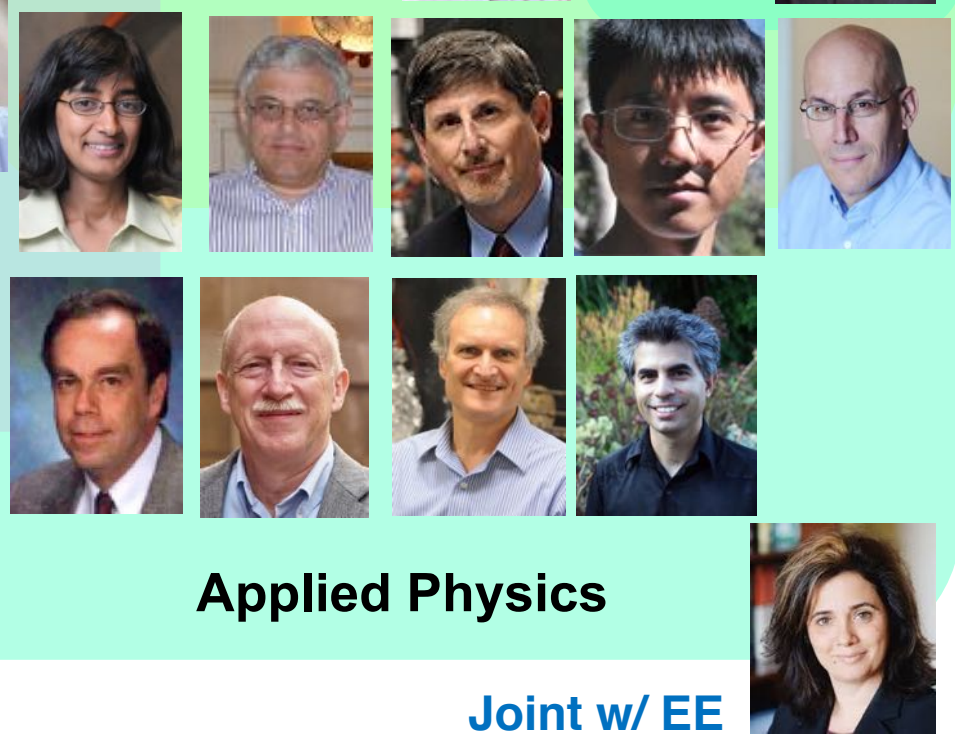
Applied Physics and Applied Mathematics with Materials Science and Engineering

Materials Science and Engineering

Applied Mathematics

Applied Physics



Joint w/ EE

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Applied Physics

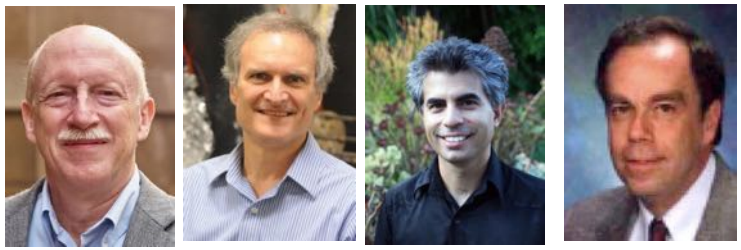
Materials Physics

Atmospheric and Earth Physics

Nanoscience/ Nanomaterials

Optical Physics

Plasma Physics



State-of-the-Art Facilities

CNI Cleanroom Facility

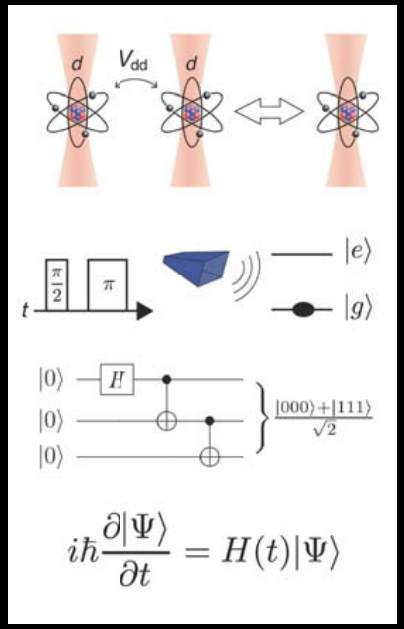
CUNY Nanofabrication Facility

Brookhaven National Labs

Columbia | Quantum Initiative

https://quantum.columbia.edu

Atoms and molecules

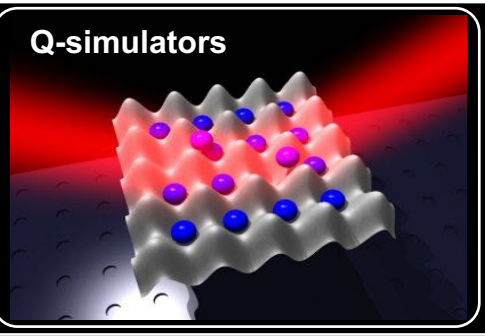



Yu

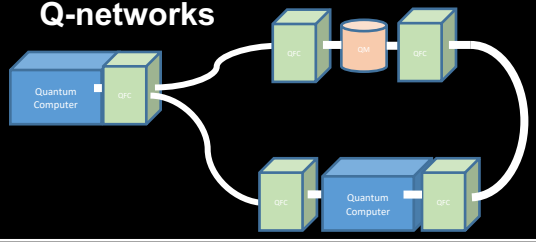

Will


Asenjo-Garcia

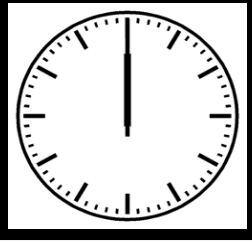
Q-simulators



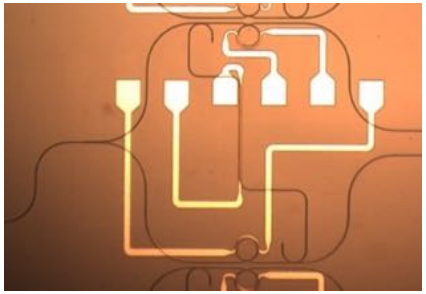
Q-networks

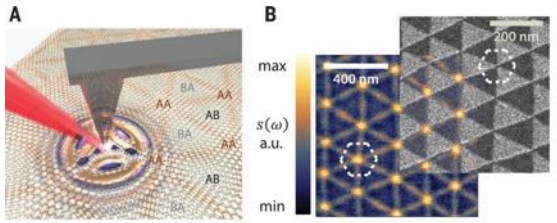


Q-sensors, ultrasensitive measurements



Materials & photonics





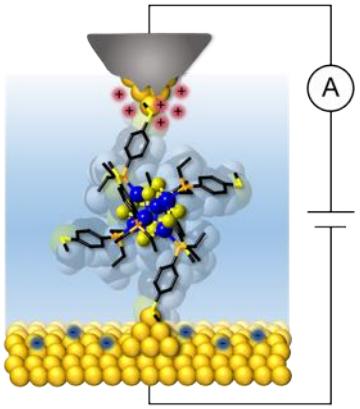

Gaeta


Lipson


Basov

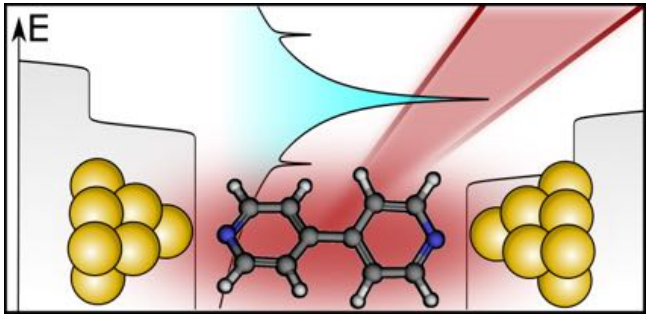
Venkataraman Lab

Fundamentals of electron transport



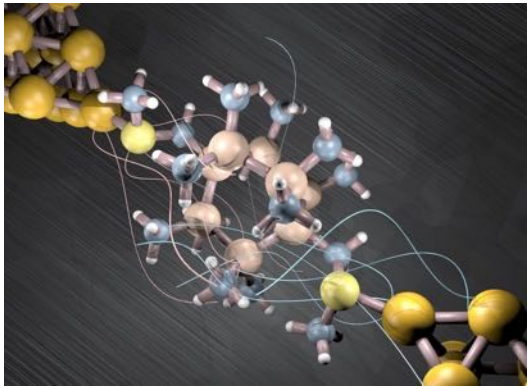
Venkataraman & Roy, Nature Nano. 2017

Illuminating a Single-Molecule Junction



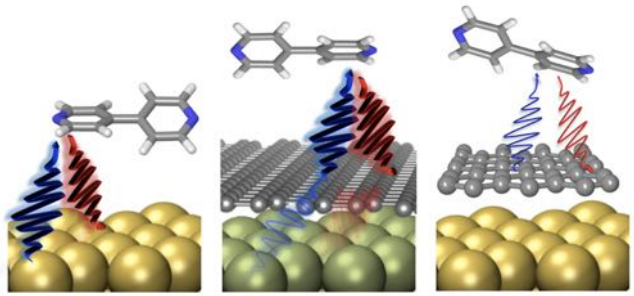
Venkataraman, Nano Letters 2017

Thermo-electrics & Destructive Interference in molecular junctions



Xiao, Nuckolls, Venkataraman, Solomon, Nature 2018

Charge transfer dynamics through x-ray spectroscopy



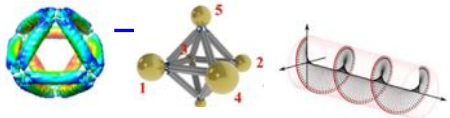
Morgante, Cvetko, Venkataraman, Nano Letters 2015

Oleg Gang Lab

Designed Nanomaterial Systems through Self-Assembly

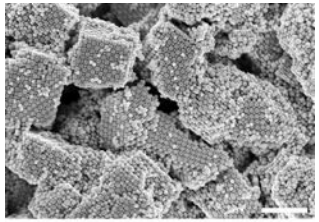
- Engineered targeted nanoparticle-based lattices, clusters and arbitrarily designed architectures via self-assembly.
- Applications: nano-optics, nano-mechanics, and chemically active systems.
- Hybrid reconfigurable materials w/ regulated responses, pathways and transformations.

Optical Nanodevices via Self-Assembly



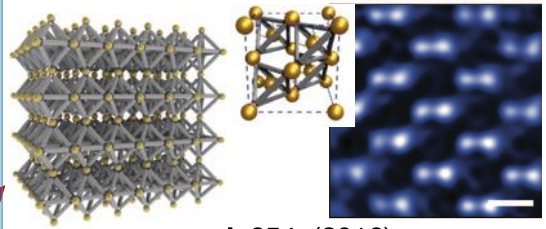
ACS Nano 9, 5657 (2015); Nature Nano. **10**, 637 (2015); in preparation (2019)

Assembly of Anisotropic Nanoparticles



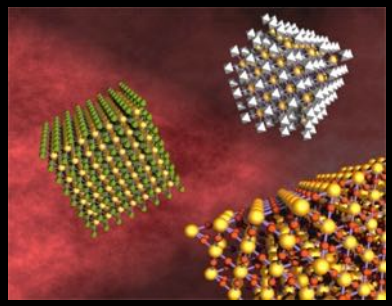
Nature Com., 6, 6912, (2015)

Prescribed 3D Superlattices

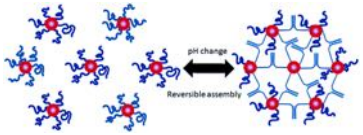


Nature Mater. **15**, 654 (2016)
Science ***351****, 582 (2016)*

Programmable Nanoscale Assembly: Principles and Phenomena

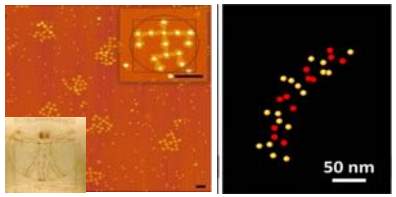


Switchable interfaces and bulk nanomaterials



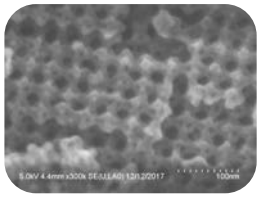
Soft Matter (2018); Nature Nano. ***8****,865 (2013); Nature Mater.* ***14****, 840 (2015)*

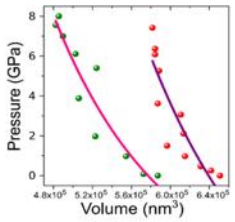
Arbitrarily Designed Structures



Nature Chem. (2016); *ACS Nano, 7036 (2017)*

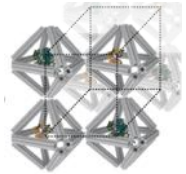
Mechanics of Architectured 3D Nanomaterials

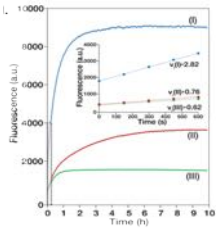




S. Srivastava et al, Soft Matter (2013)
In submission (2019)

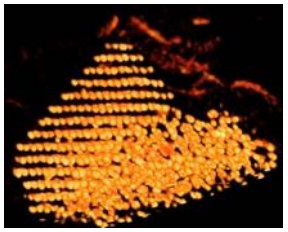
3D Nano-Bio-Reactors





In submission (2019)

3D Nanoscale Imaging of Nanoparticle Organizations



In preparation (2019)

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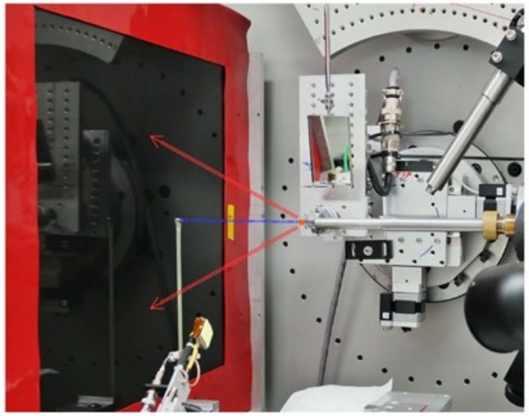
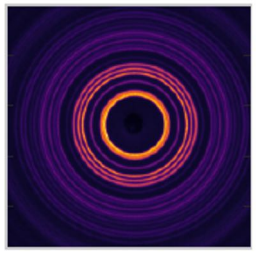
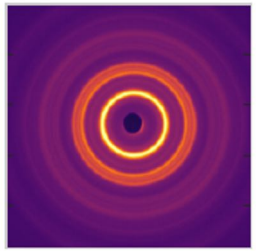
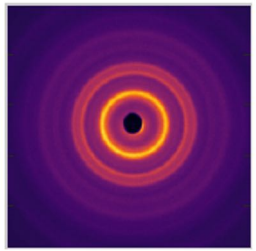
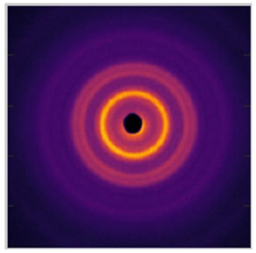
Billinge Group

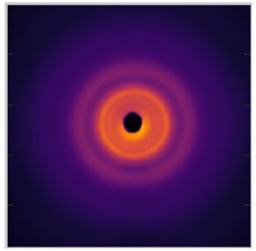




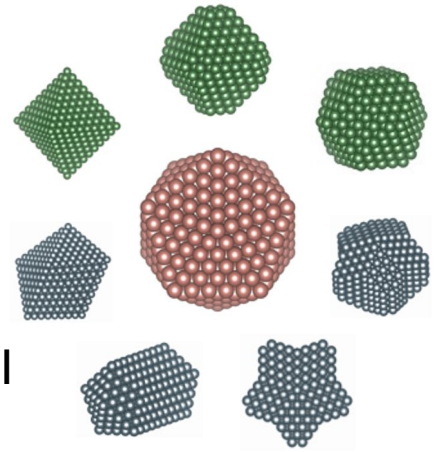


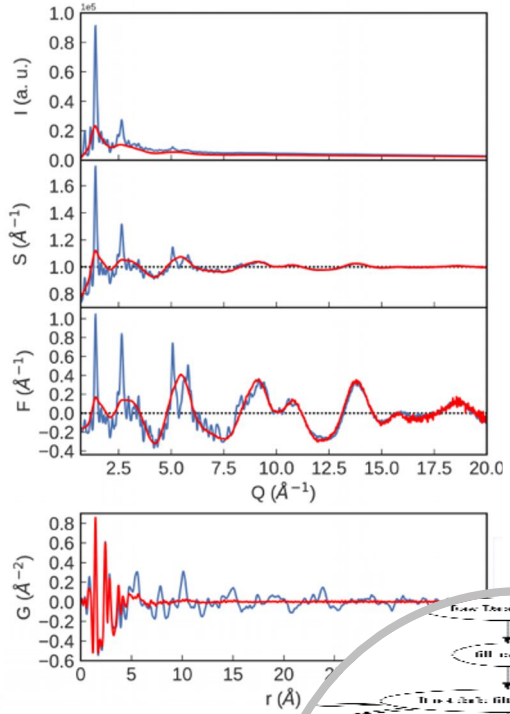


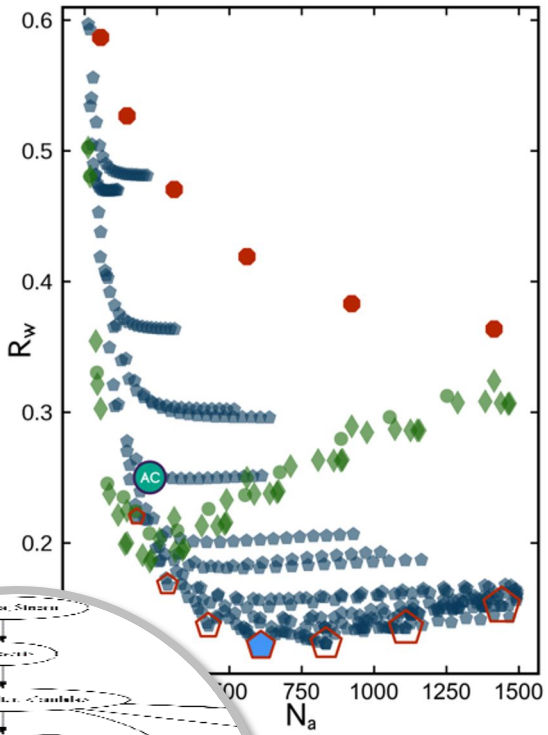


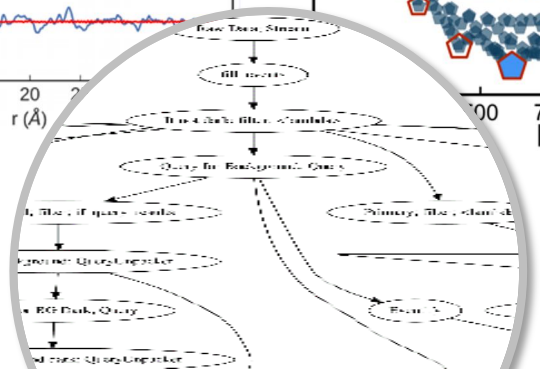


Solving nanostructure-property relationships using advanced scattering and AI









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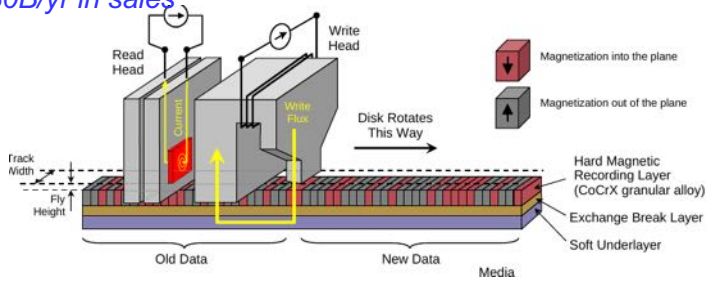
Bailey Group
Nanomagnetics and Spin Electronics

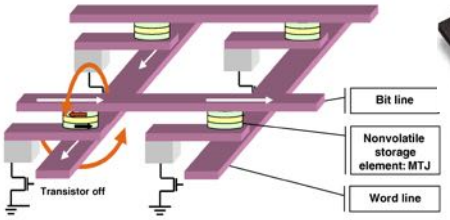
Magnetic information storage technology

Hard disk drives (HDD): $30B/yr in sales



courtesy R. New, HGST/Western Digital

Magnetic random access memory (MRAM), emerging

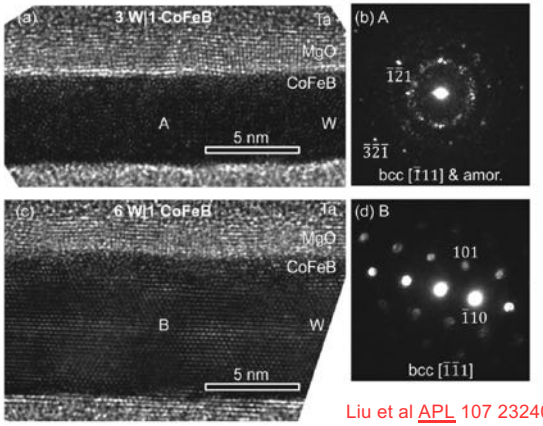


Everspin device, shipping

B. Dieny, L. Prejabnu, SPINTEC (2017)

Materials: ultrathin films & heterostructures

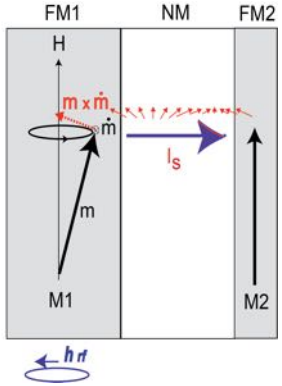
Ultrathin tungsten films for giant spin Hall effects



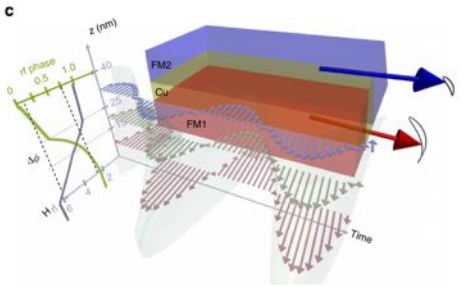
Liu et al APL 107 232408 (2015)

Study of new physical phenomena

interaction of spin current with ~100 ps magnetization dynamics



Magnetization precession pumps chargeless spin current



Bailey et al Nature Comms 4 2025 (2013)

Pinczuk Group

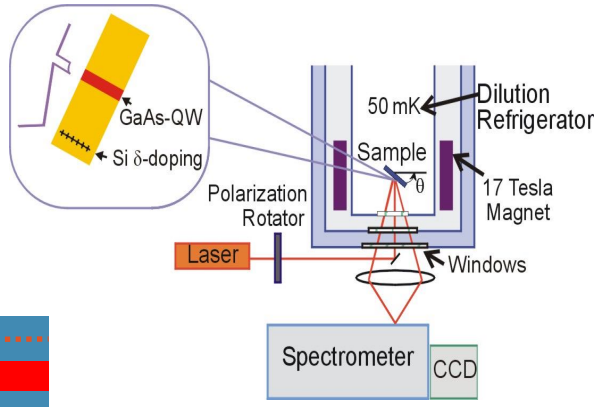
Spectroscopy of Semiconductors Nanostructures

Research Topics:

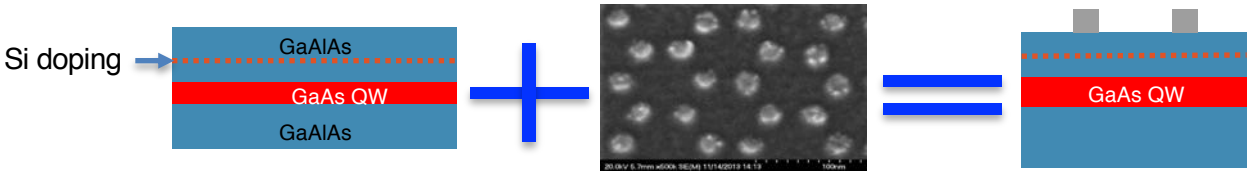
Quantum Hall Fluids

Artificial Topological Insulators

milli-kelvin spectroscopy



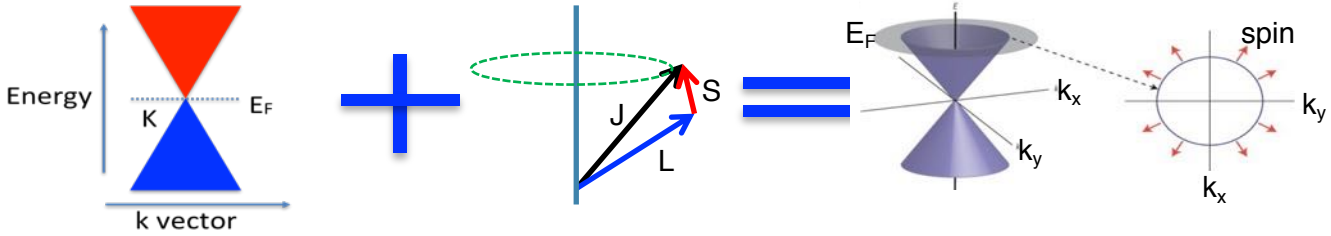
Artificial Graphene



modulation-doped GaAs Quantum Well (QW)

honeycomb pattern

processing: creation of AG



Dirac fermions (linear k- dispersion)

Spin-orbit coupling

Topological states

Selected Recent Publications:

Levy et al, *Phys. Rev. Lett.* **116**, 016801 (2016).

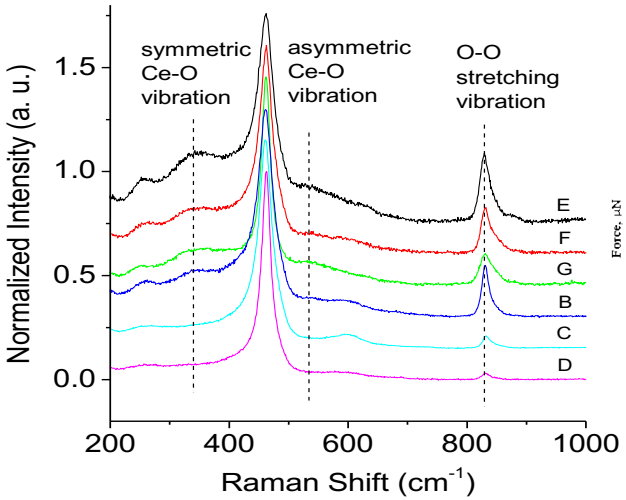
Wang et al, *Appl. Phys. Lett.* **109**, 113101 (2016).

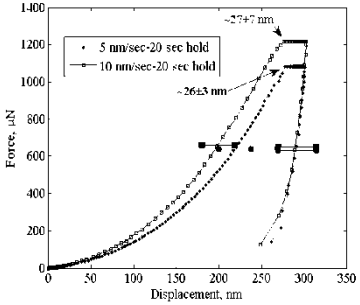
Wang et al, *Nature Nanotechnology* **13**, 29 (2018).

Du et al, *Nature Communications* **9**, 3299 (2018).

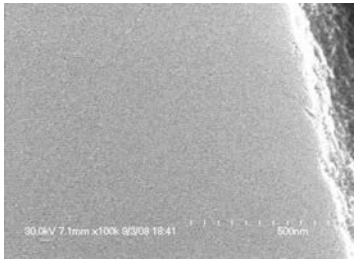
Du et al, *Science Advances* **5**, eaav3407 (2019).

Herman Group
Nanophysics/Materials/Optics

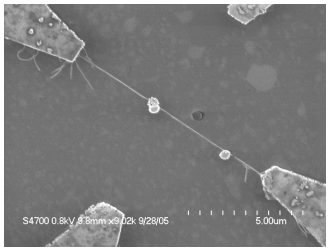




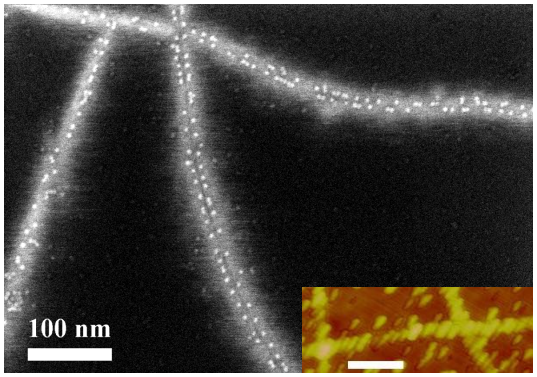
Optical and mechanical properties of **nanomaterials**, including nanocrystal/polymer assemblies (catalysis, material integrity)



Ordered solids of **quantum dots**/ **nanocrystals** (negative index of refraction, magnetics, photonic band gap materials, sensors)



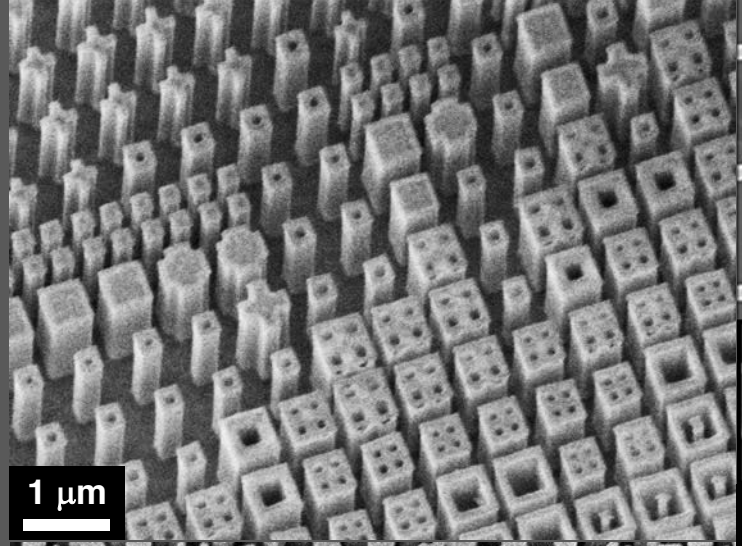
Electric-field assisted **nano-assembly** (photovoltaics, sensors)

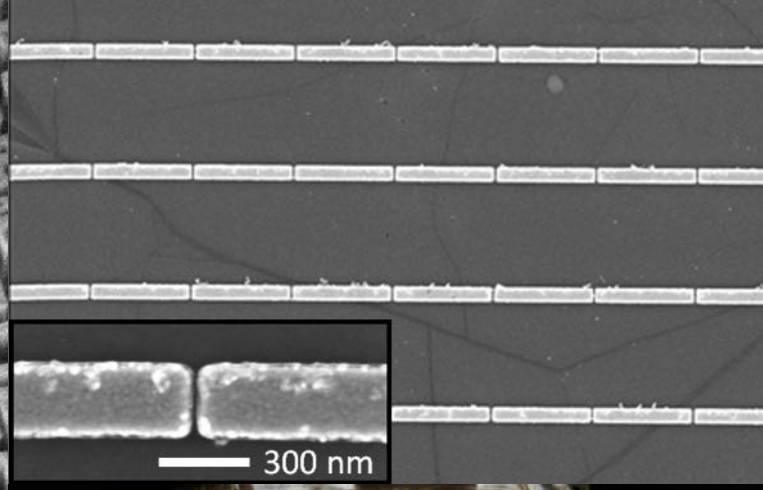


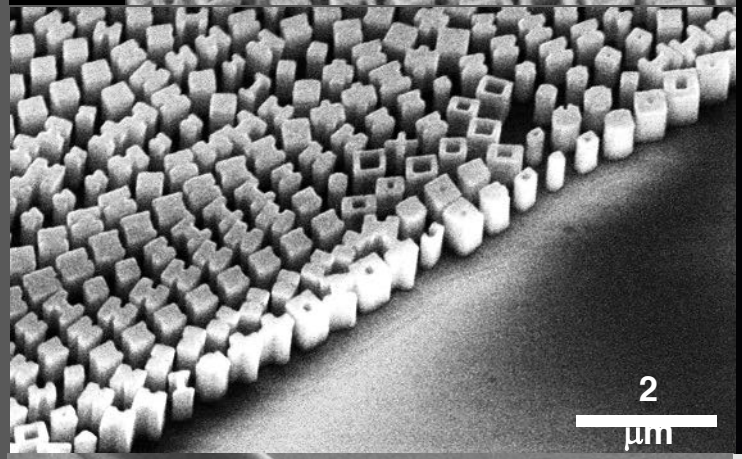
Nano-hybrid materials and **van der Waals** layers (photovoltaics, sensors)

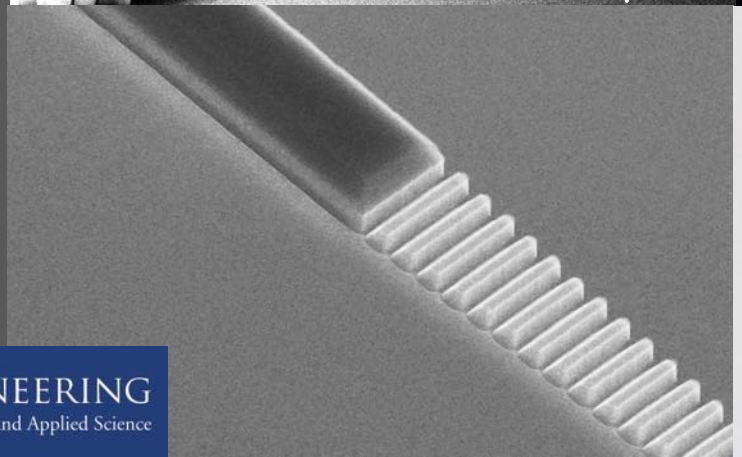
Flat Optics

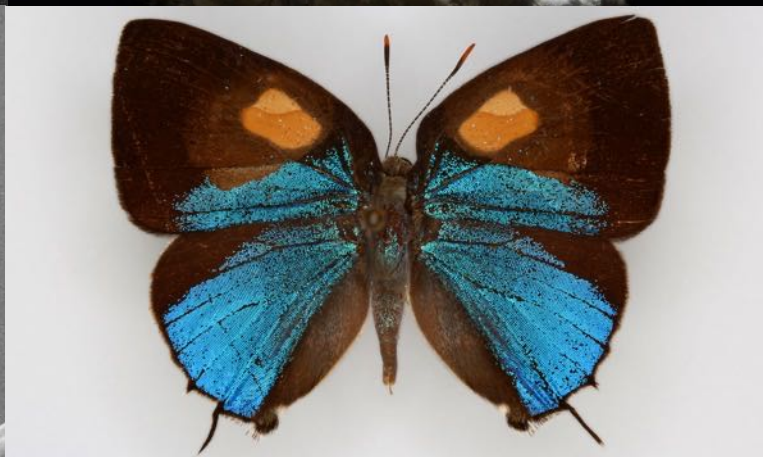
Nanfang Yu











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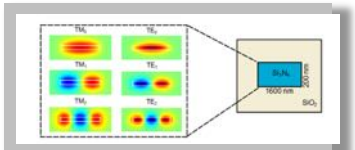
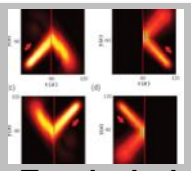
Lipson Nanophotonics Group

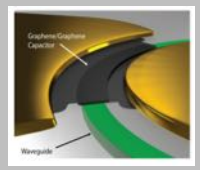
NOVEL RESEARCH AREAS ENABLED BY SILICON PHOTONICS



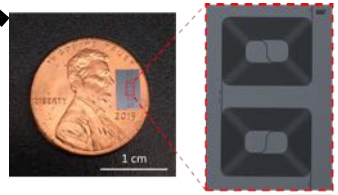
Quantum Photonics (leveraging miniaturization multiplexing)



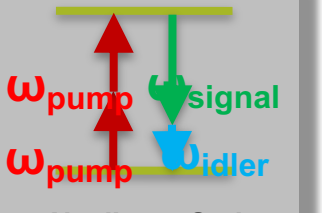
Topological photonics



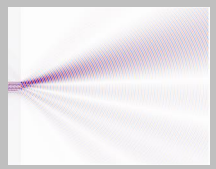
Materials



Silicon Photonics



Nonlinear Optics

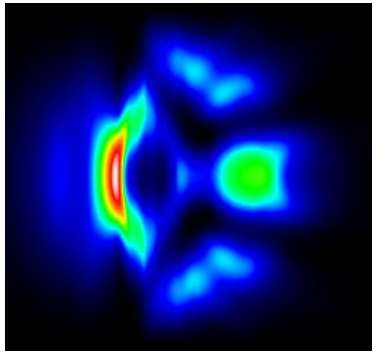


Lidar on a chip

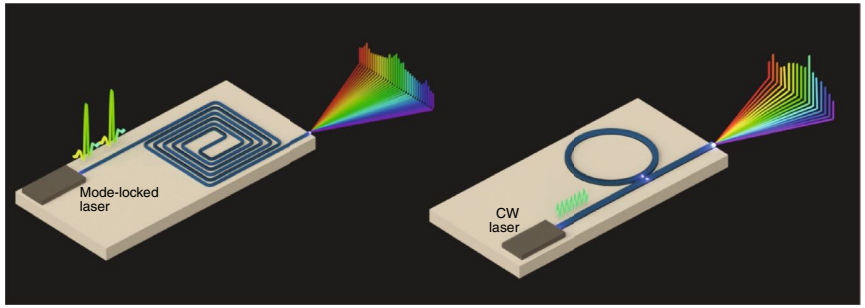
Opto-Mechanics

Gaeta Lab: Quantum and Nonlinear Photonics Group

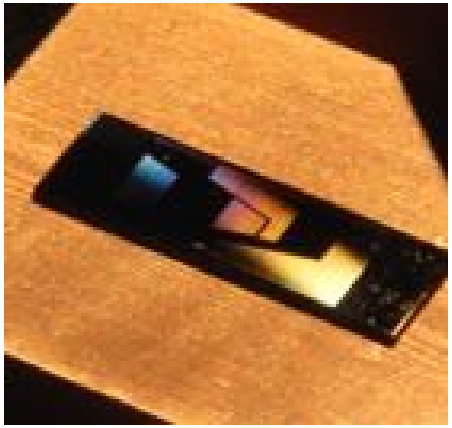
Intense-Field Physics



Optical Frequency Combs



Chip-Based Nanophotonics



Quantum Photonics