Department of Materials Science and Engineering
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Shed light on quantum materials and devices

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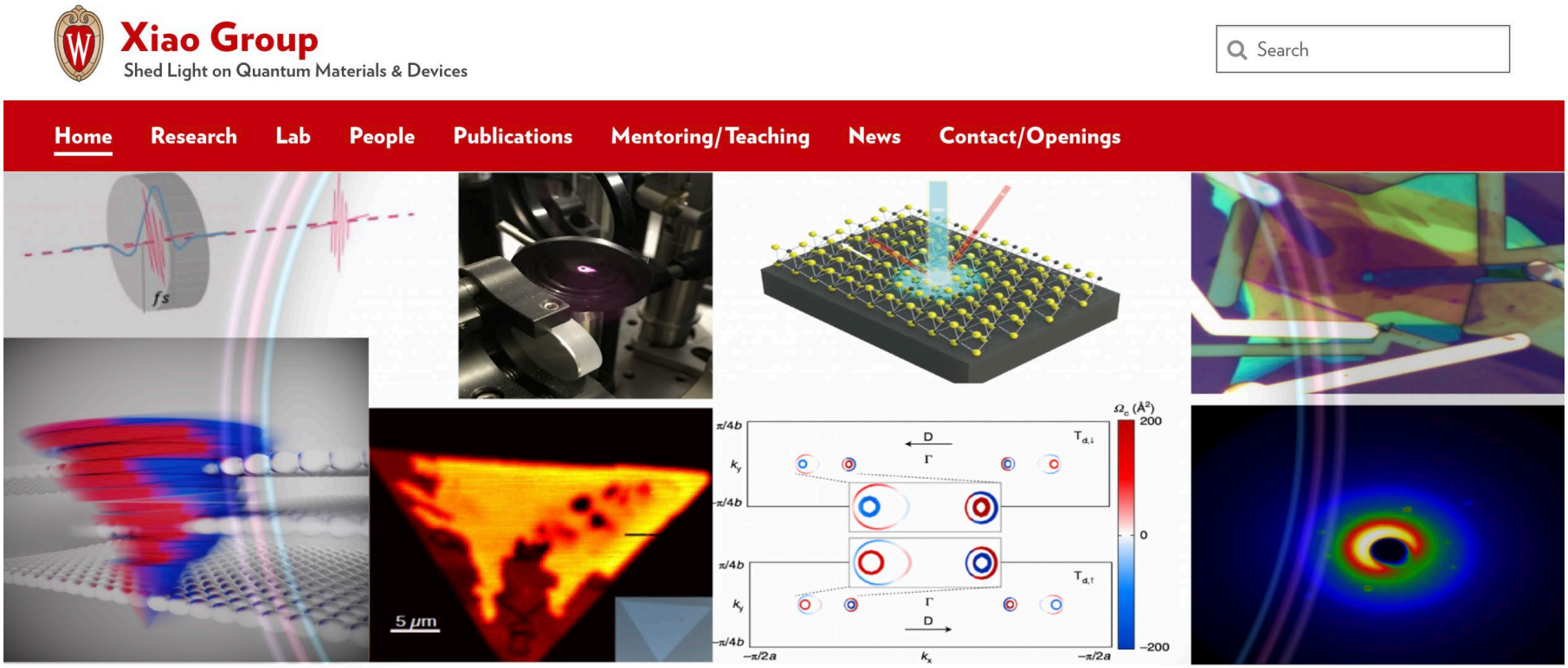
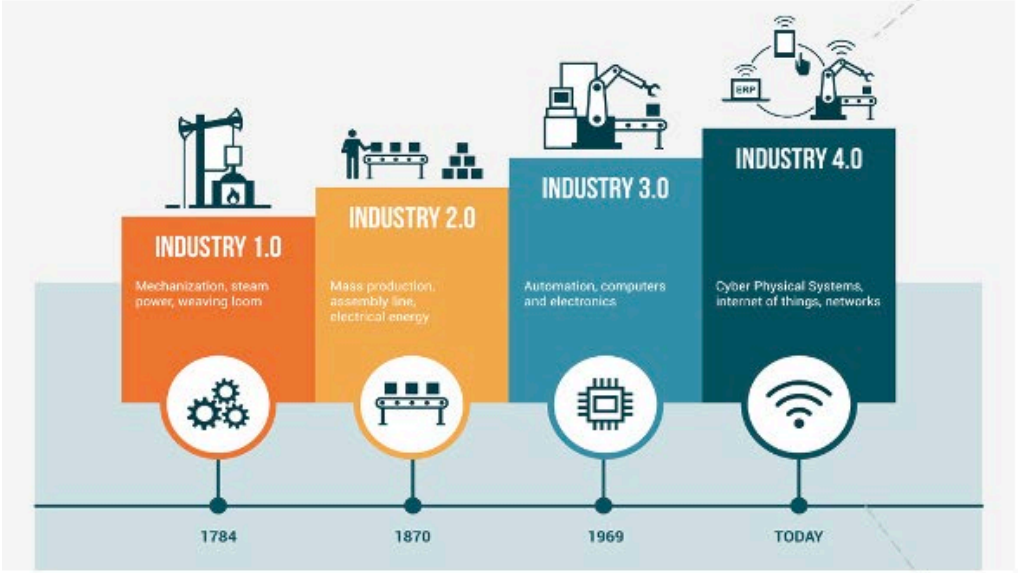
Ovewview



- Light driven nonequilibrium phenomena in quantum materials
- THz optoelectronic materials and devices for 6G communications
- Nano opto-mechanics for sensing and quantum transduction

2 to 3 PhD positions

Data-driven world

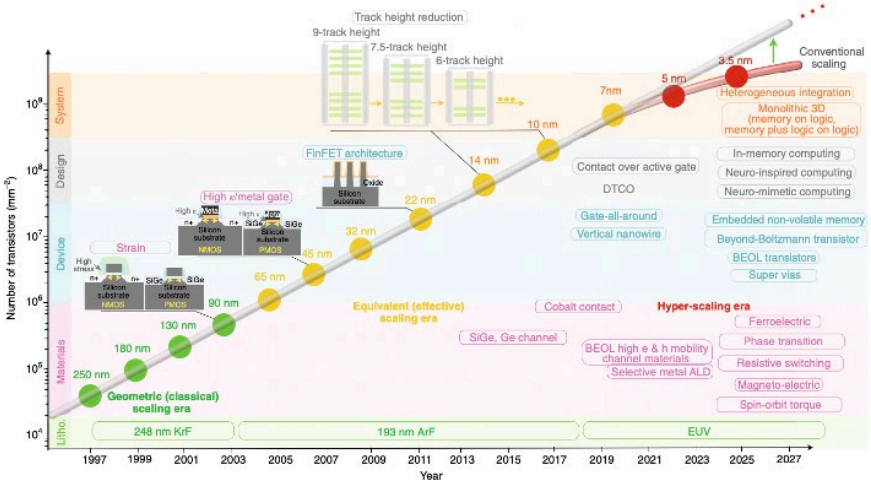


4th industrial revolution
highlights connectivity
between the physical, digital, and biological worlds

Grand challenges

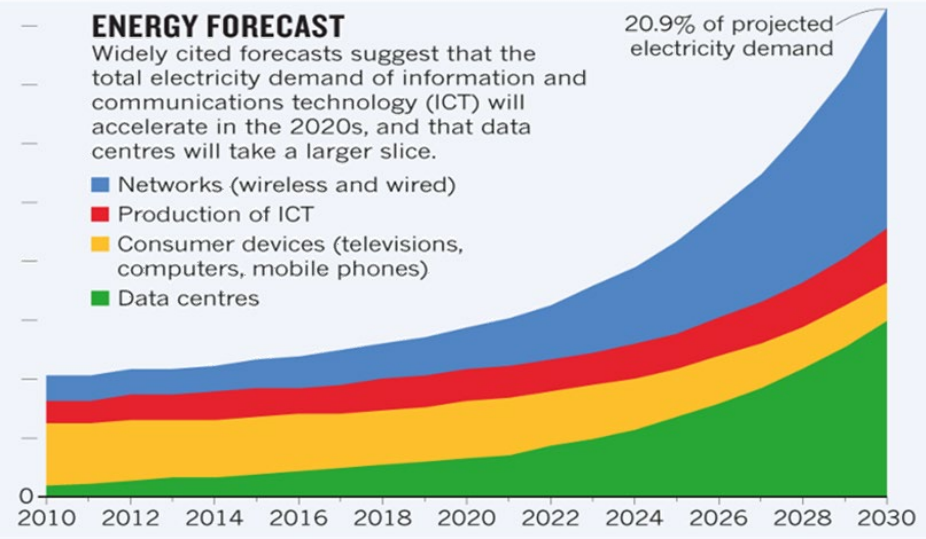
- **Data Capacity**

• from 1.1 to 175 zettabytes in next 5 years



Nature Electronics 1, 442 (2018)

- **Energy consumption**



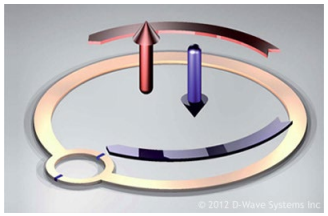
Quantum materials

Emerging technology

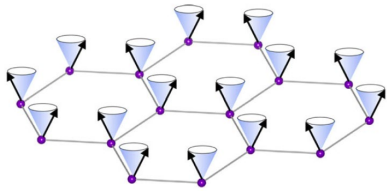
- Quantum computing (information capacity ↑)
- Neuromorphic engineering (information capacity ↑)
- Energy-efficient electronics (energy cost/unit ↓)
- …

Quantum Materials

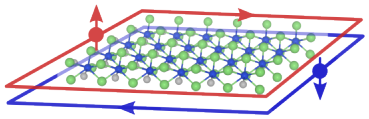
Superposition



Correlation



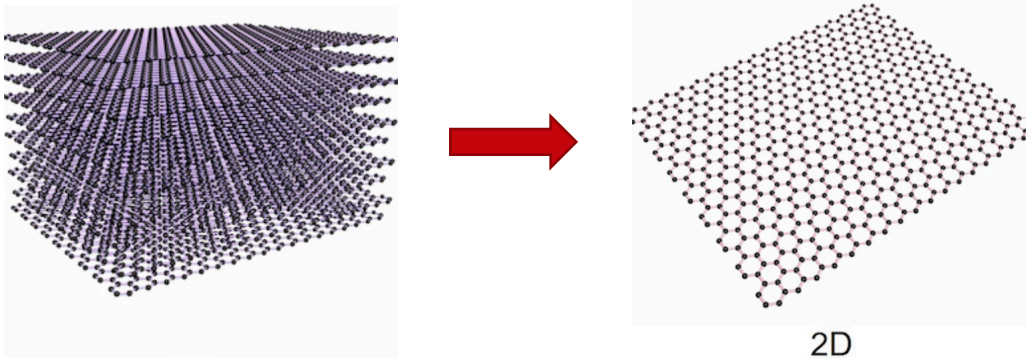
Topology



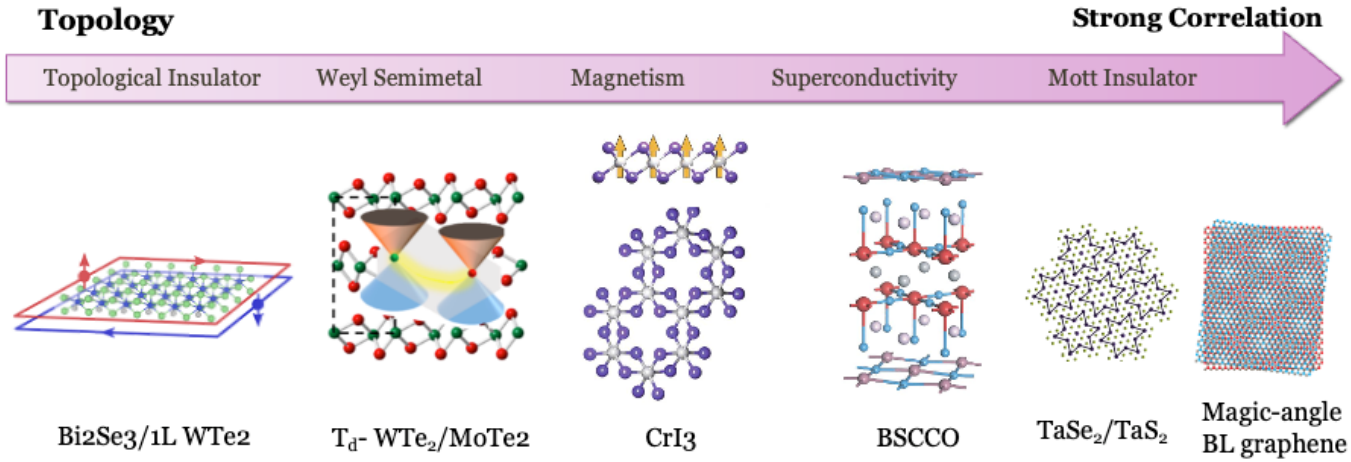
Material Requirement

- Rich quantum properties
- Easy engineering

Layered van der Waals materials

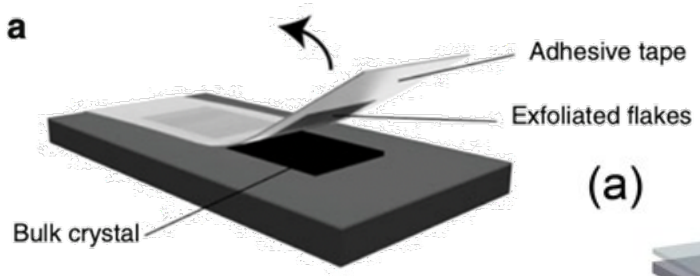


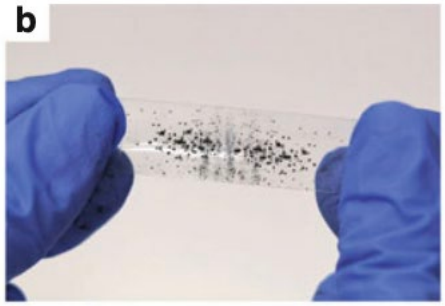
- Layer thickness ~ nm, anisotropic and quantum confined
- **Easy surface engineering and large tunability (electrical ~ $10^{14}/cm^2$, mechanical ~ 10% strain…)**

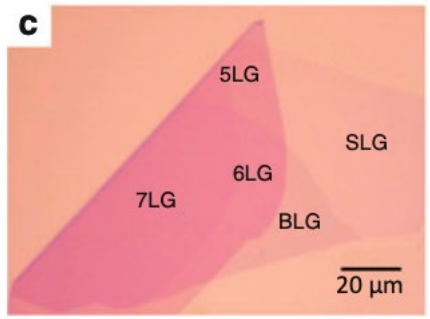


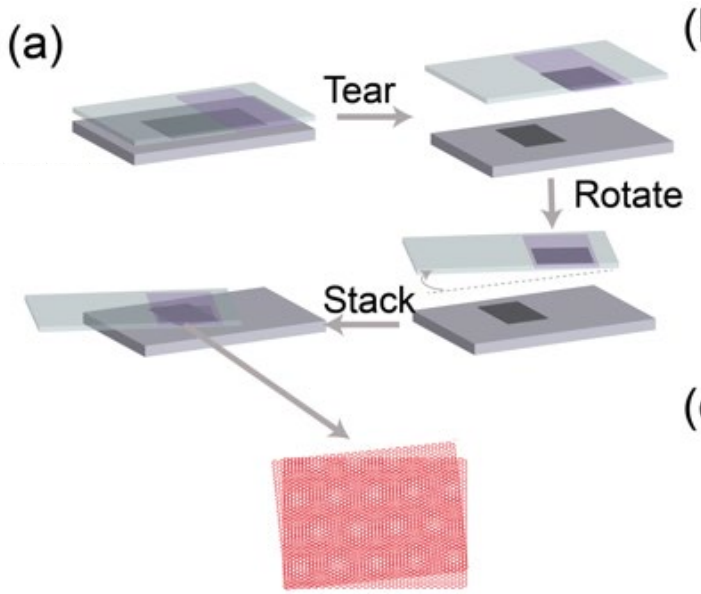
What we do

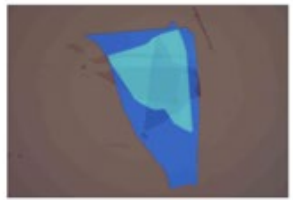
2D Material and Device Fabrication

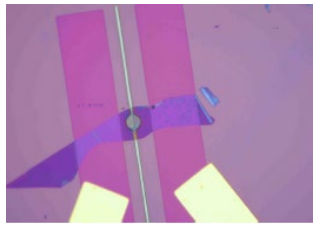






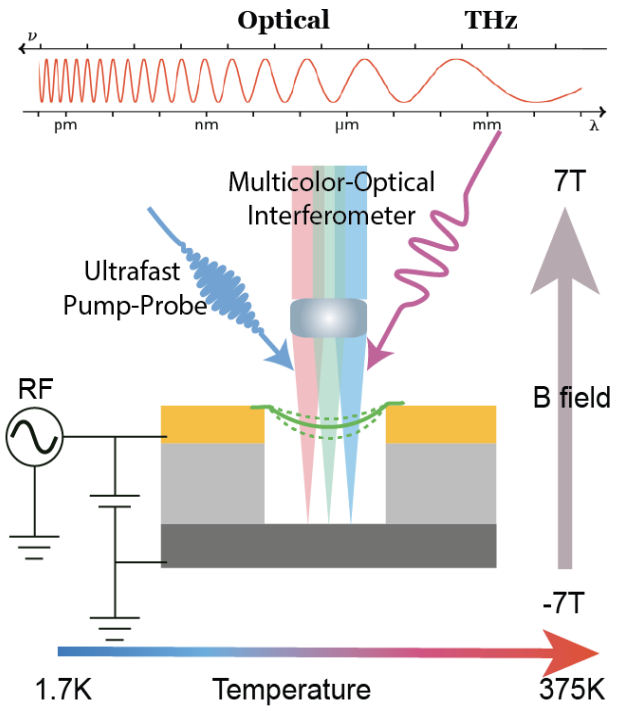




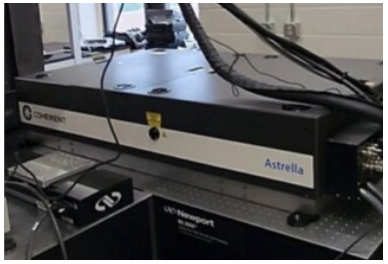


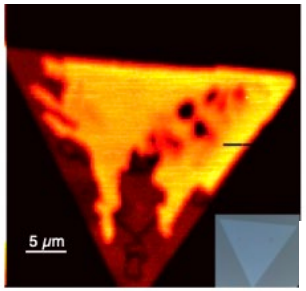
What we do

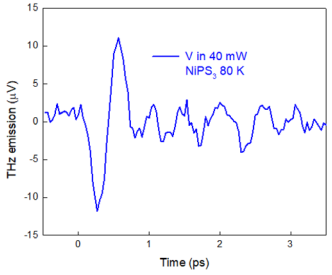
Multimodal characterization platform

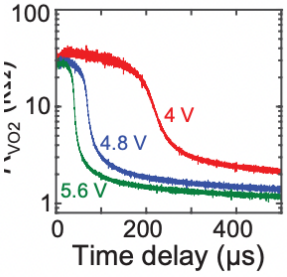


Spectroscopy, Transport, Optomechanics









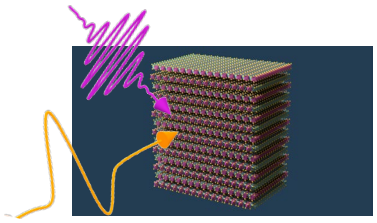
Direction I

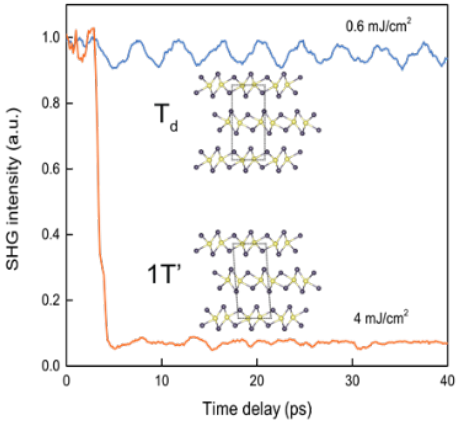
Optical probing and engineering of quantum materials

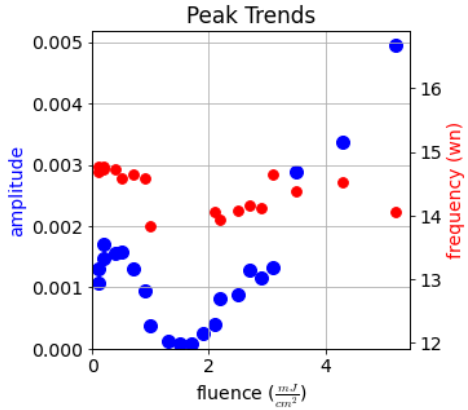
Emergent sliding ferroelectricity

Objective:

- Ultrafast switching
- Interplay with magnetism, correlation and topology







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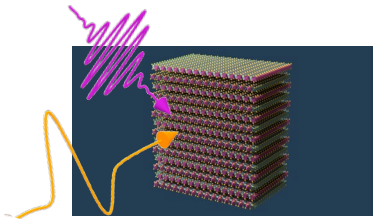
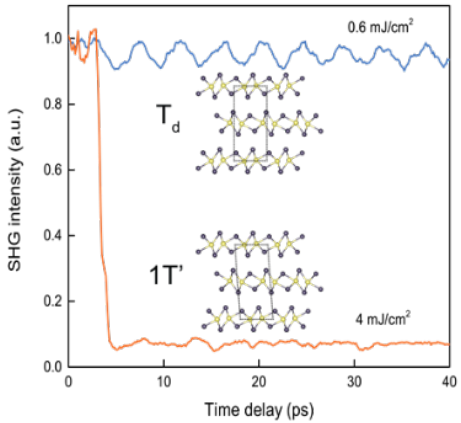
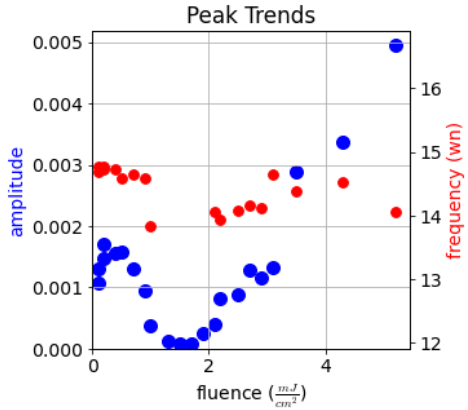
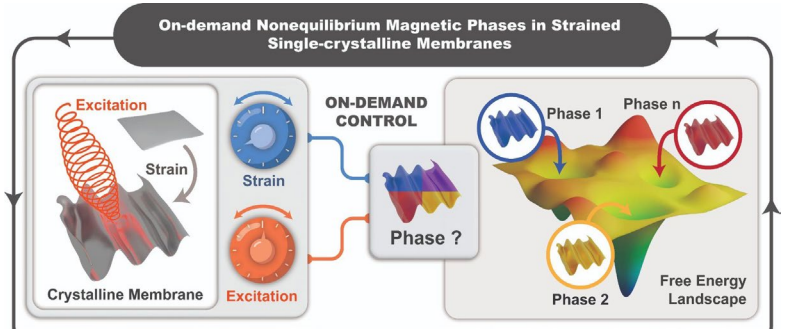






New (spin) physics at extreme conditions



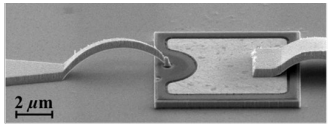
Oxide, Heusler compound, 2D materials

Objective:
Explore uncharted phase ordering and dynamics at extreme conditions

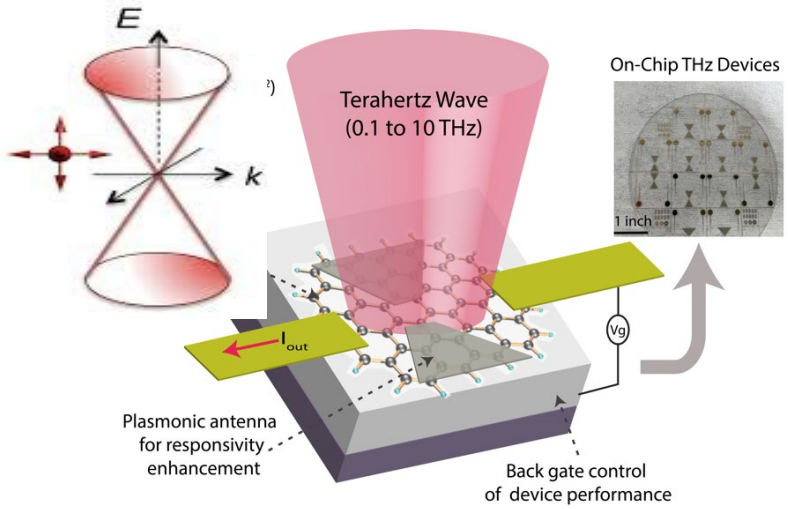
e.g., strain, doping + ultrafast optical/THz

Quantum devices for communication

Quantum THz optoelectronics



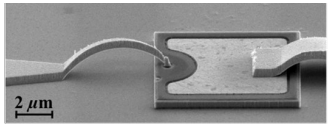
Objective:
Long-sought THz detection
Large responsivity, broadband, fast, room temperature



Direction II

Quantum devices for communication

Quantum THz optoelectronics



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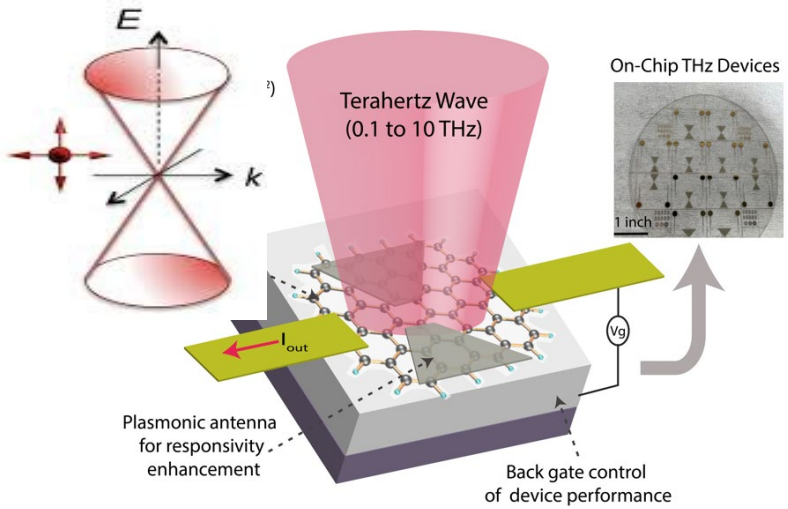
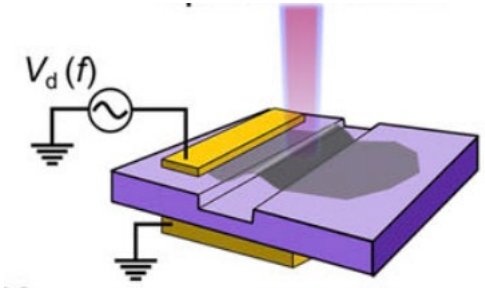
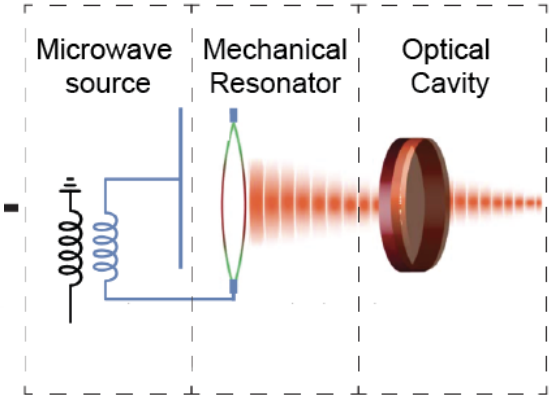
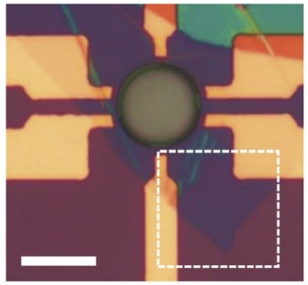


Nano opto-mechanics



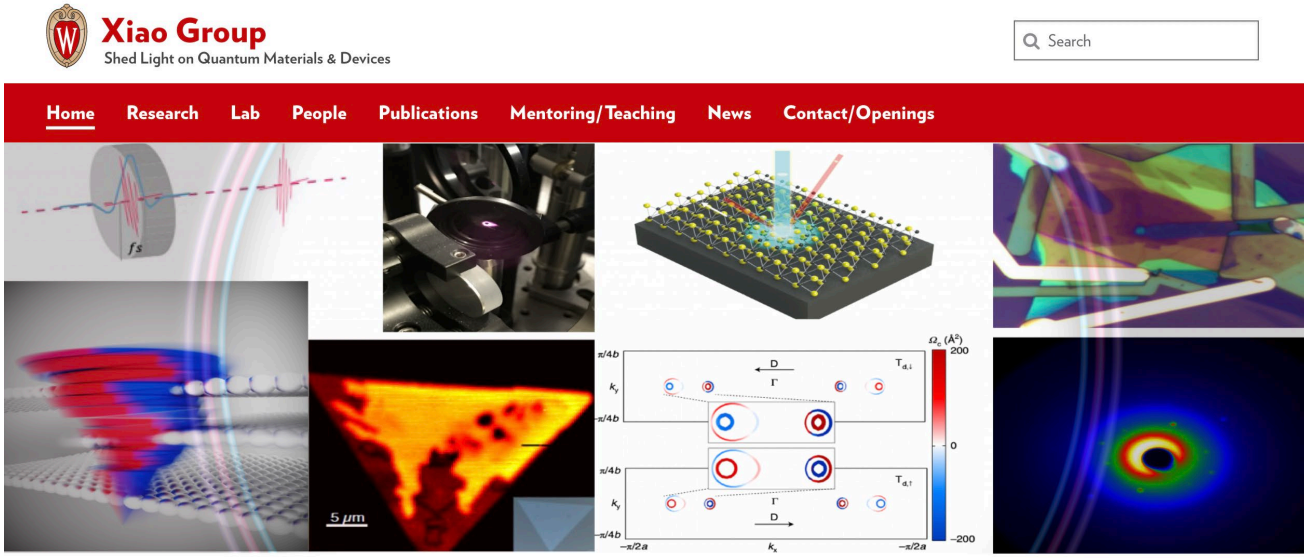




Objective:

- New platform of quantum transduction between qubit and light

Summary



- Photo-induced nonequilibrium phenomena in quantum materials
- THz optoelectronic materials and devices for 6G communications
- Nano opto-mechanics for sensing and quantum transduction

2 to 3 PhD positions

More information including mentoring philosophy can be found
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