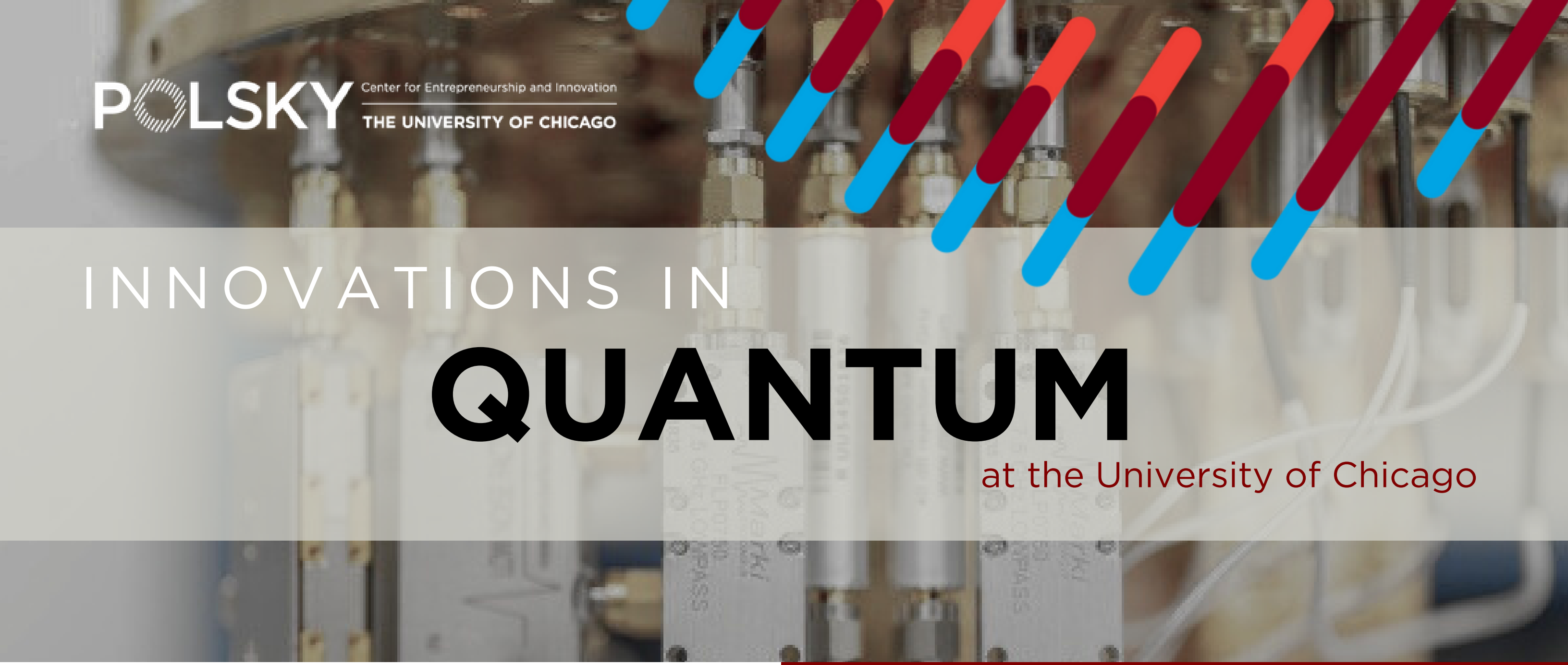


POLSKY Center for Entrepreneurship and Innovation
THE UNIVERSITY OF CHICAGO

INNOVATIONS IN QUANTUM at the University of Chicago

The University of Chicago is at the forefront of the fields of quantum science and engineering.

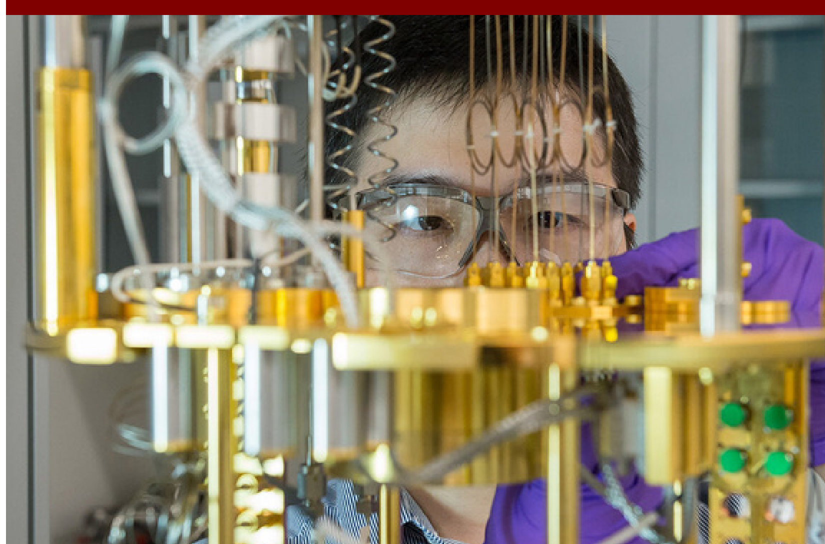
Our faculty members come from multiple departments and institutes, including Pritzker Molecular Engineering (PME), the James Franck Institute (JFI), the Department of Physics, and the Department of Chemistry.

Many are also engaged in the Chicago Quantum Exchange (CQE), an intellectual hub and community of researchers spanning academia, national labs, and industry who are advancing scientific and technological efforts in the field.

Advances in quantum sensing, encryption, and computing will transform science and engineering and have far-reaching impact on industry, the economy, and other aspects of our society.

Quantum engineering at the Pritzker School of Molecular Engineering

While some of the most impactful technologies of the 20th century, such as the transistor and the laser, rely on quantum physics, they do not use the most extreme kinds of quantum phenomena. The ability to harness effects like quantum superposition and entanglement will usher in a new generation of transformative technologies. The Pritzker School of Molecular Engineering stands at the forefront of this rapidly emerging field.



RESEARCHERS TO KNOW

David Awschalom

Awschalom's work is in the fields of spintronics and quantum information engineering, exploring and controlling the spins of electrons, nuclei, and photons in semiconductors and molecules. His research includes implementations of information processing with potential applications in quantum computing, communication, and sensing.

Hannes Bernien

Bernien studies quantum many-body physics and quantum information processing and seeks to develop new ways of engineering large, complex quantum systems. Bernien has had research published in numerous journals, including Nature, Science, and the Proceedings of the National Academy of Sciences.

Aashish Clerk

Clerk's research focuses on understanding complex phenomena in quantum systems that are both strongly driven by and subject to dissipation. Such effects are not only interesting from a fundamental perspective, but can also enable quantum technologies to transcend the limitations of purely classical systems. His group's work intersects the fields of condensed matter physics, quantum optics, and quantum information.

Fred Chong

Chong's research interests include emerging technologies for computing, quantum computing, multicore and embedded architectures, computer security, and sustainable computing. He has been funded by NSF, DOE, Intel, Google, AFOSR, IARPA, DARPA, Mitsubishi, Altera and Xilinx. He has led or co-led over $40M in awarded research and been co-PI on an additional $41M. Chong also is the Chief Scientist for Quantum Software at Infleqtion.

Supratik Guha

The Guha Group's interests lie in the engineering of materials, devices, and nanofabrication techniques for applications in future information processing systems. These include non-traditional systems such as those enabling quantum information processing, networked cyberphysical sensors and devices for distributed processing, and novel devices and materials for classical computing. Guha pioneered the materials research that led to IBM's high dielectric constant metal gate transistor.

RESEARCHERS TO KNOW

Liang Jiang

Jiang theoretically investigates quantum systems and explores various quantum applications, such as sensing, transduction, communication, and computation. His research focuses on using quantum control and error correction to protect quantum information from decoherence to realize robust quantum information processing.

Peter Maurer

The Maurer Lab focuses on developing and applying novel sensing and imaging modalities that combine techniques from quantum optics, quantum engineering, and single-molecule biophysics. Technologies include a nanoscale quantum sensor for nuclear magnetic resonance (NMR) spectroscopy of individual biomolecules, a single-molecule platform for quantum sensing, and new nanophotonics techniques for bio-imaging.

Dmitri Talapin

Dmitri Talapin's group has broad expertise in synthesis, self-assembly, surface chemistry, and device applications of inorganic nanomaterials. His research interests lie in the development of novel functional materials through the assembly of rationally designed nanoscale and molecular components. This work has significantly advanced our understanding of synthetic methodology and structure-property relationships for low-dimensional functional materials.

Tian Zhong

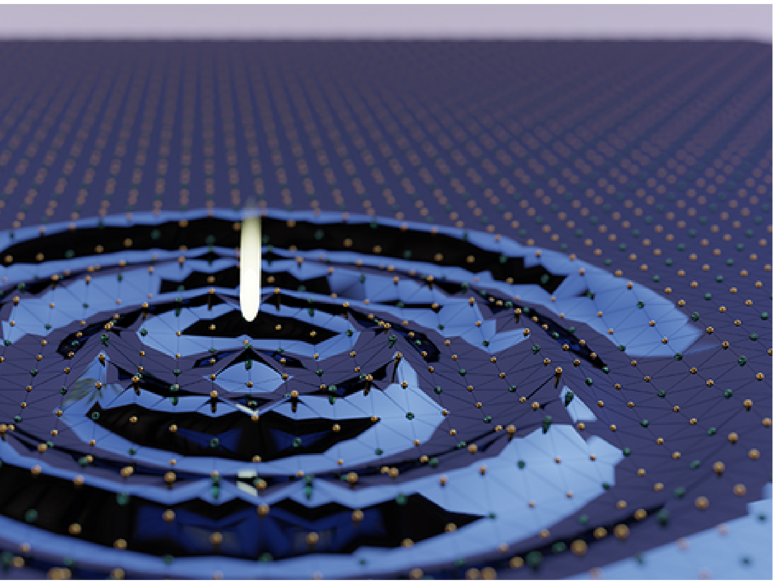
Zhong's research focuses on developing enabling nanophotonic and molecular technologies for building an efficient, global-scale quantum internet. Additionally, Zhong has pioneered the field of rare-earth quantum nanophotonics. Zhong's work has contributed to significant progress in nanoscale quantum network nodes and high-throughput quantum communication links interconnecting distant nodes.

AVAILABLE TECHNOLOGIES

Materials – Hardware

Electrically Tunable Quantum Platform Using Spin Defects in SIC Heterostructures

A general method for reducing spectral diffusion in solid state emitters, while utilizing the unique properties of p-i-n devices to create integrated defect based systems with ideal properties for quantum technologies.



Low-loss Niobium Josephson Junction Fabrication Method for Quantum Devices

Method allows for loss levels that are approaching those of traditional aluminum junctions, but with a higher operating temperature due to the use of Niobium

Small Waist Lens Resonator for Quantum Science

A new way to make high-cooperativity optical resonators, which are necessary for achieving strong coupling to localized optical emitters, such as quantum dots, individual atoms in tweezer arrays, individual ions in ion traps, rare earth ions, and even potentially high-precision scanning microscopy of surfaces using higher order modes of said resonators (super-resolution imaging using mode zeros).

Tunable High-Q Superconducting mm-Wave Cavities for Circuit and Cavity QED Experiments

A hybrid system through a 3-dimensional mm-wave activity with a measured resonance in the mm-wave frequency band, sufficient to reach strong coupling in a Rydberg cavity quantum electrodynamics system.

Epitaxial Rare Earth Quantum Devices and Heterogeneous Integration with Silicon

A new scalable approach to localize rare-earth emitters at the maximum optical intensity in the waveguide to achieve unprecedented enhancement of fluorescence emission and highly indistinguishable photons from individual ions.

AVAILABLE TECHNOLOGIES

Communications

Method to Improve Data Rate in Quantum Communication Networks

Methods and systems for establishing a long range quantum link in a quantum communication network while improving connection rate of the quantum link. The quantum link is established across multiple quantum repeaters relying on quantum entanglement swap operations in the multiple quantum repeaters.

Fiber-Integrated Bi-Directional Microwave-Optical Transducer Based on Rare-Earth-Ion Doped Thin Films

Device and method for efficient bi-directional conversion between microwave and optical electromagnetic radiation enabling improved quantum transduction efficiency by orders of magnitude from previously described methods.

Sensing

Biocompatible Surface Functionalization Architecture for a Diamond Quantum Sensor

Quantum sensor for biomolecules that consists of a diamond substrate containing NV centers and biocompatible functional layers. The functionalization architecture provides precise control over protein adsorption density.

Chemically Tunable, Optically Addressable Ground State Molecular Spins for Quantum Information Processing and Sensing

Molecular materials with an optically addressable ground state spin enabling a variety of novel functionality including optical spin readout of a ground state electron spin in a molecular system and a platform for quantum information processing or quantum sensing.

Spin Amplifier for Enhanced Quantum Sensing using Spin Ensemble Sensors

Fundamentally new strategy to perform spin amplification that overcomes the generation of entanglement and noise by directly exploiting cavity-induced dissipation as the key resource.

AVAILABLE TECHNOLOGIES

Computing

Fast Flux Control of High-Q 3D Multimode Cavities

Control device to achieve fast flux control of localized magnetic fields in high-Q 3D microwave cavities. The design incorporates a fast flux bias line that is inserted in a slot between two seamless 3D cavities supporting higher frequency transverse electromagnetic waves than current cavity modes of interest.

A Dual-Element Atom Array for Quantum Information Processing

A dual-element atom array with individual control of single rubidium and cesium atoms with independent placement in arrays and negligible crosstalk. A dual-element processor allows a new continuous operation mode for atom arrays without any off-time.

Efficient Algorithm of Molecular Vibronic Spectra

Quantum-inspired classical algorithm to compute and analyze molecular vibronic spectra without the need for a quantum machine. The technology achieves better outcomes than other implementations based on quantum simulators and commercial products.

Real-Time Coherent Noise Correction Using an Array of Spectator Qubits

Method to use additional qubits (spectator qubits) to monitor noise and in real-time coherently correct this noise on the data qubits. Also, the technology allows the ability to get new spectator qubits while keeping data qubits coherent.

Individual Qubit Control for Atom Array Processors

Individual qubit control system for large atom arrays that enables individually targeted single qubit and 2-qubit operations on timescales that are much shorter than the coherence time and Rydberg lifetime

Practical Architectures and Algorithms for Quantum Source Coding

A method to improve the practicality of quantum compression using architectures and algorithms based on quantum sorting networks that have logarithmic running time and can be easily implemented in a distributed environment.

Model-Free Interferometry Enabled by Machine Learning

Machine learning model to infer the physical parameters from images generated by an atom interferometer even under poor resolution and/or low signal-to-noise data

Coordinated Optimization and Interpolation of Quantum Control Pulses Through Tikhonov Regularization

Generation of control pulses for continuous sets of gates for a small number of specific operations optimized to be similar to each other through Tikhonov regularization. The method allows interpolations between these operations to obtain high-accuracy pulses for new operations with negligible extra computation significantly improving both the speed and accuracy of quantum computers.

CHICAGO
QUANTUM
EXCHANGE

The Chicago Quantum Exchange (CQE) is an intellectual hub for advancing the science and engineering of quantum information between the CQE community, across the Midwest, and around the globe.

A catalyst for research activity across its member and partner institutions, the CQE is based at the University of Chicago and is anchored by the U.S. Department of Energy's Argonne National Laboratory and Fermi National Accelerator Laboratory, the University of Illinois Urbana-Champaign, the University of Wisconsin-Madison, and Northwestern University.

<DUALITY>
Accelerating Quantum Startups

Led by the Polsky Center at the University of Chicago and the Chicago Quantum Exchange, alongside founding partners the University of Illinois Urbana-Champaign, Argonne National Laboratory, and P33, the program draws on the region's deep well of scientific, corporate, and industry expertise to develop practical applications of quantum technology.

Where the world's most promising quantum companies learn to succeed in business >>

Argonne NATIONAL LABORATORY

The U.S. Department of Energy's Argonne National Laboratory is recognized as a major player in the nation's quantum efforts. The lab's cutting-edge science was awarded Q-NEXT, which will form a hub of research focused on quantum information. These advancements in quantum information science have the potential to revolutionize how we process and share information, with profound impacts such as advanced medical imaging, the creation of novel materials, and ultrasecure communication networks.

Argonne has demonstrated achievement in meeting a spectrum of quantum research challenges. The laboratory has assembled a novel material based on copper and carbon monoxide molecules to mimic graphene, a promising but difficult-to-make host for quantum data. Additionally, a team at Argonne and the University of Chicago created a record-breaking qubit that was read on demand and stayed intact for over five seconds. Argonne convenes some of the world's foremost experts in quantum information science and is fostering crucial conversations and collaborations in this flourishing field.

UChicago, through its wholly-owned affiliate, UChicago Argonne LLC, has been the prime contractor for Argonne since the lab's founding in 1946.

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POLSKY Center for Entrepreneurship and Innovation THE UNIVERSITY OF CHICAGO

The Polsky Center for Entrepreneurship and Innovation at the University of Chicago drives the translation of research innovations from the lab to the market through startups, licensing, and industry collaboration.

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