Quantum Computing,
Quantum Information Research
Island – Quantum computing, quantum sensing

Areas of Research

• Nanotechnology, device physics
• Photodetection and quantum sensing
• Quantum computing, topological qubits
• Non-equilibrium, driven systems
• Superconductivity, proximity effects
• Low dimensional materials

Island's Lab website
Quantum computing: Topological phases for fault-tolerant, universal quantum computing.

Industry-disruptive photodetectors: Ultra-sensitive phototransistors designed with 2D materials and heterostructures.

Transient phases of driven systems: Non-equilibrium response of pumped nanomaterials below the diffraction limit.


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Journal publications:

**Spin-orbit-driven band inversion in bilayer graphene by van der Waals proximity effect**

**Enhanced superconductivity in atomically thin TaS2**

**Proximity-induced Shiba states in a molecular junction**

**T1S3 transistors with tailored morphology and electrical properties**

**Environmental instability of few-layer black phosphorus**

**Ultrahigh photoresponse of few-layer TiS3 nanoribbon transistors**

**Gate controlled photocurrent generation mechanisms in high-gain In2Se3 phototransistors**

**Precise and reversible band gap tuning In single-layer MoSe2 by uniaxial strain**

Island's Lab website
Chemical reaction pathway in ultracold K+KRb collisions. Quantum engineered KRb molecules have been prepared at 300 nK. Ultracold polar molecules such as KRb are potential candidates for quantum computing and quantum information processing.
Controlling reaction outcome through quantum interference

Left panel: Two paths for a chemical reaction. These two paths can interfere constructively or destructively, maximizing or minimizing the reaction rate. This quantum effect becomes magnified in the ultracold regime (Kendrick, Hazra, and Balakrishnan, Nature Comm. 6, 7918 (2015).

Right panel: The nature of the interference can be controlled by including “geometric phase”. In the image on the right, inclusion of the geometric phase enhances the reactivity. The geometric phase (that correctly describes the sign of the wave function near a conical intersection with an excited electronic state) acts as a “quantum switch” (Hazra, Balakrishnan, and Kendrick, J. Phys. A 119, 12291 (2015))
References

Zhou Lab – Experimental AMO physics

• Dr. Yan Zhou
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Research projects
• Explore new physics beyond the Standard Model by precision measurements using quantum logically controlled molecular ions
• Precision metrology and spectroscopy using optical frequency combs
• Quantum transducer – link ion trap and superconducting quantum computers
• Experimental astrochemistry – cold ion-radical collisions
Search for $T,P$-odd symmetry violation

- On-chip Quantum sensors
- Entanglement between atomic ions and molecular ions
- Scalability and multiplexing measurements
- New table-top platform to investigate nuclear physics
Bernard Zygelman

• Quantum Computing and Information
• Computational Physics
• Atomic and Molecular Processes in Plasmas
• Quantum Workforce Development
Research Expertise and Activities

• Over 70 publications, h-index 27-Google Scholar
• Work funded by AFOSR, DOE, IAEA, NSF, NASA, W. M. Keck Foundation
• Topics include remote sensing of the thermosphere, matter-anti-matter interactions, QED, radiative and non-radiative charge transfer in hot plasmas, atomic processes in the early universe, ultra-cold physics, geometric phase and magnetism, quantum computing and information


