I will present a new theoretical framework for deriving control waveforms that dynamically combat errors and decoherence. This theory exploits a rich geometrical structure hidden within the time-dependent Schrödinger equation in which quantum evolution is mapped to geometric space curves. I will discuss the application of this technique to the design of gates for superconducting, semiconducting and atomic qubits.

Victor Acosta

Associate Professor of Physics,
University of New Mexico

Victor Acosta is an Associate Professor in the Department of Physics & Astronomy and a core faculty member of the Center for High Technology Materials at the University of New Mexico (UNM). His research lab specializes in quantum sensing, precision measurement and spectroscopy with solid-state spins.

Acosta also leads training programs in quantum technology at the undergraduate and graduate levels, including the Quantum Photonics and Quantum Technology (QPAQT) graduate program at UNM.

Precision measurement and spectroscopy with diamond NV centers

I will discuss recent developments in the field of quantum sensing with Nitrogen- Vacancy (NV) centers in diamond, with a focus on advances at the sensitivity frontier.

Matthew Doty

Professor, Materials Science and Engineering, University of Delaware

Matt Doty earned a B.S. in physics from Penn State in 1998 and a Ph.D. in physics from the University of California, Santa Barbara in 2004. He spent three years at the Naval Research Laboratory before joining the University of Delaware (UD) in 2007. He was the faculty director of the UD Nanofabrication Facility and is now Professor of Materials Science and Engineering and the Founding Director of UD's Quantum Science and Engineering program.

Toward scalable nanophotonic devices exploiting InAs QDs

Solid state single photon emitters are a crucial component of photonic quantum computing approaches, serving, for example, as a source of entangled cluster or graph states. We would like to realize scalable arrays of such emitters at wafer scale with deterministic control over the emitter placement, the photon emission energy, the spin precession frequencies and the integration with nanophotonic device components. This talk will use recent advances related to InAs QD single-photon sources to illustrate the current challenges and opportunities related to scalability.

Yuval Baum

Head of Quantum Control Research, Q-CTRL

Yuval Baum leads a diverse research team that has carved a niche in the quantum computing sector through innovative integration of quantum physics, machine learning and control theory. His work stands at the cutting edge of enhancing quantum algorithmic performance. His team work has been theoretically conceptualized and practically tested on real quantum computers, demonstrating significant improvements and showcasing early instances of quantum utility. Before joining Q-CTRL, Baum was a research fellow at the California Institute of Technology.

Transforming the path to quantum advantage with quantum software

Quantum computers have the potential to solve problems beyond the reach of today's supercomputers. Before this cutting-edge technology can achieve the first commercial demonstration of quantum advantage, quantum computers must become much more capable. I will survey promising applications in quantum chemistry and optimization where commercial quantum utility may appear in the near future, well before fault-tolerant quantum computing will be available, and demonstrate how Q-CTRL software tools enable these applications, bringing the utility era closer.

Saikat Guha

Clark Distinguished Chair Professor, Electrical and Computer Engineering, University of Maryland

Saikat Guha is Clark Distinguished Endowed Chair Professor of Electrical and Computer Engineering at the University of Maryland (UMD), and Co-Director of National Science Foundation (NSF) Center for Quantum Networks. He received his B.Tech. in Electrical Engineering (IIT Kanpur, 2002), S.M., Ph.D. in Electrical Engineering and Computer Science (MIT, 2004, 2008), and was with Raytheon BBN for nine years and University of Arizona for eight years, prior to joining UMD in 2024. His research focuses on quantum limits of photonic information processing. He is an Institute of Electrical and Electronics Engineers (IEEE) Fellow.

Quantum enhanced photonic information processing

Light is inherently a quantum object. Hence, fundamental performance limits of systems where light is the bearer of information are ultimately governed by principles of quantum information. I will discuss some examples of quantum enhanced photonic systems with applications to receiver design for deep-space laser communications, active-probing opto-mechanical sensors and passive imaging telescopy. I will close with a high-level overview of the Center for Quantum Networks, a full-stack NSF Engineering Research Center (ERC) developing the technologies underlying fault-tolerant quantum communications and networking.

Ryan Hadt

Assistant Professor of Chemistry, Caltech

Ryan G. Hadt received his B.S. and M.S. degrees in chemistry at the University of Minnesota Duluth and his Ph.D. at Stanford University. He was a visiting postdoctoral fellow at Harvard University before continuing research at Argonne National Laboratory as a postdoctoral appointee and an Enrico Fermi Fellow. In 2018, he joined the Division of Chemistry and Chemical Engineering at the California Institute of Technology.

Unveiling a New Regime of Electron Spin Coherence

This talk will describe picosecond all-optical detection of electron spin coherence by leveraging the codesign of ultrafast magneto-optical instrumentation and electronic structure. This approach improves experimental time resolution by up to five orders of magnitude relative to traditional microwave-based techniques. Doing so unveils a new regime of electron spin coherence. Proof-of-concept quantum sensing measurements under ambient chemical conditions will be discussed.

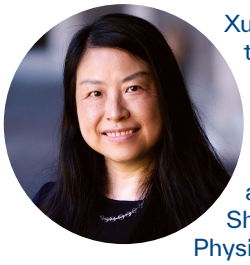
Antonio Mezzacapo

Principal Research Scientist, Quantum-centric Supercomputing and Applied Quantum Science, IBM

Antonio Mezzacapo is currently a Principal Research Scientist at IBM Quantum, leading IBM Quantum's efforts around quantum-centric supercomputing and the applied quantum sciences. One of his areas of interest is quantum simulations of chemistry and materials science, where he contributed with advancements on quantum algorithms for computing molecular energies, more efficient encodings for fermionic simulations, and experiments that have pushed the frontier of quantum simulations with quantum processors.

Xuemei Cheng

Dean of Graduate Studies, Professor of Physics and the Rachel C. Hale Professor in the Sciences and Mathematics, Bryn Mawr College



Xuemei (May) Cheng is the Rachel C. Hale Professor in the Sciences and Mathematics and Professor of Physics at Bryn Mawr College. She earned her Ph.D. in Physics from Johns Hopkins University and completed a postdoctoral fellowship at Argonne National Laboratory before joining Bryn Mawr in 2009. With her expertise in nanofabrication, synchrotron x-ray spectra, and magnetic imaging, she is interested in exploring interface magnetism and quantum materials, such as topological spin textures.

Magnetic skyrmions for information storage and quantum computing

Magnetic skyrmions—swirling spin textures with nontrivial topology—have drawn significant attention for their intriguing physics and potential in data storage and quantum computing. In this talk, I will present our discovery of the skyrmion Hall effect and a topological spin memory effect in magnetic multilayers, and offer insights into the promise of nanoskyrmions as building blocks for future quantum computing technologies.

Quantum simulations of large lattice models and chemistry beyond the scale of exact diagonalization methods

In the last decade, variational algorithms have been the tool of choice for researchers and practitioners of quantum. Currently, a number of practical and theoretical issues prevent their scalability to large system sizes. In this talk, I will discuss two quantum diagonalization methods which overcome the limitations of variational algorithms, allowing the simulation of lattice models of up to 50 spins, and enabling realistic chemistry computations of up to 77 qubits on a quantum-centric supercomputing architecture.

Brandon Mitchell

Professor, Physics and Engineering, West Chester University

Dr. Brandon Mitchell, Professor of Physics, specializes in rare earth-doped semiconductors for micro-LED displays and quantum technologies. His research focuses on Er-doped GaAs for electrically-pumped single-photon emitters in Telecom C-band, and Eu-doped GaN for quantum sensing in noisy environments. As Director of WCU's Center for STEM Inclusion, he leads a STEM education ecosystem in Southeastern Pennsylvania connecting schools, non-profits, industry and higher education institutions.

Quantum-Ready: Creating Comprehensive Pathways in Quantum Science Education

To meet future workforce demands in quantum information science, it is essential to increase student training in critical areas like quantum optics, materials science and quantum computing. We have developed a comprehensive program providing targeted education in quantum science and engineering, career-oriented training and hands-on workshops utilizing state-of-the-art equipment. This presentation will highlight our program structure and current outcomes.

Justyna Zwolak

Mathematician, Applied and Computational Mathematics Division, NIST

Justyna P. Zwolak is a mathematician at the National Institute of Standards and Technology and a Joint Center for Quantum Information and Computer Science (QuICS) Affiliate Fellow at the University of Maryland. Her research centers on developing machine learning algorithms to optimize and automate quantum experiments, focusing on semiconductor quantum dots and cold atom systems. For her pioneering work at the intersection of artificial intelligence and quantum technologies, she received the U.S. Department of Commerce Bronze Medal and the Presidential Early Career Award for Scientists and Engineers (PECASE).

Smart calibration of quantum dot devices

Scaling up semiconductor quantum dot (QD) qubits requires efficient, reliable gate voltage selection to maintain proper operation. QDs are inherently dynamic systems with electron confinement and tunneling sensitive to voltage changes and requiring near-continuous monitoring and adjustment. A key challenge hindering scalability is the need for manual control. I will present our modular, autonomous and platform-agnostic tuning system for QD device calibration, with specialized sub-systems designed for the various steps of the tuning process.

Mauricio Terrones

Verne M. Willaman Professor of Physics, Professor of Chemistry and Materials Science & Engineering, Penn State

Mauricio Terrones is an Evan Pugh University Professor and Department Head of Physics at Penn State. With a D.Phil. from the University of Sussex under Nobel Laureate Harold Kroto, he has over 650 publications and 93,000-plus citations (H-index: 148). A Fellow of the American Physical Society (APS), the American Association for the Advancement of Science (AAAS), the World Academy of Sciences (TWAS) and the Royal Society of Chemistry (RSC), he has received numerous international awards. Terrones is the Founder Director of Penn State's Center for 2-Dimensional and Layered Materials and Editor-in-Chief of Carbon (IF=10.5).

Controlling Functionality in 2D materials: From ferromagnetism to single photon emission and bio-applications

This talk will define defects in transition metal dichalcogenides (TMDs) and hBN monolayers, detailing their atomic structures and characterization via advanced optical techniques. Key topics include the roles of vacancies, dopants and edges, with a focus on how dopants and local strain induce ferromagnetism and single photon emission. The talk also highlights biomolecular interactions, and applications of TMDs as fluorescent biomarkers when ingested by cells, revealing their potential in biological advancements.

2025 SYMPOSIUM SCHEDULE

Monday, May 5

10:00 a.m. CHECK-IN / NETWORKING BRUNCH BITES ..... SINGH LOBBY

11:15 a.m. WELCOME & OPENING REMARKS
Lee Bassett, *University of Pennsylvania, QUIEST Director* ..... GLANDT FORUM

SESSION 1: MATERIALS FOR QUIEST | MODERATOR: **Bo Zhen**, *University of Pennsylvania*

11:30 a.m. *Unveiling a New Regime of Electron Spin Coherence*
Ryan Hadt, *Caltech* ..... GLANDT FORUM

12:00 p.m. *Controlling Functionality in 2D Materials: From ferromagnetism to single photon emission and bio-applications* **Mauricio Terrones**, *Penn State* ..... GLANDT FORUM

12:30 p.m. *Magnetic skyrmions for information storage and quantum computing*
Xuemei Cheng, *Bryn Mawr College* ..... GLANDT FORUM

1:00 p.m. COFFEE / NETWORKING BREAK ..... GLANDT FORUM

SESSION 2: QUANTUM DEVICES | MODERATOR: **Anthony Sigillito**, *University of Pennsylvania*

1:30 p.m. *Precision measurement and spectroscopy with diamond NV centers*
Victor Acosta, *University of New Mexico* ..... GLANDT FORUM

2:00 p.m. *Smart calibration of quantum dot devices*
Justyna Zwolak, *NIST* ..... GLANDT FORUM

2:30 p.m. *Toward scalable nanophotonic devices exploiting InAs QDs*
Matthew Doty, *University of Delaware* ..... GLANDT FORUM

3:00 p.m. POSTER SESSION / COCKTAIL HOUR AND HORS D'OEUVRES ..... SINGH LOBBY

5:00 p.m. FEATURED PANEL DISCUSSION (RSVP REQUIRED VIA GENERAL REGISTRATION FORM) ..... GLANDT FORUM

MODERATOR: **Steve Zdancewic**, *University of Pennsylvania*

Edwin Barnes, *Virginia Tech*
Yuval Baum, *Q-CTR*
Justyna Zwolak, *NIST*
Ryan Hadt, *Caltech*
Vijay Kumar, *University of Pennsylvania*

6:00 p.m. RECEPTION DINNER / NETWORKING ..... GLANDT FORUM
(RSVP REQUIRED VIA GENERAL REGISTRATION FORM)

Tuesday, May 6

9:00 a.m. CHECK-IN / NETWORKING BREAKFAST ..... SINGH LOBBY

9:45 a.m. OPENING REMARKS ..... GLANDT FORUM

SESSION 3: QUANTUM SYSTEMS | MODERATOR: **Gushu Li**, *University of Pennsylvania*

10:00 a.m. *Quantum control and error mitigation from geometric space curves*
Edwin Barnes, *Virginia Tech* ..... GLANDT FORUM

10:30 a.m. *Quantum enhanced photonic information processing*
Saikat Guha, *University of Maryland* ..... GLANDT FORUM

11:00 a.m. *Optional QUIEST Lab Tours* ..... TOURS MEET IN SINGH LOBBY

11:30 a.m. LUNCH / NETWORKING ..... GLANDT FORUM

SESSION 4: QUIEST IMPACT | MODERATOR: **Eric Schelter**, *University of Pennsylvania*

12:30 p.m. *Quantum-Ready: Creating Comprehensive Pathways in Quantum Science Education*
Brandon Mitchell, *West Chester University* ..... GLANDT FORUM

1:00 p.m. *Transforming the path to quantum advantage with quantum software*
Yuval Baum, *Q-CTRL* ..... GLANDT FORUM

1:30 p.m. *Quantum simulations of large lattice models and chemistry beyond the scale of exact diagonalization methods*
Antonio Mezzacapo, *IBM* ..... GLANDT FORUM

2:00 p.m. CLOSING REMARKS
Lee Bassett, *University of Pennsylvania, QUIEST Director* ..... GLANDT FORUM

2:30 p.m. OPTIONAL GROUP OUTING TO THE **SCIENCE HISTORY INSTITUTE**
(RSVP REQUIRED VIA GENERAL REGISTRATION FORM) . BUS DEPARTURE AT 2:30 P.M. FROM SINGH CENTER ENTRANCE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