

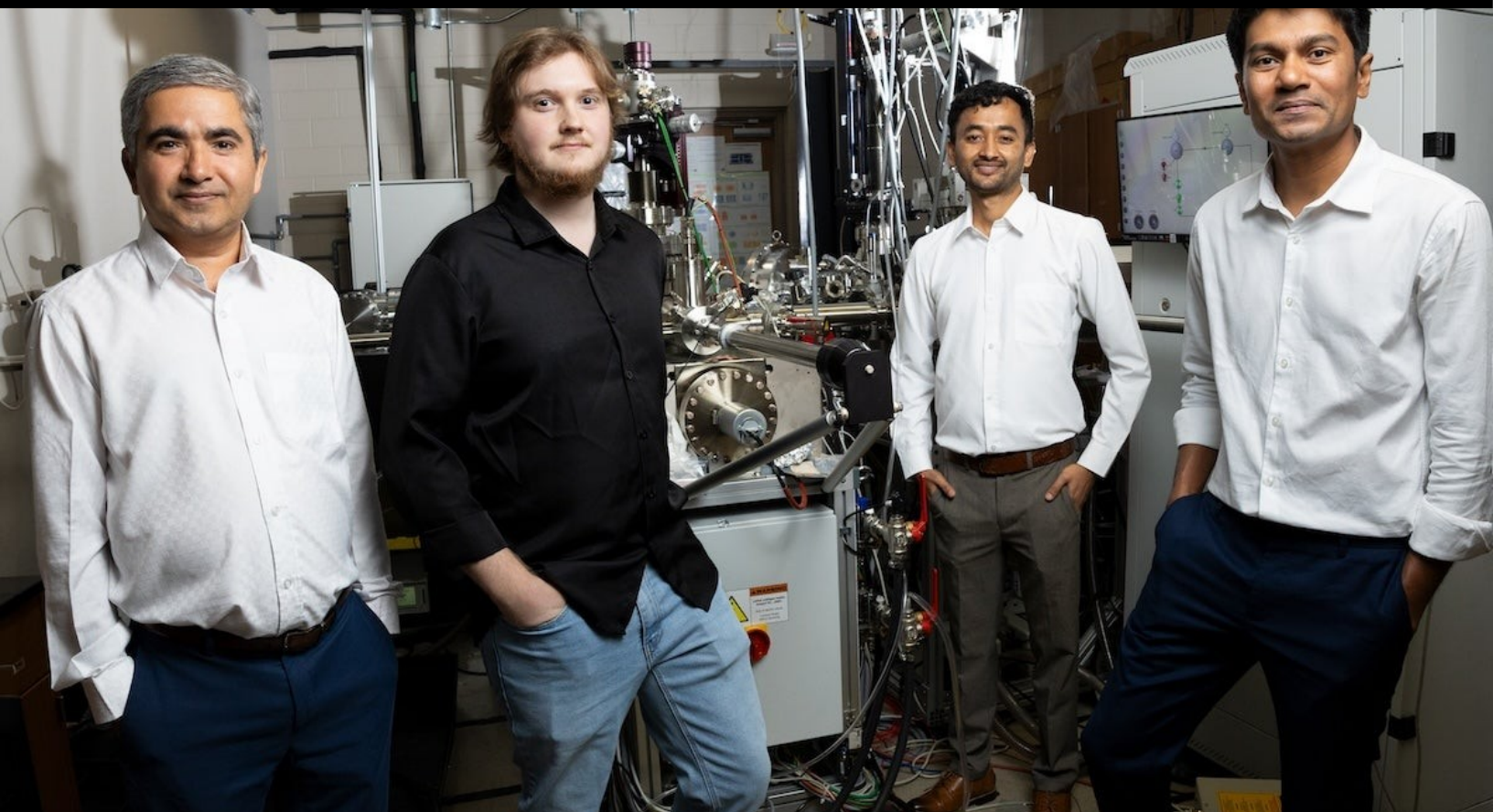
UNIVERSITY OF CENTRAL FLORIDA



UCF PHYSICS

PhD Program

DISCOVER THE RESEARCH. MEET THE PEOPLE.



From electron motion to distant worlds

A research community at the University of Central Florida

Your PhD at UCF Physics

Welcome to UCF Physics! Our department brings together a broad array of research activities and a talented community of faculty and student researchers. We invite you to use this booklet and online resources to explore the questions we pursue and the opportunities to become part of this community.

Our research explores matter, light, living systems, and planetary worlds. Students investigate quantum materials and devices, ultrafast atomic and molecular dynamics, optics and photonics, energy conversion, biophysics, and the ways people learn physics. The profiles in this booklet introduce the faculty and the scientific questions that could shape your doctoral research.

Our faculty are committed to working with students as partners in the research enterprise. Through advanced coursework and a close relationship with your advisor, you will develop the knowledge, skills and judgment to carry out original research. As your project develops, you will share your findings with the scientific community and prepare for a career in research, teaching, or industry.

Our research laboratories and facilities support experimental, theoretical, and computational work, and our faculty lead projects supported by NSF, DOE, NASA, NIH, and other agencies. Many projects reach across disciplines, and collaborations with national agencies and private industry broaden the opportunities available to our students, both at UCF and externally, and connect their work with questions beyond a single discipline.

We strive to build a strong sense of community in our graduate program. Our graduate and other student societies provide opportunities for support, involvement, and professional growth. We have departmentally organized activities throughout the semester, as well as chances to interact with the broader central Florida community. Faculty, staff and fellow students all contribute to a welcoming environment where you can exchange ideas, ask questions and develop as a physicist.

As you consider UCF, we encourage you to meet our faculty, speak with current students, and learn about the research and mentoring opportunities that interest you. We look forward to learning about your aspirations and the contributions you could make to UCF Physics.



Adrienne Dove

Professor and Chair
Department of Physics

Meet Adrienne Dove

**Our students are
partners in the
research
enterprise.**

Adrienne Dove

Chair, Department of Physics

Physics at UCF

Our strength is the combination of several areas. In one department, a short walk apart, students work on attosecond light pulses, quantum materials, the chemistry of energy, planetary surfaces, living matter and how physics is learned, with the faculty who lead those laboratories as their advisors.



Lauren Mc Keown at NASA's Jet Propulsion Laboratory, where she was a postdoctoral fellow before joining UCF in 2025. Photo: Mc Keown lab.

55

graduate faculty in Physics and its partner units

8

research areas, from ultrafast science to the science of learning

No. 12

in atomic, molecular and optical physics, U.S. News 2026 graduate rankings

128

graduate students, from 12 countries

Our own laboratories

Experimental, theoretical and computational groups work in the Physical Sciences Building and nearby buildings: attosecond and ultrafast-laser labs, cryogenic and spectroscopic probes of quantum materials, surface-science and electrochemistry labs, planetary-surface and microgravity experiments, biophysics and high-performance computing.

A department that backs its students

First-year teaching assistantships with tuition support; research assistantships by candidacy, often sooner. The Graduate Society of Physics Students, Gender Minorities and Women in Physics (GWIP) and an APS student chapter run the department's student life. UCF Physics is an APS Bridge Program site and hosted the 2023 Conference for Undergraduate Women in Physics.

Partners when a project needs them

The College of Optics and Photonics, the NanoScience Technology Center, the Florida Space Institute and the College of Engineering share the campus, and several of their faculty hold Physics graduate-faculty status and supervise our students. They extend the reach of a Physics PhD; the department is where it is done.

Ranking: U.S. News & World Report, 2026 Best Graduate Schools, physics specialties.

Our students

Physics PhD students at UCF are partners in the research enterprise from the first year: in the laboratory, at conferences and in the life of the department. After the PhD, they go on to national laboratories, industrial R&D, postdoctoral and faculty positions.

In their words

In my doctoral work within Professor Christian Heide's group, I use intense, ultrafast lasers to program and probe quantum materials. Working at the intersection of several advanced fields is exciting, and UCF's collaborative research community makes it especially rewarding. Our work brings together experts in optics, materials synthesis, characterization, and quantum technology, creating an environment where ideas are challenged, refined, and transformed into new possibilities. Being part of this exchange pushes me to think beyond my own field and gives me the tools and confidence to help drive pioneering research.

Denis Aglagul · 2nd-year PhD student · Heide group

My favorite thing about UCF is being able to work on research that excites me. In Professor Han Zhao's group, I've learned how to build an experiment from the ground up, from simulations to fabrication to measurements, and how to connect optics with quantum mechanical systems to help push the boundaries of quantum technologies. Through classes, research, and conferences, I've been able to connect and discuss many concepts with other students which often leads to new ideas to try. The professors and the bridge program at UCF act as great resources for me, giving me guidance and opportunities to grow as a scientist but also as a person as well. The knowledge I've gained and the connections I've made has really made me glad I came to UCF, opening up a world of possibilities and how to navigate it.

Shantanu Chaudhary · 3rd-year PhD student · Zhao group

At UCF, I've found a balance between supportive community and academic rigor. We are always given the opportunity to ask questions and engage with ideas through a healthy skepticism. The coursework helps develop the research skills tied to my interests, while staying broad enough to inspire new directions for future projects. Working with my advisor, Dr. Kerri Donaldson Hanna, I use spectroscopy to study the lunar surface and expand our understanding of the Moon. Alongside this, I have had the rare opportunity to observe the development of a real lunar mission, which has strengthened my organization, collaboration, and problem-solving skills and given me well-rounded preparation for my academic career.

Angelina Minocha · 3rd-year PhD student, planetary sciences · Donaldson Hanna group



Chris Lantigua, PhD student, in the attosecond-physics laboratory. Photo: UCF College of Sciences.

Pursuing my Ph.D. in Physics at UCF has opened more opportunities than I had anticipated when entering graduate school. My research in Dr. Michael Leuenberger's group focuses on nanoplasmonic and photonic systems for quantum sensing and fundamental materials research, and I especially value how collaboration across UCF Physics, Optics, Biology, and Engineering allows me to pursue interdisciplinary research. Through the Department of Energy's SCGSR program, I have advanced my dissertation at the National Energy Technology Laboratory as one of several UCF Physics students who conducted research at national laboratories during 2025 and 2026. Back on campus, UCF's Knights Research Scholars Program has given me the opportunity to mentor undergraduate researchers on dissertation-related projects, gaining valuable experience in research leadership and project management. These experiences and others have made UCF an outstanding place to pursue my Ph.D., with the resources and connections to pursue ambitious research and the opportunities to develop the skills to lead it.

Jayden Craft · 5th-year PhD student · Leuenberger group

My Ph.D. at UCF has let me work at the intersection of theoretical atomic physics, ultrafast laser science and high-performance computing. In Professor Luca Argenti's group, I develop computational methods to understand how electrons in atoms and molecules respond to ultrashort laser pulses on attosecond (10^{-18} s) timescales. I have particularly valued the freedom to pursue challenging theoretical problems while staying closely connected with experiment: our simulations help experimental groups in the United States and Europe interpret measurements at state-of-the-art laser facilities. Through the Department of Energy's SCGSR program, I also spent five months at Lawrence Berkeley National Laboratory, which broadened how I approach research and gave me the skills and network to pursue increasingly ambitious questions.

Nicholas Lewis · 4th-year PhD student · Argenti group

Recent placements of our PhD graduates. Postdoctoral positions at Los Alamos National Laboratory (2026), the Space Research Institute of the Austrian Academy of Sciences (2025), the National High Magnetic Field Laboratory (2025) and UCF (2024); research scientist at UCF (2026).

How the UCF Physics PhD works

A physics PhD combines a broad foundation in advanced physics with original research. UCF's 72-credit program includes 18 core credits, 39 elective and research credits, and at least 15 dissertation credits.

Entering after a bachelor's

Students commonly enter a U.S. PhD directly after a four-year bachelor's degree. At UCF, an orientation diagnostic (used only for placement) helps shape your first-year coursework. During your first year, meet faculty and choose a research advisor.

THE PHYSICS CORE · 18 CREDITS

Quantum Mechanics I and II
Electrodynamics I and II
Classical Mechanics
Statistical Physics

Six core courses normally fill year one. Electives and methods courses support your research specialization. Planetary and Space Sciences and the Planetary Sciences track have separate curricula.

Bringing a master's?

A master's degree may bring substantial overlap with the advanced physics core. Approved prior coursework can free more time for research from your first semester.

The Graduate Program Director reviews your plan of study and **course equivalence**. The College of Graduate Studies makes the final **transfer-credit decision**. Submit transcripts and syllabi during your first semester; international coursework may need a credential evaluation.

The Physics PhD totals **72 credits** beyond a bachelor's. Approved master's credit can reduce the remaining requirement to **42**.

Planning your research path

The handbook's sample plan spans five years. With substantial approved prior coursework and a suitable advisor, a research-focused path of about four years may be possible. Plan your coursework and research together; progress and the dissertation determine the completion date.

Typical milestones: written candidacy within two years; oral candidacy and research proposal by the summer of year three; original research and a dissertation defense.

TEACHING AND RESEARCH ASSISTANTSHIPS

First-year fall/spring support is offered through graduate teaching assistantships (GTAs), subject to good standing and departmental funds. Summer and later GTAs depend on availability. Students should move to graduate research assistantships (GRAs) by candidacy, often sooner. Assistantships include tuition support; students pay fees unless covered by an advisor. Your offer specifies the appointment period, stipend and benefits.

Teaching appointments require GTA training and, where applicable, a spoken-English assessment.

Degree structure · Advisor guide · [Transfer-credit](#) guidance · Assistantships

Find your research interests

46 research profiles across Physics and its partner units, and nine secondary joint appointments.

Follow a field, a method or a question that catches your attention.

Atomic and molecular physics and ultrafast science

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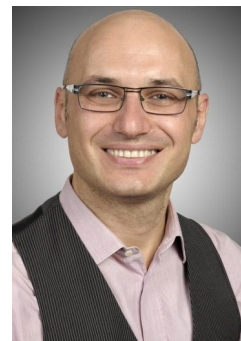
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Luca Argenti

Theoretical Attosecond Science Lab

Associate Professor; Chair, Graduate Recruitment Committee

PhD Scuola Normale Superiore, Pisa · 2008



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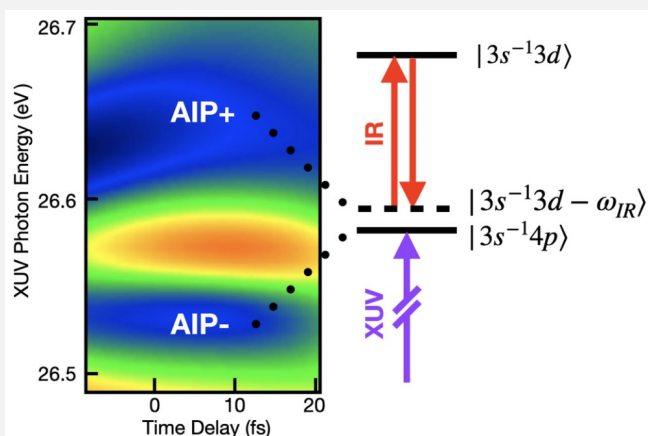
Office: PSB 304

Group website

Faculty profile

Luca Argenti leads the Theoretical Attosecond Science Lab, developing quantum theory and computational methods to understand and control electron motion in atoms and molecules. The group studies correlated ionization, short-lived resonances, and the coherence and entanglement shared by an escaping electron and its parent ion. Its tools include ASTRA, a framework for molecular ionization, and models of atoms dressed by intense light. Collaborations with attosecond experiments connect calculated spectra to the underlying dynamics and identify ways to steer quantum processes with tailored laser pulses.

RESEARCH TOOLKIT Quantum dynamics · Scientific computing · Light-matter interaction



Light reshapes an atomic resonance

An infrared field couples autoionizing states into hybrid light-matter states. Their two branches emerge in the calculated absorption spectrum.

Cariker *et al.*, Phys. Rev. A **110**, 063119 (2024), Fig. 1.

SELECTED PAPERS

- V. Gruson *et al.*, *Attosecond dynamics through a Fano resonance* Science **354**, 734 (2016)
- N. Harkema *et al.*, *Autoionizing Polaritons in Attosecond Atomic Ionization* Phys. Rev. Lett. **127**, 023202 (2021)
- J. M. Randazzo *et al.*, *ASTRA: TDM approach to molecular ionization* Phys. Rev. Res. **5**, 043115 (2023)
- S. Yanez-Pagans *et al.*, *Nonperturbative effects in attosecond FWM spectra* Phys. Rev. A **112**, 013107 (2025)
- C. Marante *et al.*, *Fs Nonadiabatic Confinement of Molecular Dication Yield* J. Phys. Chem. Lett. **17**, 797 (2026)
- C. Ott *et al.*, *Reconstruction and control of a time-dependent two-electron wave packet* Nature **516**, 374 (2014)

SELECTED SUPPORT

DOE DE-SC0026377 · PI: Sep 2025-Aug 2028.
 NSF 2309133 · PI: Sep 2023-Aug 2027.
 NSF 1912507 · PI: Aug 2019-Jul 2023.
 DOE **Early Career** DE-SC0020311 · PI: Sep 2019-Aug 2025.

Nicolas Douquet

Strong-field and ultrafast quantum dynamics

Assistant Professor

PhD UCF & Université Paris-Sud · 2010



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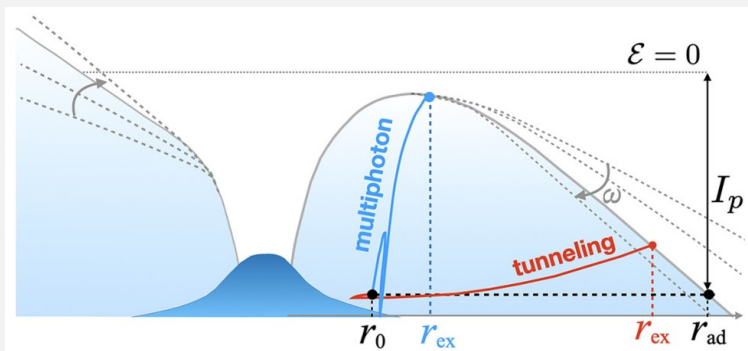
Office: PSB 410

Group website

Faculty profile

Nicolas Douquet develops theoretical and computational descriptions of electrons driven by intense, ultrashort laser pulses. His group studies strong-field ionization, high-harmonic generation and charge migration in molecules. These processes connect the shape of a laser pulse to the trajectories and quantum interference of the electrons it releases. Time-dependent simulations help interpret experiments and design sources of attosecond light. Students explore how electronic structure and laser control can be combined to follow chemical change on its fastest timescales.

RESEARCH TOOLKIT Time-dependent quantum mechanics · Numerical methods · Strong-field physics



Following an electron's escape

Computed quantum trajectories show two routes out of an atom: absorbing several photons (blue) and tunneling through a laser-distorted barrier (red).

Moon *et al.*, Phys. Rev. Lett. **133**, 073201 (2024), Fig. 1.

SELECTED PAPERS

D. Robinson *et al.*, *Generation of bright and controllable isolated attosecond x-ray pulses from synchronized mid-infrared and ultrashort ultraviolet laser fields* Phys. Rev. A **113**, L031101 (2026)

T. Moon *et al.*, *SFI Phenomena Revealed by Quantum Trajectories* Phys. Rev. Lett. **133**, 073201 (2024)

U. S. Sainadh *et al.*, *Attosecond angular streaking and tunnelling time in atomic hydrogen* Nature **568**, 75 (2019)

S. Donsa *et al.*, *Circular Holographic Ionization-Phase Meter* Phys. Rev. Lett. **123**, 133203 (2019)

M. Khamesian *et al.*, *Formation of CN-, C3N-, and C5N- Molecules by Radiative Electron Attachment and their Destruction by Photodetachment* Phys. Rev. Lett. **117**, 123001 (2016)

C. Penson *et al.*, *Photoionization of the CH molecule* Phys. Rev. A **111**, 013105 (2025)

SELECTED SUPPORT

NSF 2608128 · PI: Aug 2026-Jul 2029.

NSF 2419382 · PI: Feb 2024-Aug 2024.

NSF 2012078 · PI; award to Kennesaw State: Aug 2020-Mar 2024.

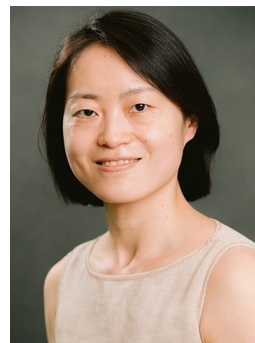
NSF 2311928 · co-PI; award to the University of Colorado Denver: Sep 2023-Aug 2028.

Li Fang

Ultrafast atomic, molecular and nanoplasma physics

Assistant Professor

PhD University of Connecticut · 2009



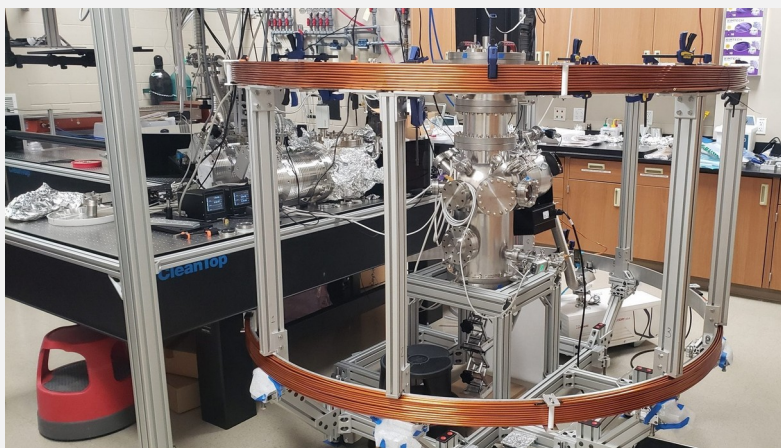
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Group website

Faculty profile

Li Fang investigates how atoms, molecules and nanoscale matter respond to intense, ultrashort light pulses. Her group develops laser sources and measures electrons and ions to follow charge motion, energy transfer and fragmentation. Experiments span attosecond molecular dynamics, strong-field processes and laser-driven nanoplasmas, using facilities at UCF and collaborations at free-electron lasers. Students connect instrument development with the interpretation of time-resolved measurements, exploring how the wavelength, timing and intensity of light govern the evolution of an excited system.

RESEARCH TOOLKIT Ultrafast lasers · Electron and ion spectroscopy · Vacuum instrumentation



Catching the first response to light

The Atto Lab spectrometer records electron and ion momenta together, connecting the motion of an escaping electron to the breakup of its parent molecule.

Fang group, UCF.

SELECTED PAPERS

- S. Li *et al.*, *Attosecond coherent electron motion in Auger-Meitner decay* *Science* **375**, 285 (2022)
- M. Britton *et al.*, *Generation of 3.3-mJ, 2.45- μ m, sub-2-cycle laser pulses via hollow-core fiber pulse compression* *Opt. Lett.* **51**, 3441 (2026)
- V. Leshchenko *et al.*, *Nanoplasma resonance condition in the middle-infrared spectral range* *Phys. Rev. E* **107**, 055207 (2023)
- Z. Chang *et al.*, *Intense infrared lasers for strong-field science* *Adv. Opt. Photonics* **14**, 652 (2022)
- L. Fang *et al.*, *X-ray-initiated photodissociation of the glycine molecule* *Phys. Rev. A* **98**, 053408 (2018)

SELECTED SUPPORT

- NSF **CAREER** 2340570 · PI: May 2024-Apr 2029.
- NSF 2117826 · PI: Sep 2021-Jan 2027.
- DOE **Early Career** DE-SC0021336 · PI: Sep 2020-Aug 2027.
- DOE DE-SC0026869 · PI: Sep 2026-Aug 2028.
- DOE DE-SC0022540 · PI: Mar 2022-Aug 2026.

Christian Heide

Lightwave electronics and quantum materials

Assistant Professor

PhD FAU Erlangen-Nürnberg · 2020



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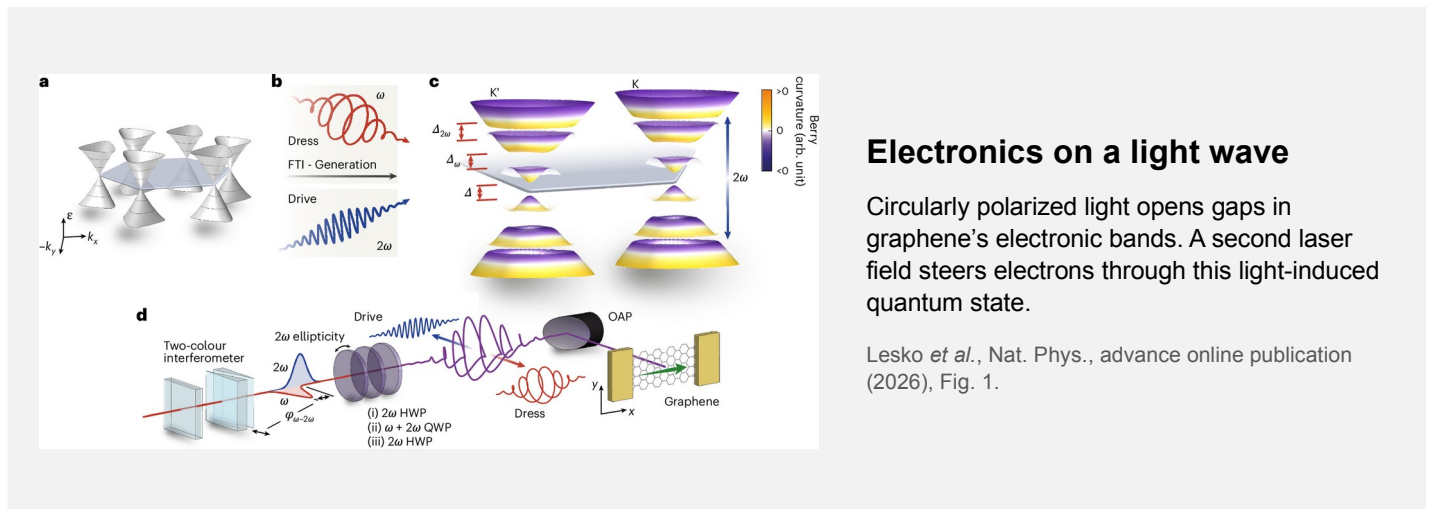
Office: PSB 111

Group website

Faculty profile

Christian Heide studies the control of electrons in solids with the electric field of light. His group uses few-cycle laser pulses and measurements within an optical cycle to investigate ultrafast currents, strong-field dynamics and light-induced states in quantum materials. Shaping a pulse provides a way to select electronic pathways and tune a material's response. The research combines ultrafast optics, experimental instrument development and quantum-materials physics, with applications to electronics operating on the timescale of an optical wave.

RESEARCH TOOLKIT Few-cycle lasers · Field-resolved spectroscopy · Quantum materials



SELECTED PAPERS

- T. Boolakee *et al.*, *Light-field control of real and virtual charge carriers* Nature **605**, 251 (2022)
- D. M. B. Lesko *et al.*, *Optical control of electrons in a Floquet topological insulator* Nat. Phys., advance online publication (2026)
- T. Weitz *et al.*, *Strong-Field Bloch Electron Interferometry for Band-Structure Retrieval* Phys. Rev. Lett. **132**, 206901 (2024)
- C. Heide *et al.*, *Petahertz electronics* Nat. Rev. Phys. **6**, 648 (2024)
- C. Heide *et al.*, *Ultrafast high-harmonic spectroscopy of solids* Nat. Phys. **20**, 1546 (2024)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.

Slava Kokoouline

Molecular collisions and quantum reaction theory

Professor

PhD Université Paris-Sud XI & St Petersburg State University · 1999



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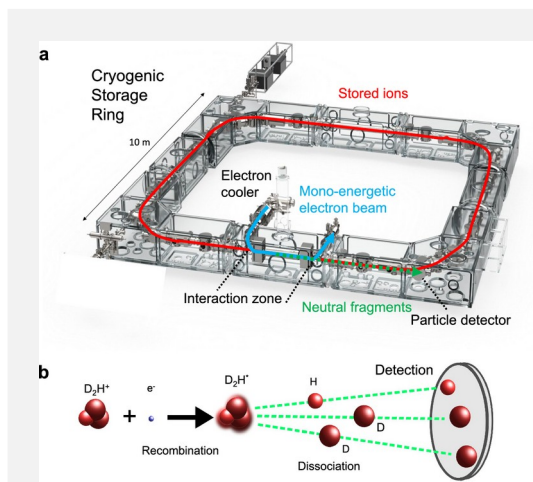
Office: PSB 302

Research profile

Faculty profile

Slava Kokoouline studies atomic and molecular collisions using quantum theory and numerical simulation. His group calculates how electrons attach to molecules, break molecular ions apart, or excite and ionize them. These elementary processes help determine the chemistry of interstellar clouds, planetary atmospheres and laboratory plasmas. Molecular structure and quantum scattering calculations provide reaction probabilities that can be tested against precision experiments. Related work explores ultracold collisions and the control of molecular quantum states with light.

RESEARCH TOOLKIT Quantum scattering · Molecular structure · Reaction-rate calculations



One collision changes the chemistry

Inside a cryogenic storage ring, electrons meet molecular ions. Detecting the neutral fragments reveals how electron capture breaks the molecule apart.

Znotins *et al.*, Nat. Commun. **16**, 7738 (2025), Fig. 1a-b.

SELECTED PAPERS

- A. Znotins *et al.*, *Electron recombination of rotationally cold D₂H⁺ ions* Nat. Commun. **16**, 7738 (2025)
- C. Penson *et al.*, *Photoionization of the CH molecule* Phys. Rev. A **111**, 013105 (2025)
- J. Forer *et al.*, *Dissociative recombination of CF⁺* Phys. Rev. A **110**, L040801 (2024)
- M. Khamesian *et al.*, *Formation of CN⁻, C₃N⁻, and C₅N⁻ Molecules by Radiative Electron Attachment and their Destruction by Photodetachment* Phys. Rev. Lett. **117**, 123001 (2016)
- J. Forer *et al.*, *Unified treatment of resonant and nonresonant mechanisms in dissociative recombination: Benchmark study of CH⁺* Phys. Rev. A **107**, 042801 (2023)

SELECTED SUPPORT

NSF 2409570 · PI: Oct 2024-Sep 2027.
 NSF 2110279 · PI: Sep 2021-Jun 2025.
 NSF 2102188 · PI: Aug 2021-May 2025.

Mihai Vaida

Ultrafast surface photochemistry

Associate Professor

PhD Ulm University · 2011



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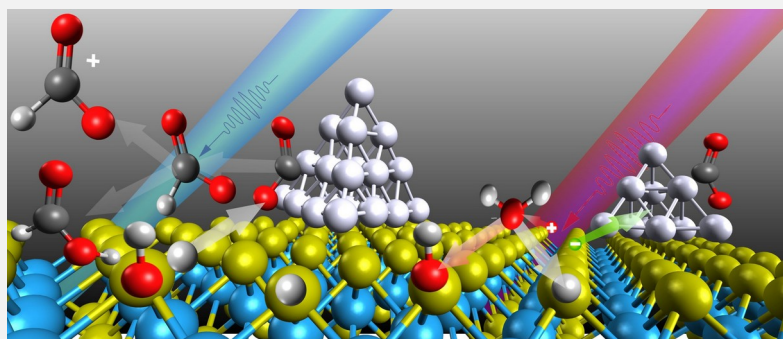
Office: Research I, Room 167

Group website

Faculty profile

Mihai Vaida investigates ultrafast photochemistry at surfaces and interfaces. His group uses femtosecond laser pulses to initiate reactions and time-resolved spectroscopy to follow charge transfer, molecular dissociation and product formation. Carefully prepared thin films, supported metal clusters and adsorbed molecules reveal how the local atomic environment controls a reaction. Measurements link dynamics at the surface with products entering the gas phase. Students combine surface preparation, vacuum instrumentation and laser spectroscopy to understand the physical steps that enable light-driven chemistry.

RESEARCH TOOLKIT Pump-probe spectroscopy · Surface preparation · Mass spectrometry



Watching a surface reaction unfold

Ultrashort laser pulses initiate and probe reactions on a nanostructured surface, tracing the fleeting molecular intermediates that lead to new chemical products.

Vaida Research Lab, UCF.

SELECTED PAPERS

K. Blackman *et al.*, *Simultaneous tracking of ultrafast surface and gas-phase dynamics in solid-gas interfacial reactions* Rev. Sci. Instrum. **95**, 083003 (2024)

M. A. K. Pathan *et al.*, *Understanding the Effect of an Amorphous Surface on the Ultrafast Dynamics of a Heterogeneous Photoinduced Reaction: CD3I Photoinduced Reaction on Amorphous Cerium Oxide Films* J. Phys. Chem. Lett. **13**, 9759 (2022)

M. E. Vaida *et al.*, *Nonmetal-to-Metal Transition of Magnesia Supported Au Clusters Affects the Ultrafast Dissociation Dynamics of Adsorbed CH₃Br Molecules* J. Phys. Chem. Lett. **13**, 4747 (2022)

M. E. Vaida *et al.*, *Nonmetal to Metal Transition and Ultrafast Charge Carrier Dynamics of Zn Clusters on p-Si(100) by fs-XUV Photoemission Spectroscopy* Nano Lett. **18**, 4107 (2018)

A. Gupta *et al.*, *Direct Detection of Reactive Intermediates in Photocatalytic Water Splitting with Small Carbon Species on TiO₂(100)* J. Phys. Chem. Lett., advance online publication (2026)

SELECTED SUPPORT

NSF **CAREER** 1943697 · PI: Jul 2020-Jun 2027.

NSF 2348914 · co-PI: Apr 2024-Mar 2027.

NSF 2117826 · co-PI: Sep 2021-Jan 2027.

Leonid Chernyak

Semiconductor transport, defects and photodetectors

Professor

PhD Weizmann Institute of Science · 1996



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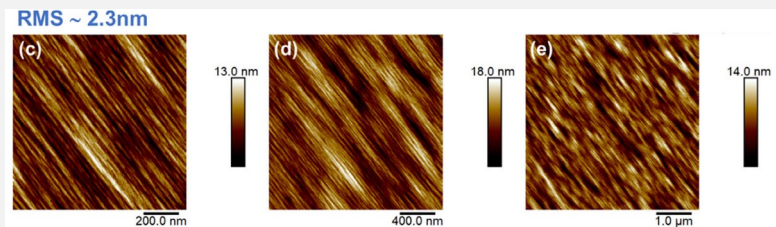
Office: PSB 406

Research profile

Faculty profile

Leonid Chernyak investigates how charge carriers move, recombine and become trapped in semiconductors. His group uses electron-beam and optical measurements to connect defects and interfaces with the performance of ultraviolet and infrared detectors. Current directions include gallium oxide, III-nitride materials and methods for restoring carrier transport after radiation exposure. By measuring where electrical charge travels and how long it survives, the research identifies ways to improve semiconductor materials and the devices built from them.

RESEARCH TOOLKIT Electron-beam-induced current · Cathodoluminescence · Carrier transport



Opening new paths for charge

Atomic-force microscopy maps a p-type gallium oxide film at three length scales, revealing its surface texture and nanometer-scale roughness.

Chi *et al.*, *Adv. Electron. Mater.* **11**, e00190 (2025), Fig. 3c-e. CC BY 4.0.

SELECTED PAPERS

Z. Chi *et al.*, *p-Type β -Ga₂O₃ Homoepitaxial Films with Superior Electrical Transport Properties* *Adv. Electron. Mater.* **11**, e00190 (2025)

Z. Chi *et al.*, *Native defects association enabled room-temperature p-type conductivity in β -Ga₂O₃* *J. Alloys Compd.* **969**, 172454 (2023)

L. Chernyak *et al.*, *EBIC studies of minority electron diffusion length in undoped p-type gallium oxide* *AIP Adv.* **14**, 115301 (2024)

S. J. Pearton *et al.*, *Perspective on comparative radiation hardness of Ga₂O₃ polymorphs* *J. Vac. Sci. Technol. A* **43**, 038501 (2025)

O. Amzallag *et al.*, *Bias-induced polarization effect in Cd_{1-x}Zn_xTe and Cd_{1-y}MnyTe detectors* *Nucl. Instrum. Methods Phys. Res. A* **1072**, 170148 (2025)

SELECTED SUPPORT

NSF 2341747 · PI: May 2024-Apr 2028.

NSF 2310285 · PI: Aug 2023-Jul 2027.

NSF 1802208 · PI: Aug 2018-Jul 2022.

Paulo de Faria Junior

Theory of low-dimensional quantum materials

Assistant Professor

PhD University of São Paulo · 2016



paulo@ucf.edu

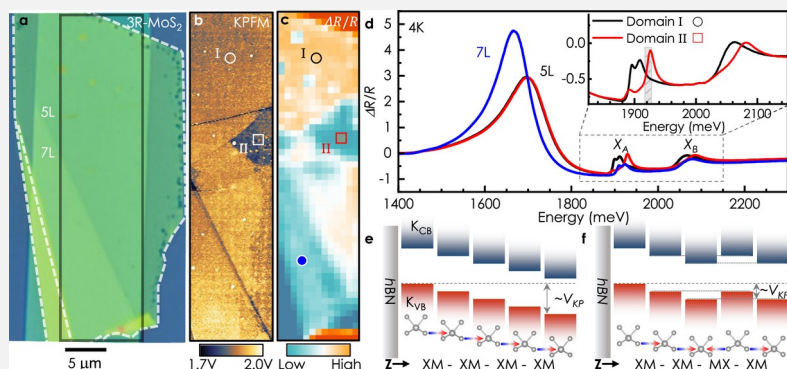
Office: PSB 436

Group website

Faculty profile

Paulo de Faria Junior develops theoretical models and computational methods for quantum materials and their interaction with light. His group studies excitons, spin-orbit coupling, quantum geometry and the properties that emerge when atomically thin layers are stacked, twisted or placed beside magnetic materials. First-principles calculations, effective Hamiltonians and symmetry analysis connect microscopic electronic states with optical and transport measurements. The work explores electric, magnetic and optical control of these materials and their potential for optoelectronics and quantum information.

RESEARCH TOOLKIT Electronic-structure theory · Exciton physics · Symmetry analysis



Tuning a crystal one layer at a time

Optical microscopy, surface-potential maps and reflection spectra distinguish ferroelectric domains in stacked molybdenum disulfide, linking atomic stacking to electronic structure.

Deb *et al.*, Nat. Commun. **15**, 7595 (2024), Fig. 1.

SELECTED PAPERS

G. Pasquale *et al.*, *Spin polarization detection via chirality-induced tunnelling currents in indium selenide* Nat. Mater. **24**, 212 (2025)

K. Olkowska-Pucko *et al.*, *Extremely High Excitonic g Factors in 2D Crystals by Alloy-Induced Admixing of Band States* Phys. Rev. Lett. **136**, 076901 (2026)

S. Deb *et al.*, *Excitonic signatures of ferroelectric order in parallel-stacked MoS2* Nat. Commun. **15**, 7595 (2024)

K.-Q. Lin *et al.*, *Ultraviolet interlayer excitons in bilayer WSe2* Nat. Nanotechnol. **19**, 196 (2024)

S. Raiber *et al.*, *Ultrafast pseudospin quantum beats in multilayer WSe2 and MoSe2* Nat. Commun. **13**, 4997 (2022)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.

Enrique del Barco

Spin dynamics and molecular electronics

Pegasus Professor

PhD University of Barcelona · 2001



delbarco@ucf.edu

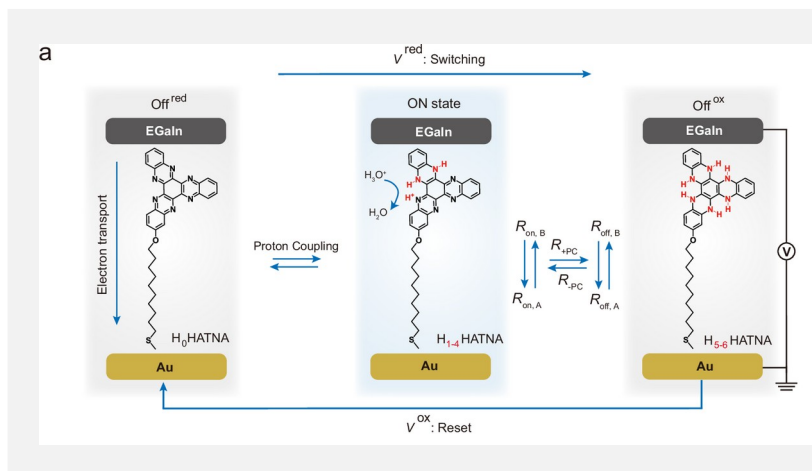
Office: PSB 464

Group website

Faculty profile

Enrique del Barco investigates spin dynamics and electrical transport in nanoscale systems. His group studies molecular magnets, molecular electronic junctions and collective magnetic motion in antiferromagnets. Low-temperature transport and high-frequency measurements reveal how charge, spin and molecular structure interact. These experiments address quantum control, spin-to-charge conversion and the operation of devices built from individual molecules. Students combine instrument development with measurements that resolve how a small number of quantum degrees of freedom govern an observable current or magnetic response.

RESEARCH TOOLKIT Magnetic resonance · Cryogenic measurements · Molecular electronics



Switching a molecular junction

A molecular junction switches between conducting states through coupled proton and electron transfer, making chemical motion part of an electronic circuit.

Zhang *et al.*, Nat. Commun. **15**, 8300 (2024), Fig. 1a.

SELECTED PAPERS

G. Fritjofson *et al.*, *Coherent Spin Pumping Originated from Sub-Terahertz Néel Vector Dynamics in Easy Plane α -Fe₂O₃/Pt* Phys. Rev. Lett. **135**, 216704 (2025)

Q. Zhang *et al.*, *Molecular switching by proton-coupled electron transport drives giant negative differential resistance* Nat. Commun. **15**, 8300 (2024)

L. Yuan *et al.*, *Transition from direct to inverted charge transport Marcus regions in molecular junctions via molecular orbital gating* Nat. Nanotechnol. **13**, 322 (2018)

R. Liu *et al.*, *Stable Universal 1- and 2-Input Single-Molecule Logic Gates* Adv. Mater. **34**, 2202135 (2022)

G. Fritjofson *et al.*, *Probing polarization-tunable sub-terahertz spin pumping in bimodal α -Fe₂O₃/Pt* npj Spintronics **3**, 24 (2025)

SELECTED SUPPORT

NSF 2403788 · PI: Aug 2024-Jul 2028.

NSF 2437811 · PI: Sep 2024-Aug 2027.

AFOSR · PI: Sep 2024-Aug 2028 (UCF project listing).

NSF 2013662 · PI: May 2020-Apr 2024.

Masahiro Ishigami

Nanoscale electronic materials and interfaces

Professor; Associate Chair for Research

PhD University of California, Berkeley · 2004



ishigami@ucf.edu

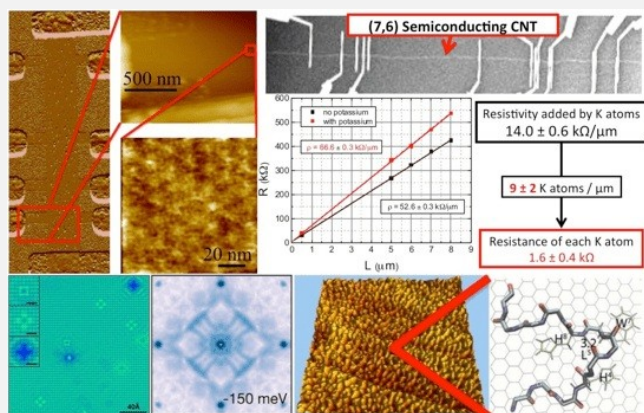
Office: PSB 110/ PS 120 & 117 (lab)

Research profile

Faculty profile

Masahiro Ishigami studies the electronic and optical properties of materials at the nanoscale. His group investigates how defects, interfaces and atomic structure influence the behavior of low-dimensional systems. Scanning-probe microscopy, transport measurements and materials characterization connect individual structural features with a device's response. Instrument development and data analysis extend what can be resolved and quantified. Students explore the connection between an atomically detailed view of a material and the collective properties used in electronic and optoelectronic devices.

RESEARCH TOOLKIT Scanning tunneling microscopy · Nanoscale transport · Image analysis



The defect in the device

Atomic-resolution images and transport measurements connect individual defects and adsorbed atoms to the electrical behavior of graphene and carbon-nanotube devices.

Ishigami group, UCF.

SELECTED PAPERS

S. D. Lough *et al.*, *Integration of in situ field-directed sputter sharpening in Scienta Omicron systems* J. Vac. Sci. Technol. B **43**, 035001 (2025)

D. Smalley *et al.*, *Determining the density and spatial descriptors of atomic scale defects of 2H-WSe₂ with ensemble deep learning* APL Mach. Learn. **2**, 036104 (2024)

S. D. Lough *et al.*, *Effect of thermal annealing on photoluminescence in single layer MoS₂ on Au* MRS Adv. **9**, 585 (2024)

S. Lough *et al.*, *Impact of Thermal Annealing on the Interaction Between Monolayer MoS₂ and Au* Adv. Eng. Mater. **26**, 2301944 (2024)

R. Selhorst *et al.*, *Role of Strain on Ferroelectricity in Ultrathin CuInP₂S₆* Chem. Mater. **36**, 7822 (2024)

SELECTED SUPPORT

NSF 2120214 · PI: Jan 2022-Oct 2027.

NSF CAREER 0955625 · PI: Feb 2010-Jul 2018.

Daniel Kaplan

Quantum geometry and driven matter

Assistant Professor

PhD Weizmann Institute of Science · 2023



daniel.kaplan@ucf.edu

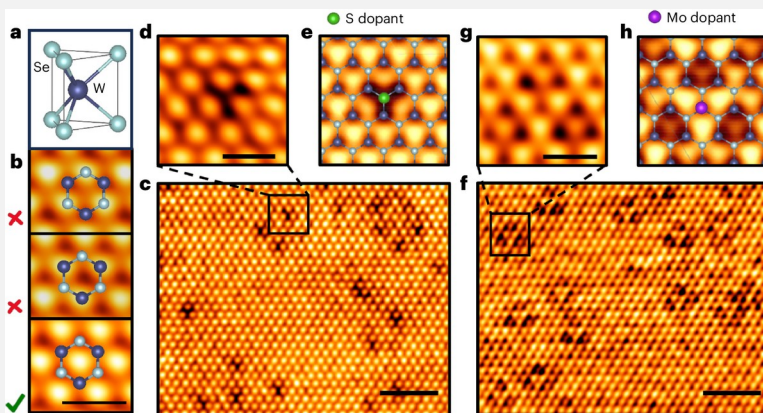
Office: PSB 303

Group website

Faculty profile

Daniel Kaplan investigates how electron interactions, symmetry and quantum geometry determine the properties of solids. His group studies nonlinear electrical and optical responses, unconventional superconductivity, excitons and phases created by light. Calculations range from first-principles electronic structure to analytical many-body theory and interpretable machine learning. Close collaborations with experimentalists connect these predictions to spectroscopy, microscopy and transport measurements. Students explore both the fundamental organization of quantum matter and practical ways to discover and control new material behavior.

RESEARCH TOOLKIT Quantum geometry · Response theory · Electronic-structure calculations



The geometry hidden in a current

Scanning tunneling microscopy resolves tungsten diselenide at the atomic scale. Comparing pristine and doped regions connects electronic patterns to the crystal lattice.

Holbrook *et al.*, Nat. Phys. **22**, 680 (2026), Fig. 1.

SELECTED PAPERS

N. Wang et al., *Quantum-metric-induced nonlinear transport in a topological antiferromagnet* Nature **621**, 487 (2023)

M. Holbrook *et al.*, *Real-space imaging of the band topology of transition metal dichalcogenides* Nat. Phys. **22**, 680 (2026)

D. Kaplan et al., *Tunable Spatiotemporal Orders in Driven Insulators* Phys. Rev. Lett. **134**, 066902 (2025)

J. Wang et al., *Even-integer quantum Hall effect in an oxide caused by a hidden Rashba effect* Nat. Nanotechnol. **19**, 1452 (2024)

G. Parra-Martínez *et al.*, *Band Renormalization, Quarter Metals, and Chiral Superconductivity in Rhombohedral Tetralayer Graphene* Phys. Rev. Lett. **135**, 136503 (2025)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.

NSF-supported KITP visit · acknowledged in a 2026 publication.

Saiful Khondaker

Low-dimensional materials and nanodevices

Professor

PhD University of Cambridge · 1999



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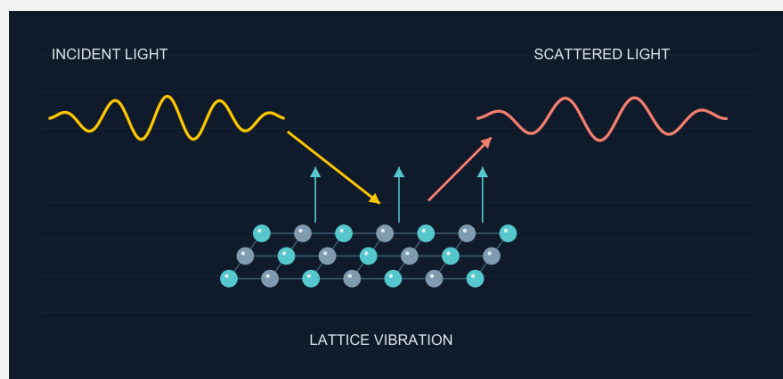
Office: MH 243

Group website

Faculty profile

Saiful Khondaker investigates low-dimensional materials and their use in electronic and optoelectronic devices. His group grows and assembles thin materials, fabricates devices and measures their electrical, optical and magnetic responses. Research includes two-dimensional semiconductors, carbon-based systems and emerging quantum materials. Doping, interfaces and nanoscale structure provide ways to tune charge transport and light detection. Students combine materials preparation, device fabrication and measurement to connect a material's microscopic properties with its performance in a working structure.

RESEARCH TOOLKIT Raman spectroscopy · Nanodevice fabrication · Electrical transport



Reading the vibrations of a thin crystal

Light exchanges energy with vibrations in a material. The resulting Raman spectrum provides a fingerprint of its structure and local environment.

SELECTED PAPERS

J. M. DeStefano *et al.*, *Giant coercivity and enhanced intrinsic anomalous Hall effect at vanishing magnetization in a compensated kagome ferrimagnet* Sci. Adv. **11**, eadx4671 (2025)

K. Harrison *et al.*, *In-Plane Anisotropy in the Layered Topological Insulator Ta₂Ni₃Te₅ Investigated via TEM and Polarized Raman Spectroscopy* ACS Nano **18**, 4811 (2024)

D. A. Jeff *et al.*, *Lattice dynamics of layered kagome lattice material Nb₃Br₈ investigated via Raman spectroscopy and DFT* Nanoscale **17**, 28165 (2025)

S. S. Withanage *et al.*, *Low pressure CVD growth of 2D PdSe₂ thin film and its application in PdSe₂-MoSe₂ vertical heterostructure* 2D Mater. **9**, 025025 (2022)

S. S. Withanage *et al.*, *Charge Transfer Doping of 2D PdSe₂ Thin Film and Its Application in Fabrication of Heterostructures* Adv. Electron. Mater. **7**, 2001057 (2021)

SELECTED SUPPORT

NSF 2424976 · PI: Sep 2024-Aug 2030.

NSF 2121953 · PI: Sep 2021-May 2026.

NSF 1728309 · PI: Aug 2017-Nov 2021.

Richard Klemm

Layered superconductors and quantum devices

Professor

PhD Harvard University · 1974



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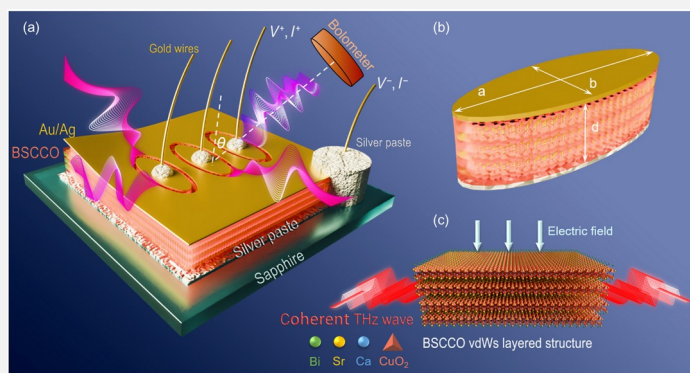
Office: PSB 402

Research profile

Faculty profile

Richard Klemm investigates high-temperature superconductivity and the quantum behavior of layered materials. His theoretical work connects electron pairing, charge order and magnetic response to the structure of a crystal. Working with experimental collaborators, he also studies how stacks of Josephson junctions inside a superconductor can emit coherent terahertz radiation. These projects connect fundamental questions about superconducting states with the design of compact sources for spectroscopy, sensing and communication.

RESEARCH TOOLKIT Superconductivity theory · Quantum transport · Josephson devices



Terahertz light from a layered crystal

An electrical bias drives synchronized oscillations in a layered superconductor. An elliptical cavity shapes the resulting coherent terahertz radiation.

Zhang *et al.*, Phys. Rev. Appl. **24**, 054012 (2025), Fig. 1.
CC BY 4.0.

SELECTED PAPERS

M. Zhang *et al.*, *Tunable terahertz source on a chip with decade-long stability using layered-superconductor elliptical microcavities* Phys. Rev. Appl. **24**, 054012 (2025)

A. Zhao *et al.*, *Magnetic-Field Oscillations of the Critical Temperature in Ultraclean, Two-Dimensional Type-I Superconductors* Condens. Matter **10**, 61 (2025)

A. Zhao *et al.*, *Angular dependence of the upper critical induction of clean s- and dx^2-y^2 -wave superconductors with self-consistent ellipsoidal effective mass and Zeeman anisotropies* J. Phys. Condens. Matter **34**, 355601 (2022)

K. Terao *et al.*, *Superconducting and tetragonal-to-orthorhombic transitions in single crystals of $\text{FeSe}_{1-x}\text{Te}_x$ ($0 \leq x \leq 0.61$)* Phys. Rev. B **100**, 224516 (2019)

K. Delfanazari *et al.*, *Integrated, Portable, Tunable, and Coherent Terahertz Sources and Sensitive Detectors Based on Layered Superconductors* Proc. IEEE **108**, 721 (2020)

SELECTED SUPPORT

U.S. Air Force SFFP · AFRL/RQ faculty fellowship: summer 2024 (9 weeks).

Michael Leuenberger

Quantum materials, optics and information

Professor

PhD University of Basel · 2002



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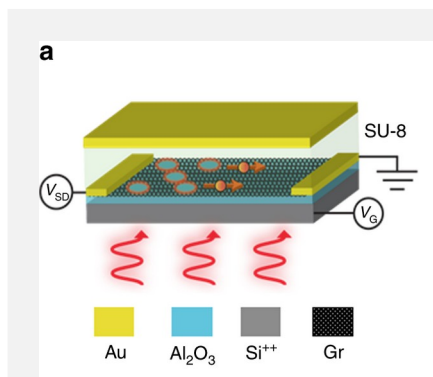
Office: PVL 428

Group website

Faculty profile

Michael Leuenberger develops quantum theories of electronic, optical and spin phenomena in materials and nanostructures. His research spans excitons, low-dimensional systems, plasmonic devices and proposals for quantum information technologies. Models connect material composition and geometry with the absorption, transport and emission of energy. Work with experimental collaborators includes infrared detection and light-matter interactions in patterned graphene. Students use analytical theory and computation to identify mechanisms, interpret measurements and assess how a proposed material or device could function.

RESEARCH TOOLKIT Many-body theory · Quantum optics · Materials and device modeling



Designing matter for quantum light

Patterning part of a graphene sheet concentrates infrared light and produces an asymmetric flow of energetic carriers, turning absorbed light into an electrical signal.

Safaei *et al.*, Nat. Commun. **10**, 3498 (2019), Fig. 1a.

SELECTED PAPERS

A. Safaei *et al.*, *Dirac plasmon-assisted asymmetric hot carrier generation for room-temperature infrared detection* Nat. Commun. **10**, 3498 (2019)

M. A. Khan *et al.*, *Emergent superfluidity of hard-core excitons in single-layer breathing-kagome Nb₃TeXCl_{8-x}* Phys. Rev. B **114**, 105130 (2026)

M. W. Shabbir *et al.*, *Theoretical Model of a Plasmonically Enhanced Tunable Spectrally Selective Infrared Photodetector Based on Intercalation-Doped Nanopatterned Multilayer Graphene* ACS Nano **16**, 5529 (2022)

M. A. Khan *et al.*, *Multiferroic dark exciton crystal in the breathing-kagome lattice material Nb₃Cl₈* Phys. Rev. B **113**, 155153 (2026)

D. Skachkov *et al.*, *On-chip high-order parametric downconversion in the excitonic Mott insulator Nb₃Cl₈ for programmable multiphoton entangled states* APL Quantum **3**, 026114 (2026)

SELECTED SUPPORT

AFOSR FA95502310472 · PI: Jul 2023-Jun 2028.

DARPA night-vision collaboration · announced February 2022.

Eduardo Mucciolo

Quantum information and nanoscale transport

Professor

PhD Massachusetts Institute of Technology · 1994



eduardo.mucciolo@ucf.edu

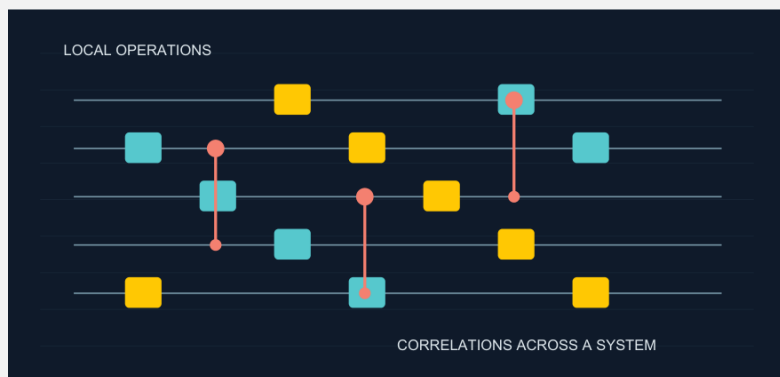
Office: PSB 457

Group website

Faculty profile

Eduardo Mucciolo studies quantum information and electron transport using analytical theory and numerical computation. His research explores quantum circuits, entanglement, algorithms and the relationship between physical correlations and computational complexity. A second strand examines how electrons move through nanoscale materials and superconducting devices. Methods developed across these areas connect microscopic models with measurable behavior and the resources needed to process information. Students combine condensed-matter physics, quantum computing and many-body mathematics.

RESEARCH TOOLKIT Quantum circuits · Tensor networks · Statistical mechanics



How complicated is a quantum circuit

Quantum operations connect different parts of a circuit. Following the correlations they create helps reveal how information spreads through an interacting system.

SELECTED PAPERS

C. Chamon *et al.*, *Circuit complexity and functionality: A statistical thermodynamics perspective* Proc. Natl. Acad. Sci. U.S.A. **122**, e2415913122 (2025)

P. Jouzdani *et al.*, *Quantum algorithms for state preparation and data classification based on stabilizer codes* Phys. Rev. A **109**, 022602 (2024)

J. Nieminen *et al.*, *Atomistic modeling of a superconductor-transition metal dichalcogenide-superconductor Josephson junction* Phys. Rev. B **107**, 174524 (2023)

S. Dhara *et al.*, *Logical Majorana zero modes in a nanowire network* Phys. Rev. B **107**, 075402 (2023)

P. Jouzdani *et al.*, *Alternative approach to quantum imaginary time evolution* Phys. Rev. A **106**, 062435 (2022)

SELECTED SUPPORT

NSF 2428488 · PI: Sep 2024-Aug 2029.

NSF 1740228 · co-PI: Sep 2017-Aug 2022.

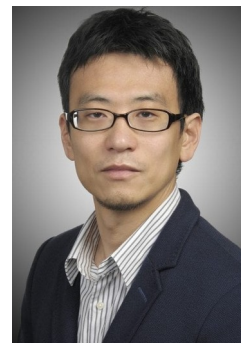
NSF 1844434 · PI: Oct 2018-Sep 2020.

Yasuyuki Nakajima

Correlated-electron quantum materials

Associate Professor

PhD University of Tokyo · 2007



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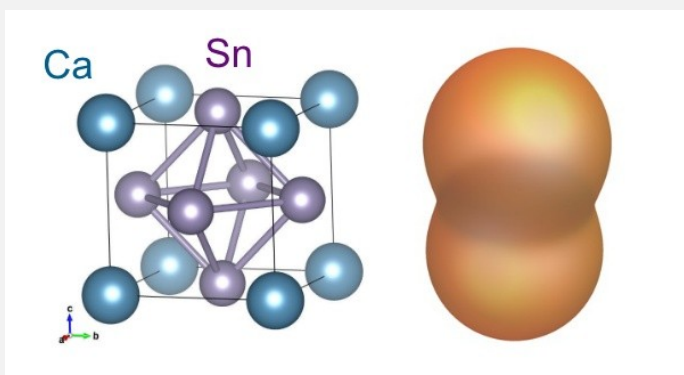
Office: PSB 102

Group website

Faculty profile

Yasuyuki Nakajima studies correlated-electron quantum materials, including superconductors and systems with unusual magnetic or topological properties. His group grows single crystals and measures their electrical, thermal and magnetic responses at low temperatures. Changing composition, pressure or magnetic field reveals how interactions between electrons produce collective phases. Recent work examines kagome materials, superconductivity and quantum critical behavior. Students follow the research process from crystal synthesis to precision measurement, developing a physical picture of how a material's structure shapes its electronic states.

RESEARCH TOOLKIT Single-crystal growth · Cryogenics · Transport and thermodynamics



Growing a new quantum phase

An unconventional superconducting phase emerges in a cubic topological semimetal, breaking the rotational symmetry of the underlying crystal lattice.

Siddiquee *et al.*, Phys. Rev. B **105**, 094508 (2022).

SELECTED PAPERS

K. Kumarasinghe *et al.*, *Enhancement of the superconducting transition temperature due to multiband effect in the topological nodal-line semimetal $Pb_{1-x}Sn_xTaSe_2$* Phys. Rev. B **112**, 054504 (2025)

Q.-P. Ding *et al.*, *Slow ferromagnetic fluctuations in the kagome metal $Sc_3Mn_3Al_7Si_5$ revealed by ^{27}Al NMR* Phys. Rev. B **112**, L121105 (2025)

Z. Liu *et al.*, *Flat band induced quantum criticality in a nonsuperconducting iron pnictide* Phys. Rev. B **109**, 075103 (2024)

C. Dissanayake *et al.*, *Gapless spinons and a field-induced soliton gap in the hyperhoneycomb Cu oxalate framework compound $[(C_2H_5)_3NH]_2Cu_2(C_2O_4)_3$* Phys. Rev. B **108**, 134418 (2023)

H. Siddiquee *et al.*, *Nematic superconductivity in the topological semimetal Ca_3Sn* Phys. Rev. B **105**, 094508 (2022)

SELECTED SUPPORT

NSF CAREER 1944975 · PI: Jul 2020–Jun 2026.

Madhab Neupane

Spectroscopy of quantum materials

Professor

PhD Boston College · 2010



madhab.neupane@ucf.edu

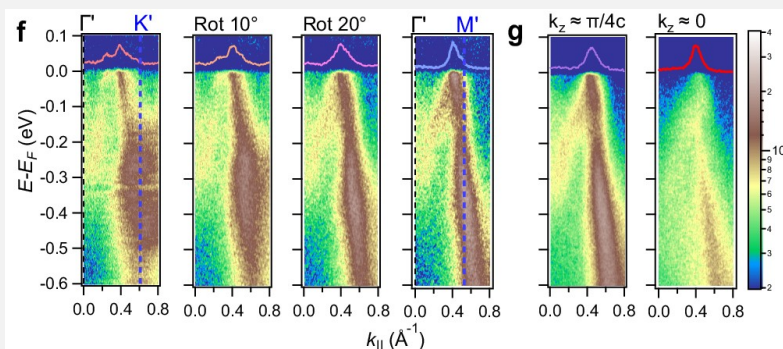
Office: PSB 422

Group website

Faculty profile

Madhab Neupane uses photoemission spectroscopy to map the electronic states of quantum materials. His group investigates topological systems, kagome materials, magnetism and the interplay between electronic structure and collective order. Measurements resolved in energy, momentum and spin reveal the bands and surface states that underpin a material's behavior. Collaborations connect crystal growth, advanced spectroscopy and theoretical calculations. Students learn how to extract a microscopic account of electronic motion from experiments and use it to identify new quantum phases.

RESEARCH TOOLKIT Photoemission spectroscopy · Thin-film growth · Synchrotron measurements



Mapping the electronic landscape

Photoemission maps trace electronic bands along different crystal directions, revealing the direction-dependent spin splitting of an altermagnetic material.

Sprague *et al.*, Nat. Commun. **17**, 9935 (2026), Fig. 2f-g.

SELECTED PAPERS

M. Sprague *et al.*, *Observation of Altermagnetic Spin-Splitting in an Intercalated Transition Metal Dichalcogenide* Nat. Commun. **17**, 9935 (2026)

P. Park *et al.*, *Spin density wave and van Hove singularity in the kagome metal CeTi₃Bi₄* Nat. Commun. **16**, 4384 (2025)

G. Bian *et al.*, *Topological nodal-line fermions in spin-orbit metal PbTaSe₂* Nat. Commun. **7**, 10556 (2016)

I. B. Elius *et al.*, *Observation of momentum dependent charge density wave gap in EuTe* Phys. Rev. B **113**, 235125 (2026)

M. I. Mondal *et al.*, *Observation of multiple flat bands and Van Hove singularities in the distorted kagome metal NdTi₃Bi₄* Phys. Rev. B **112**, L121104 (2025)

SELECTED SUPPORT

NSF 2518800 · PI: Sep 2025-Aug 2028.

NSF 2424976 · co-PI: Sep 2024-Aug 2030.

AFOSR MURI · Sep 2020-Sep 2026; DURIP · Sep 2022-Aug 2024 (UCF-listed periods).

DOE DE-SC0024304 · PI: Jun 2023-May 2027.

NSF CAREER 1847962 · PI: Feb 2019-Jan 2026.

Wayesh Qarony

Q-Lab · Silicon quantum photonics

Assistant Professor

PhD Hong Kong Polytechnic University · 2019



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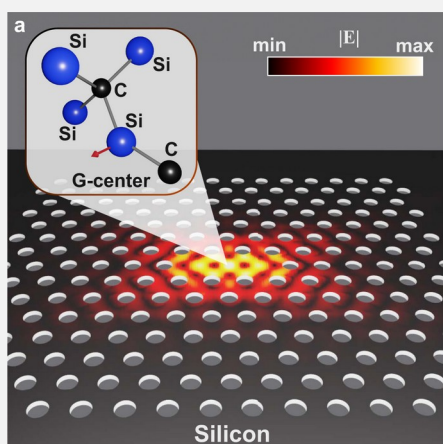
Office: Research 1 Room 255

Group website

Faculty profile

Wayesh Qarony's Q-Lab develops integrated silicon quantum photonic technologies for quantum information processing and networking. The group studies telecom spin–photon interfaces based on atomic-scale defects in silicon and integrates them with nanophotonic cavities, quantum photonic circuits and single-photon detectors. Research combines inverse-designed nanophotonics, semiconductor devices, nanofabrication and cryogenic quantum optics. Students work across simulation and experiment to develop scalable platforms for generating, controlling, interfering and detecting individual photons on silicon chips.

RESEARCH TOOLKIT Silicon quantum photonics · Spin–photon interfaces · Nanophotonic cavities · Single-photon detection



Spin–photon interfaces on silicon

Atomic-scale defects in silicon provide telecom quantum light sources and spin degrees of freedom for quantum information. Q-Lab integrates these emitters with engineered nanophotonic cavities and circuits to enhance light–matter interaction and develop scalable on-chip quantum photonic systems.

Redjem *et al.*, Nat. Commun. **14**, 3321 (2023), Fig. 1a.

SELECTED PAPERS

- M. S. Islam *et al.*, *Spin-photon qubits for scalable quantum network* Light Sci. Appl. **15**, 301 (2026)
- N. Letty, M. S. Islam and W. Qarony, *Inverse-Designed Nanobeam Cavities for High-Cooperativity Spin-Photon Interfaces in Silicon* Adv. Quantum Technol., in press (2026); arXiv:2609.32205
- K. Singh *et al.*, *Nanophotonic Design of Germanium-Silicon Single-Photon Detectors for Integrated Quantum Photonic Circuits* Nanophotonics **15**, e70188 (2026)
- K. Jhuria *et al.*, *Programmable quantum emitter formation in silicon* Nat. Commun. **15**, 4497 (2024)
- W. Redjem *et al.*, *All-silicon quantum light source by embedding an atomic emissive center in a nanophotonic cavity* Nat. Commun. **14**, 3321 (2023)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.
NSF · ONR · ARO · U.S. Department of Energy user facilities (Berkeley Lab and Sandia National Laboratories).

Jing Xu

Hybrid quantum devices and magnonics

Assistant Professor

PhD Northern Illinois University · 2019



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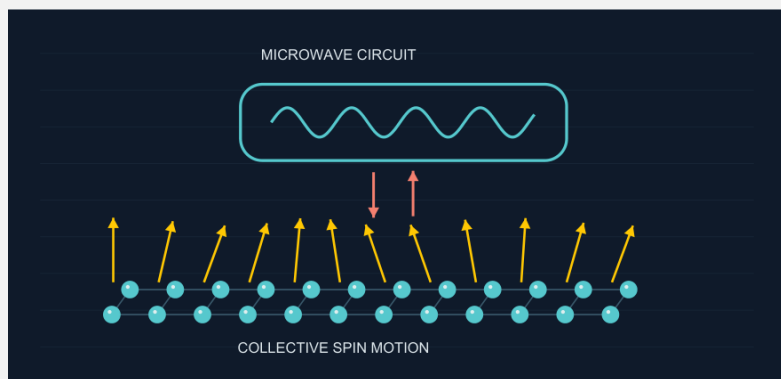
Office: PSB 154

Research profile

Faculty profile

Jing Xu investigates hybrid quantum systems that couple magnetic excitations with microwave, mechanical and superconducting devices. Her group uses thin-film materials, cryogenic measurements and microwave circuits to control how these systems exchange energy and information. Collective spin excitations, called magnons, provide a link between different physical components. The research explores coherent operations, strong coupling and tunable hybrid modes. Students combine device development with experiments that test how several kinds of excitation can function together in a quantum platform.

RESEARCH TOOLKIT Hybrid magnonics · Superconducting circuits · Cryogenic measurement



Connecting quantum systems with spin waves

Collective spin oscillations exchange energy with a microwave circuit, providing a connection between magnetic excitations and superconducting quantum devices.

SELECTED PAPERS

J. Xu *et al.*, *Slow-Wave Hybrid Magnonics* Phys. Rev. Lett. **132**, 116701 (2024)

J. Xu *et al.*, *Cryogenic hybrid magnonic circuits based on spalled YIG thin films* J. Appl. Phys. **137**, 023901 (2025)

Y. Jiang *et al.*, *Broadband magnomechanics enabled by magnon-spoof plasmon hybridization* Phys. Rev. Appl. **23**, 024003 (2025)

J. Xu *et al.*, *Floquet Cavity Electromagnonics* Phys. Rev. Lett. **125**, 237201 (2020)

J. Xu *et al.*, *Coherent Gate Operations in Hybrid Magnonics* Phys. Rev. Lett. **126**, 207202 (2021)

SELECTED SUPPORT

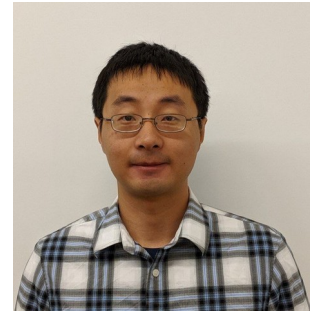
UCF start-up funds · supports the group's laboratory and graduate students.

Han Zhao

Quantum optomechanics and hybrid interfaces

Assistant Professor

PhD University of Pennsylvania · 2019



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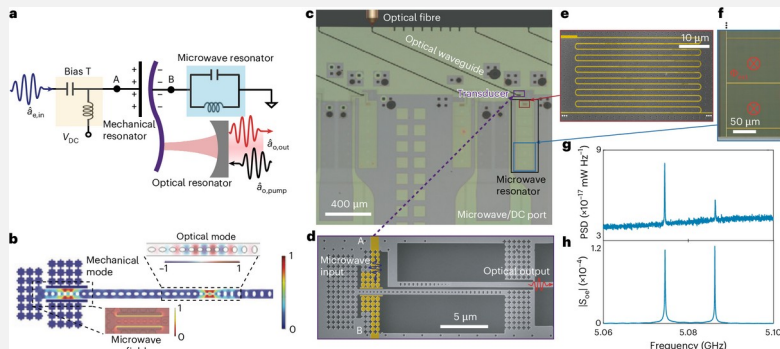
Office: PSB 152

Group website

Faculty profile

Han Zhao studies hybrid quantum systems that connect optical, microwave and mechanical excitations. His group develops nanophotonic and nanomechanical devices for quantum measurement, coherent control and information transfer. A central direction is conversion between microwave signals used in superconducting circuits and optical signals suited to communication. Experiments combine nanofabrication, precision optics and cryogenic techniques. Students investigate how device geometry, coupling and noise determine whether a physical interface can preserve quantum information during a conversion process.

RESEARCH TOOLKIT Quantum optomechanics · Nanofabrication · Superconducting devices



A mechanical bridge for quantum information

A vibrating silicon nanostructure links microwave and optical fields, providing a route for transferring quantum information between different physical platforms.

Zhao *et al.*, Nat. Nanotechnol. **20**, 602 (2025), Fig. 1.

SELECTED PAPERS

H. Zhao *et al.*, *Quantum-enabled microwave-to-optical transduction via silicon nanomechanics* Nat. Nanotechnol. **20**, 602 (2025)

A. Bozkurt *et al.*, *A quantum electromechanical interface for long-lived phonons* Nat. Phys. **19**, 1326 (2023)

H. Zhao *et al.*, *Enabling scalable optical computing in synthetic frequency dimension using integrated cavity acousto-optics* Nat. Commun. **13**, 5426 (2022)

H. Zhao, *Building photonic links for microwave quantum processors* Nanophotonics **14**, 1895 (2025)

H. Zhao *et al.*, *Electro-optic transduction in silicon via gigahertz-frequency nanomechanics* Optica **10**, 790 (2023)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.

ARO/LPS, DOE and NSF · collaborative research acknowledged in a 2025 publication.

Xiaofeng Feng

Electrochemical energy conversion

Associate Professor

PhD University of California, Berkeley · 2013



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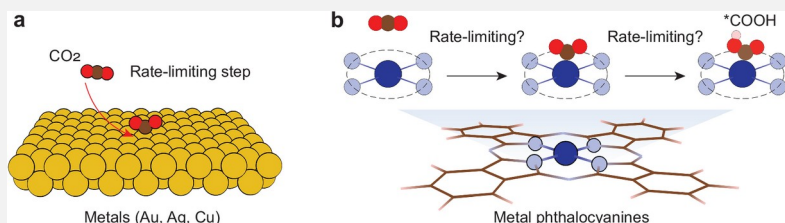
Office: Research I, Room 211

Group website

Faculty profile

Xiaofeng Feng studies electrochemical reactions that convert carbon dioxide and other abundant feedstocks into useful chemicals. His group designs catalysts and investigates the electrode-electrolyte interface, where electrons, ions and reacting molecules meet. Electrochemical measurements, surface characterization and spectroscopy help identify reaction intermediates and the steps that govern product selectivity. Research connects the atomic structure of a catalyst with its performance under operating conditions. Students combine materials preparation and mechanistic experiments to explore routes for renewable-electricity-driven chemical synthesis.

RESEARCH TOOLKIT Electrocatalysis · Materials synthesis · Operando characterization



Electricity becomes chemistry

The pathway from carbon dioxide to carbon monoxide depends on the catalyst. The diagrams identify adsorption and protonation as candidate bottlenecks.

Ren *et al.*, Nat. Commun. **17**, 3720 (2026), Fig. 1.

SELECTED PAPERS

Z. Ren *et al.*, *Elucidating the rate-limiting step of CO₂ electroreduction on metal phthalocyanines* Nat. Commun. **17**, 3720 (2026)

Z. Meng *et al.*, *Facet-Engineered Cu Nanoflake Electrocatalysts for Efficient Nitrate-to-Ammonia Conversion* ACS Appl. Mater. Interfaces **18**, 29858 (2026)

Z. Xing *et al.*, *Enhancing carbon dioxide gas-diffusion electrolysis by creating a hydrophobic catalyst microenvironment* Nat. Commun. **12**, 136 (2021)

J. Wang *et al.*, *Ambient ammonia synthesis via palladium-catalyzed electrohydrogenation of dinitrogen at low overpotential* Nat. Commun. **9**, 1795 (2018)

K. Shi *et al.*, *Ammonium Cation-Promoted CO₂ Electroreduction on Au in Acidic Media* J. Am. Chem. Soc. **147**, 23277 (2025)

SELECTED SUPPORT

NSF **CAREER** 1943732 · PI: Jul 2020-Jun 2026.

NSF 2018319 · co-PI: Aug 2020-Jul 2024.

DOE DE-SC0024083 · collaborative research: Sep 2023-Jul 2027.

William Kaden

Surface science and heterogeneous catalysis

Associate Professor; Director, Physics Graduate Program

PhD University of Utah · 2010



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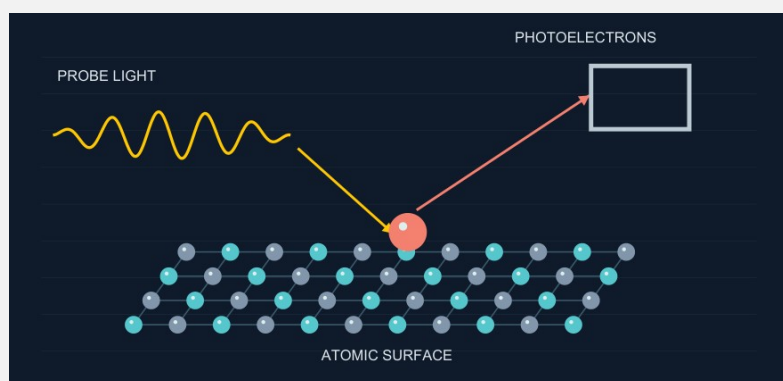
Office: Research I, Room 168

Group website

Faculty profile

William Kaden studies heterogeneous catalysis: chemical reactions accelerated by solid surfaces. His group uses surface-science experiments to connect the atomic structure and electronic properties of catalytic materials with their chemical activity. Model systems include supported metal clusters, two-dimensional films and powders prepared by wet-chemical methods. Spectroscopy, microscopy and measurements of adsorbed molecules reveal how catalyst composition, supporting materials and preparation methods influence elementary reaction steps. Students learn to prepare, characterize and test model catalysts.

RESEARCH TOOLKIT Photoelectron spectroscopy · Thin-film preparation · Surface science



The physics of catalytic activity

Photoemission measures the energies of electrons released from a surface by light, revealing the electronic states and chemical environments involved in catalysis.

SELECTED PAPERS

- K. Shi *et al.*, *Ammonium Cation-Promoted CO₂ Electroreduction on Au in Acidic Media* J. Am. Chem. Soc. **147**, 23277 (2025)
- A. Rahmani *et al.*, *Synergistic Solvent-Surface Interactions Enable Alkyne Semihydrogenation at Palladium* ACS Appl. Mater. Interfaces **18**, 37714 (2026)
- L. Hu *et al.*, *Ambient Electrochemical Ammonia Synthesis with High Selectivity on Fe/Fe Oxide Catalyst* ACS Catal. **8**, 9312 (2018)
- A. P. Warren *et al.*, *Impact of microstructure on the optical properties of ruthenium thin films* Opt. Express **34**, 7293 (2026)
- A. Rahmani *et al.*, *Selective and sustainable quinoline hydrogenation with a robust hierarchical catalyst framework* Catal. Sci. Technol. **15**, 4632 (2025)

SELECTED SUPPORT

NSF 2018319 · PI: Aug 2020-Jul 2024.
NSF 1740228 · co-PI: Sep 2017-Aug 2022.

Abdelkader Kara

Computational materials and surface physics

Professor

PhD University of Lille · 1985



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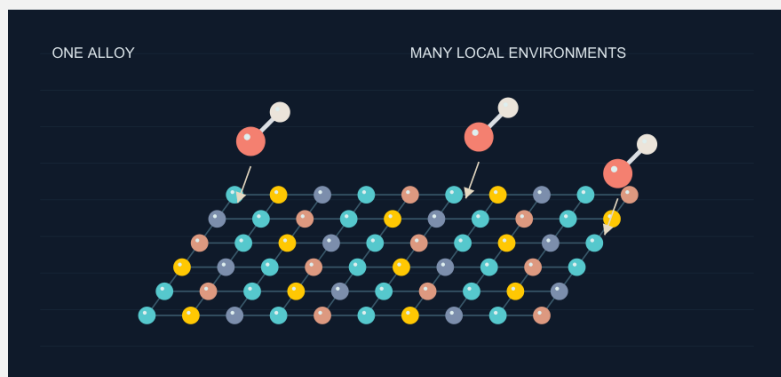
Office: PSB 303

Research profile

Faculty profile

Abdelkader Kara uses computational physics to understand and design materials and their surfaces. His group studies adsorption, catalytic reactions, two-dimensional systems and complex alloys, connecting atomic structure with electronic behavior and chemical activity. Density-functional theory and molecular simulation provide detailed physical models; machine learning helps explore large spaces of structures and compositions. Research on high-entropy materials and adsorption energies illustrates how these methods can accelerate materials discovery while retaining a clear connection to the underlying interactions.

RESEARCH TOOLKIT Density functional theory · Active learning · Surface chemistry



Searching the landscape of catalysts

An alloy presents a mosaic of atomic neighborhoods. Calculating how molecules bind at each site helps explain catalytic activity and guide material design.

SELECTED PAPERS

- J. von der Heyde *et al.*, *Active Learning for Optimizing Adsorption Energy Predictions in Large Chemical Spaces* J. Phys. Chem. A **130**, 7020 (2026)
- J. v. d. Heyde *et al.*, *Mapping high entropy state spaces for novel material discovery* Acta Mater. **278**, 120237 (2024)
- N. Zaman *et al.*, *The adsorption of oxygen on bimetallic Pd₃M₂ clusters (M = Ag, Au, Co, Cu, Mn, Ni, Pt, and Ru) with and without alumina support by density functional theory* Surf. Sci. **754**, 122684 (2025)
- W. Malone *et al.*, *Predicting adsorption energies and the physical properties of H, N, and O adsorbed on transition metal surfaces: A machine learning study* Surf. Sci. **731**, 122252 (2023)
- M. Sajid *et al.*, *DFT Investigation of Ammonia Formation via a Langmuir-Hinshelwood Mechanism on Mo-Terminated δ -MoN(0001)* ACS Omega **7**, 4277 (2022)

SELECTED SUPPORT

DOE DE-SC0007045 · PI: Sep 2011-Sep 2021.

Shyam Kattel

Computational catalysis and energy materials

Associate Professor

PhD New Mexico State University · 2012



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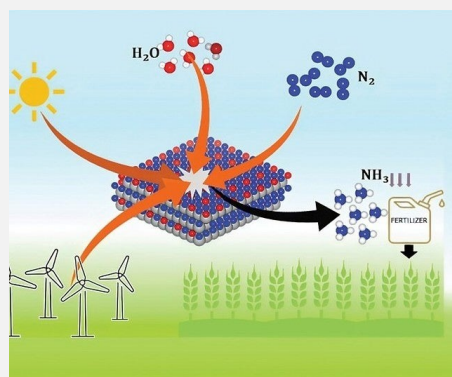
Office: PSB 463

Group website

Faculty profile

Shyam Kattel studies catalytic materials for clean-energy generation, fuel synthesis and energy storage. His group uses electronic-structure calculations, reaction models and machine learning to identify active sites and explain how molecules transform at gas-solid and liquid-solid interfaces. Projects include carbon-dioxide conversion, nitrogen chemistry and supported metal catalysts. Predictions connect composition, local coordination and reaction conditions with catalytic activity and selectivity. Students develop computational descriptions that guide experimental choices and reveal which microscopic steps control an overall reaction.

RESEARCH TOOLKIT Electronic-structure calculations · Microkinetics · Catalyst design



Predicting the route to a useful molecule

Renewable electricity can drive the catalytic conversion of nitrogen and water into ammonia. Atomistic calculations help identify surfaces that favor this reaction.

Kattel Lab, UCF.

SELECTED PAPERS

- S. Kattel *et al.*, *Active sites for CO₂ hydrogenation to methanol on Cu/ZnO catalysts* *Science* **355**, 1296 (2017)
- A. Priyadarsini *et al.*, *Highly Selective Electrochemical Nitrate Conversion to Ammonia on Ru-doped Cu Single-Atom Alloy Catalyst* *ACS Catal.* **16**, 14387 (2026)
- S. Ghoshal *et al.*, *Unraveling the Structural Sensitivity of Metal Catalysts in Ethylene Hydroformylation: Insights from Theory and Experiments* *ACS Catal.* **15**, 12325 (2025)
- C. Ezeakunne *et al.*, *Rh Single-Atom Catalyst Configurations on Ni, Cu, Pd, Ag, Ir, Pt, and Au Nanoparticles* *J. Phys. Chem. C* **130**, 9212 (2026)
- B. Lamichhane *et al.*, *The Selection of Stable Pt Single-Atom Catalysts Supported on 3d-5d Transition Metal Carbides* *Chem. Mater.* **37**, 3158 (2025)

SELECTED SUPPORT

NSF 2503612 · PI: Feb 2025-May 2026.
 NSF 2508169 · PI: Nov 2024-May 2026.
 NSF 2200456 · PI; award to FAMU: Sep 2022-Dec 2024.
 DOE FAIR DE-SC0024485 · PI at award; award to FAMU: Aug 2023-Aug 2027.

Duy Le

CoMET · Computational materials for energy

Assistant Professor

PhD University of Central Florida · 2012



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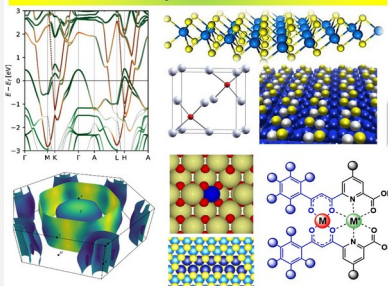
Group website

Faculty profile

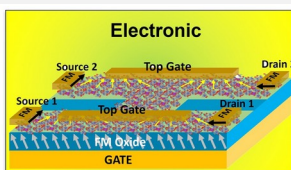
Duy Le develops computational models of materials for energy conversion and chemical transformations. His CoMET group studies electronic structure, catalytic mechanisms and the behavior of molecules at solid and liquid interfaces. Quantum calculations and machine learning connect the local environment of a reactive site with its activity and selectivity. Recent work examines how ions and proton transfer affect electrochemical carbon-dioxide conversion. Students build atomistic explanations of experiments and explore material designs that make energy-related reactions more efficient.

RESEARCH TOOLKIT Ab initio molecular dynamics · Electrochemical interfaces · Scientific software

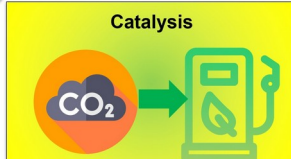
Electronic structure, Geometric Structure, composition of materials



Electronic



Catalysis



The electrode is part of the experiment

Electronic-structure calculations connect atomic arrangements to material behavior, guiding the design of nanoscale devices and catalysts that convert carbon dioxide into useful chemicals.

CoMET group, UCF.

SELECTED PAPERS

- Z. Ren *et al.*, *Cation-Mediated Proton Transfer Enhances Acidic CO₂ Electrolysis on a Molecular Catalyst* J. Am. Chem. Soc. **148**, 39724 (2026)
- K. Shi *et al.*, *Ammonium Cation-Promoted CO₂ Electroreduction on Au in Acidic Media* J. Am. Chem. Soc. **147**, 23277 (2025)
- K. Shi *et al.*, *Effect of Ammonium-Based Cations on CO₂ Electroreduction* ACS Catal. **15**, 3647 (2025)
- J. Janisch *et al.*, *Machine learned potential for defected single layer hexagonal boron nitride* J. Chem. Phys. **164**, 154705 (2026)
- S. Joshi *et al.*, *Temperature induced metallicity of the Si(001) surface: Insights from molecular dynamics simulations with machine learned interatomic potentials* J. Chem. Phys. **163**, 244708 (2025)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.

Talat Rahman

Computational condensed matter and surface physics

Trustee Chair, Pegasus and Distinguished Professor

PhD University of Rochester · 1977



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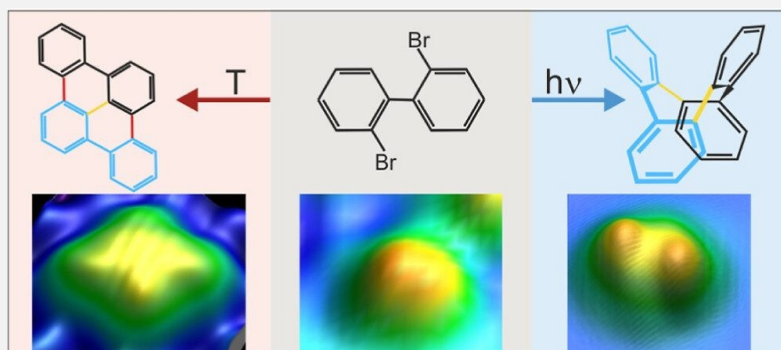
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Group website

Faculty profile

Talat Rahman investigates the microscopic physics that governs novel optical, magnetic, chemical, and vibrational properties of low dimensional materials in complex environments, to understand property-structure relationships. Her group develops and implements computational codes based on first principles to examine phenomena such as response of quantum materials to ultrafast external fields, diffusion and reaction of molecules on catalyst surfaces, thin film growth processes, and electrochemical conversion of carbon dioxide to value added products. Close comparisons with experiment guide the identification of active sites and the design of materials for energy conversion. Students develop physical explanations that span individual atoms, collective electronic states and observable material properties.

RESEARCH TOOLKIT First-principles calculations · Reaction kinetics · Machine-learned potentials



Finding the active atom

Light selectively activates bonds in molecules assembled on copper. Molecular structures and tunneling-microscope images compare the products formed by heating and illumination.

Schunke *et al.*, ACS Nano **18**, 11665 (2024), graphical abstract.

SELECTED PAPERS

- Y. Yu *et al.*, *Exciton steering via potential landscape engineered by excited electron-hole phase transition* Phys. Rev. Lett. **136**, 246901 (2026)
- J. Janisch *et al.*, *Machine learned potential for defected single layer hexagonal boron nitride* J. Chem. Phys. **164**, 154705 (2026)
- W. Tan *et al.*, *Fine-tuned local coordination environment of Pt single atoms on ceria controls catalytic reactivity* Nat. Commun. **13**, 7070 (2022)
- Z. Ren *et al.*, *Elucidating the rate-limiting step of CO₂ electroreduction on metal phthalocyanines* Nat. Commun. **17**, 3720 (2026)
- E. D. Switzer *et al.*, *Mapping spin interactions from conductance peak splitting in Coulomb blockade* Phys. Rev. B **108**, 174438 (2023)

SELECTED SUPPORT

NSF 2400068 · PI: Sep 2024-Aug 2027.
 NSF 2348914 · PI: Apr 2024-Mar 2027.
 DOE DE-SC0024083 · PI: Sep 2023-Jun 2029.
 NSF 1955343 · PI: Sep 2020-Dec 2024.
 DOE DE-FG02-07ER46354 · PI: Jan 2007-May 2027.

Patrick Schelling

Atomistic simulation and transport

Associate Professor

PhD University of Minnesota · 1999



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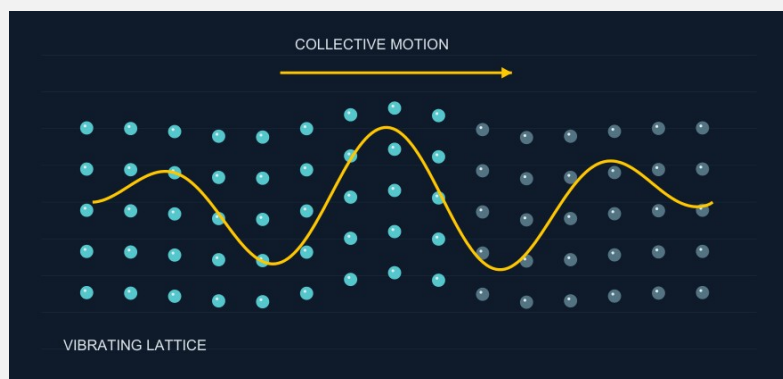
Office: PSB 305

Research profile

Faculty profile

Patrick Schelling investigates how heat, particles and mechanical energy move through materials. His research uses atomistic simulation and transport theory to study thermal conduction, diffusion, the Soret effect and energy dissipation at interfaces. Projects connect collective atomic motion with measured transport properties, including wave-like heat propagation in graphene. Related simulations examine the adhesion and collision of small grains relevant to planetary materials. Students learn to extract physical mechanisms from molecular trajectories and to connect microscopic models with macroscopic behavior.

RESEARCH TOOLKIT Molecular dynamics · Thermal transport · Multiscale physical modeling



When heat behaves like a wave

Vibrations move collectively through a crystal lattice. Their propagation and scattering determine how efficiently a material transports heat.

SELECTED PAPERS

- A. M. Margolles *et al.*, *Thermal response functions and second sound in graphene* J. Appl. Phys. **139**, 184302 (2026)
- B. Fields *et al.*, *Connection between partial pressure, volatility, and the Soret effect elucidated using simulations of nonideal supercritical fluid mixtures* J. Chem. Phys. **160**, 084501 (2024)
- P. K. Schelling, *Physical mechanisms of the Soret effect in binary Lennard-Jones liquids elucidated with thermal-response calculations* J. Chem. Phys. **158**, 044501 (2023)
- N. Bohm *et al.*, *Analysis of ballistic transport and resonance in the α -Fermi-Pasta-Ulam-Tsingou model* Phys. Rev. E **106**, 024212 (2022)
- A. H. Quadery *et al.*, *Role of Surface Chemistry in Grain Adhesion and Dissipation during Collisions of Silica Nanograins* Astrophys. J. **844**, 105 (2017)

SELECTED SUPPORT

NSF 1740228 · co-PI: Sep 2017-Aug 2022.
NSF 1616511 · PI: Sep 2016-May 2021.

Sergey Stolbov

Quantum defects and computational materials

Associate Professor

PhD Rostov State University · 1982



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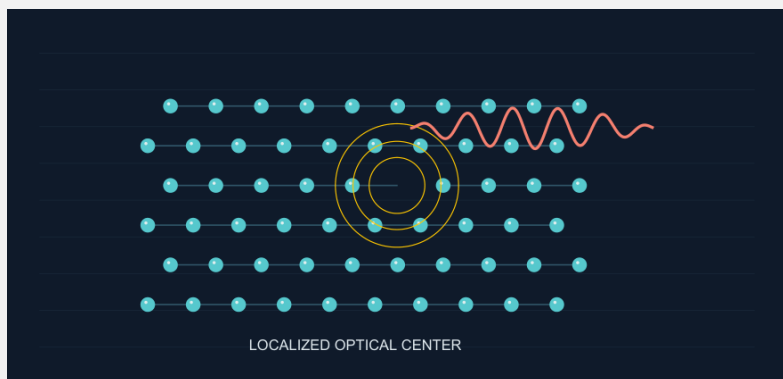
Office: PSB 309

Research profile

Faculty profile

Sergey Stolbov uses first-principles calculations to study electronic and optical properties of materials, with a recent focus on defects for quantum technologies. His research identifies atomic arrangements that can emit single photons or provide optically controllable spin states. Calculations test defect stability, localized electronic levels and optical excitation pathways in two-dimensional semiconductors and wider-bandgap hosts. Work on catalytic surfaces adds another setting for understanding local electronic structure. Students investigate how a specific atomic environment produces a useful material function.

RESEARCH TOOLKIT Defect physics · Excited-state calculations · Quantum materials



A useful imperfection

A missing atom changes the electronic environment around a crystal defect. Such local changes can reshape the material's optical response.

SELECTED PAPERS

- S. Stolbov *et al.*, *Spin qubit properties of the boron-vacancy/carbon defect in the two-dimensional hexagonal boron nitride* J. Phys. Condens. Matter **37**, 385503 (2025)
- S. Stolbov *et al.*, *Aluminum vacancy/sulfur complex in wurtzite AlN as an optically controllable spin qubit* Phys. Rev. B **109**, L241108 (2024)
- S. Stolbov *et al.*, *Computational search for efficient single-photon emitters among the substitutional doping defects in two-dimensional GaSe* Physica E **153**, 115782 (2023)
- S. Stolbov, *Local defects in two-dimensional gallium sulfide as potential single-photon emitters: First-principles evaluation* Phys. Rev. B **106**, 245205 (2022)
- M. Alcántara Ortigoza *et al.*, *Thermodynamic stability and optical properties of C-doping-induced defects in hexagonal boron nitride as potential single-photon emitters* Phys. Rev. B **105**, 165306 (2022)

SELECTED SUPPORT

NSF 1249134 · PI: Aug 2012-Jul 2013.

Kerri Donaldson Hanna

Planetary surfaces and infrared spectroscopy

Associate Professor

PhD Brown University · 2013



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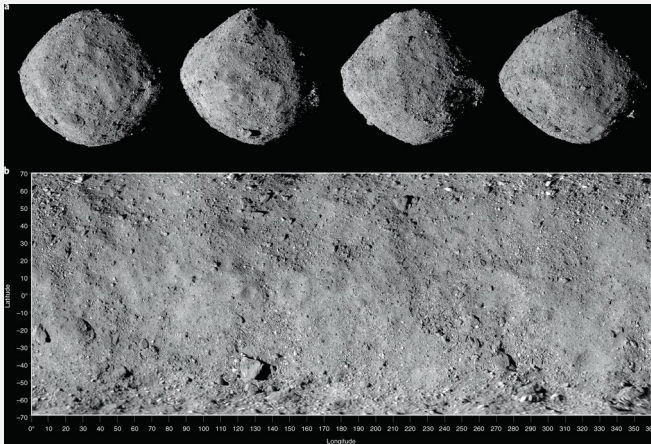
Office: PSB 404

Group website

Faculty profile

Kerri Donaldson Hanna investigates the composition and physical properties of planetary surfaces using infrared spectroscopy. Her group combines laboratory measurements of minerals and rocks with spacecraft observations of the Moon, asteroids and other airless bodies. Temperature, texture and composition all influence the emitted spectrum; laboratory studies provide the reference needed to interpret those signals. Mission work includes NASA's Lunar-VISE investigation. Students connect instrument measurements and remote sensing with questions about how planetary crusts formed and evolved.

RESEARCH TOOLKIT Infrared spectroscopy · Planetary analog experiments · Remote sensing



Reading a world through its heat

OSIRIS-REx revealed Bennu's rugged, boulder-covered surface. Global views and a surface map connect its small-scale terrain to the properties of the asteroid.

DellaGiustina *et al.*, *Nat. Astron.* **3**, 341 (2019), Fig. 2.

SELECTED PAPERS

C. W. Hergenrother *et al.*, *The operational environment and rotational acceleration of asteroid (101955) Bennu from OSIRIS-REx observations* *Nat. Commun.* **10**, 1291 (2019)

N. E. Bowles *et al.*, *The Lunar Trailblazer Lunar Thermal Mapper Instrument* *J. Geophys. Res. Planets* **131**, e2025JE009333 (2026)

D. N. DellaGiustina *et al.*, *Properties of rubble-pile asteroid (101955) Bennu from OSIRIS-REx imaging and thermal analysis* *Nat. Astron.* **3**, 341 (2019)

G. H. Jones *et al.*, *The Comet Interceptor Mission* *Space Sci. Rev.* **220**, 9 (2024)

S. M. Elardo *et al.*, *The Evolution of the Lunar Crust* *Rev. Mineral. Geochem.* **89**, 293 (2023)

SELECTED SUPPORT

NASA 80NSSC22M0303 · Lunar-VISE PI: Sep 2022-Jan 2027.

Adrienne Dove

Microgravity, dust and planetary surfaces

Professor; Chair, Department of Physics

PhD University of Colorado Boulder · 2012



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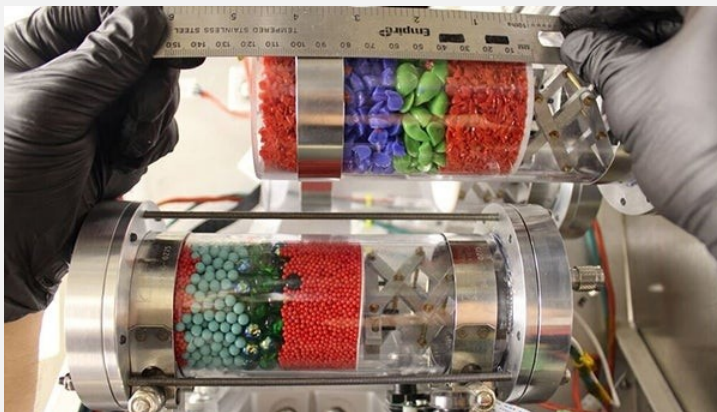
Office: PSB 430A (office) / PSB 409 (lab)

Group website

Faculty profile

Adrienne Dove studies the behavior of dust and granular materials in planetary and microgravity environments. Her group measures charging, adhesion and collisions through laboratory experiments and investigations in reduced gravity. These processes influence how particles move, collect and interact with spacecraft or planetary surfaces. Research also includes NASA's Lunar-VISE mission and experiments relevant to exploration of the Moon and small bodies. Students combine instrument design, flight experiments and data analysis to understand matter under conditions encountered beyond Earth.

RESEARCH TOOLKIT Microgravity experiments · Dust and plasma physics · Instrument design



Small grains in low gravity

Transparent sample tubes hold grains of different sizes and shapes for experiments on how loose planetary material moves in low gravity.

UCF Hawking Center for Microgravity Research.

SELECTED PAPERS

L. H. Yeo *et al.*, *Laboratory investigations of triboelectric charging of dust by rover wheels* Adv. Space Res. **72**, 1861 (2023)

K. Jardine *et al.*, *AFM Force Measurements to Explore Grain Contacts with Relevance for Planetary Materials* Planet. Sci. J. **3**, 273 (2022)

J. Brisset *et al.*, *Low-speed Impacts into Ice-Dust Granular Mixtures* Planet. Sci. J. **3**, 176 (2022)

H. Wang *et al.*, *Investigating particle-particle electrostatic effects on charged lunar dust transport via discrete element modeling* Adv. Space Res. **70**, 3231 (2022)

C. A. Knapik *et al.*, *COMPACT-a new complex plasma facility for the ISS* Plasma Phys. Control. Fusion **64**, 124006 (2022)

SELECTED SUPPORT

NASA 80NSSC22M0303 · Lunar-VISE deputy PI: Sep 2022-Jan 2027.

NSF 1616511 · co-PI: Sep 2016-May 2021.

Yan Fernández

Comets, asteroids and small-body evolution

Professor; Director, Planetary and Space Sciences Graduate Program

PhD University of Maryland · 1999



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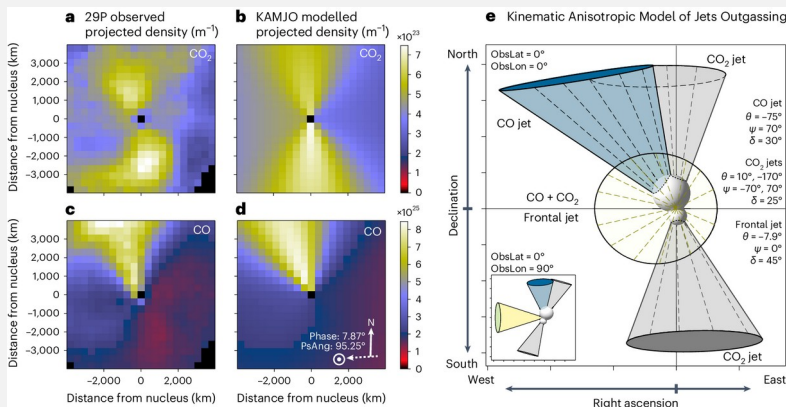
Office: PSB 133

Group website

Faculty profile

Yan Fernández studies comets, asteroids and other small bodies to understand their composition, physical properties and evolution. His research combines telescope observations with models of thermal emission, reflected light and cometary activity. Gas and dust escaping from an active body reveal how stored ices respond to sunlight and how activity varies across the surface. Studies of small-body populations place individual objects in the history of the solar system. Students develop observational and computational tools for interpreting these changing worlds.

RESEARCH TOOLKIT Telescope observations · Photometry · Thermal modeling and coding



The changing lives of small worlds

JWST images separate carbon-monoxide and carbon-dioxide jets from centaur 29P. Outflow models connect their shapes to activity on the rotating nucleus.

Faggi *et al.*, Nat. Astron. (2024), Fig. 2.

SELECTED PAPERS

S. Faggi *et al.*, *Heterogeneous outgassing regions identified on active centaur 29P/Schwassmann-Wachmann 1* Nat. Astron. **8**, 1237 (2024)

O. Harrington Pinto *et al.*, *A Survey of CO, CO₂, and H₂O in Comets and Centaurs* Planet. Sci. J. **3**, 247 (2022)

S. A. Myers *et al.*, *Constraining the Limitations of NEATM-like Models: A Case Study with Near-Earth Asteroid (285263) 1998 QE₂* Planet. Sci. J. **4**, 5 (2023)

C. Lisse *et al.*, *Spitzer's Solar System studies of comets, centaurs and Kuiper belt objects* Nat. Astron. **4**, 930 (2020)

M. L. Hinkle *et al.*, *The global thermophysical properties of (433) Eros* Icarus **382**, 114939 (2022)

Y. R. Fernández *et al.*, *Centaur Nuclei: Sizes, Shapes, Spins, and Structure* in Centaurs (K. Volk *et al.*, eds.), IOP Publishing (2025)

NASA 80NSSC21K0658 · award to Johns Hopkins University: Apr 2021-Sep 2025.

SELECTED SUPPORT

NASA 80NSSC23K0678 · collaborative research: Feb 2023-Feb 2027.

NSF 1744119 · co-PI: Apr 2018-Oct 2026.

NSF 1822073 · co-PI: Feb 2018-Oct 2026.

Joseph Harrington

Exoplanet atmospheres and scientific inference

Pegasus Professor

PhD Massachusetts Institute of Technology · 1994



jh@ucf.edu

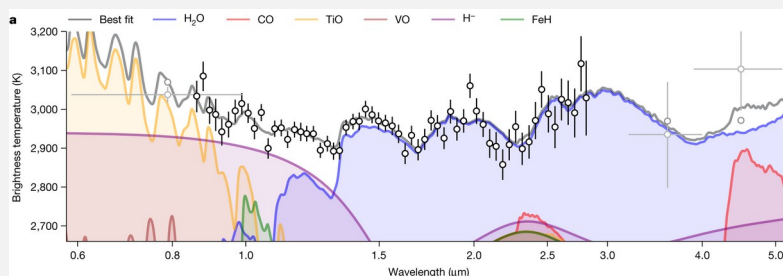
Office: PSB 441 / PSB 355 (lab)

Group website

Faculty profile

Joseph Harrington investigates planetary and exoplanetary atmospheres through observations, physical models and statistical inference. His group analyzes light emitted or filtered by planets to determine atmospheric temperatures, composition and circulation. Space-telescope measurements, including JWST observations, connect spectra and phase-dependent signals with atmospheric structure. The group also develops reproducible analysis tools, including Bayesian Atmospheric Radiative Transfer. Students work with astronomical data and computational models to assess what an observation can establish about the environment of a distant planet.

RESEARCH TOOLKIT Bayesian inference · Radiative transfer · Open scientific software



Decoding an atmosphere from starlight

Water emission features in WASP-18b's spectrum reveal an atmospheric temperature inversion: higher layers are hotter than the gas below.

Coulombe *et al.*, *Nature* **620**, 292 (2023), Fig. 2a.

SELECTED PAPERS

T. J. Bell *et al.*, *Nightside clouds and disequilibrium chemistry on the hot Jupiter WASP-43b* *Nat. Astron.* **8**, 879 (2024)

L.-P. Coulombe *et al.*, *A broadband thermal emission spectrum of the ultra-hot Jupiter WASP-18b* *Nature* **620**, 292 (2023)

E.-M. Ahrer *et al.*, *Early Release Science of the exoplanet WASP-39b with JWST NIRCам* *Nature* **614**, 653 (2023)

A. D. Feinstein *et al.*, *Early Release Science of the exoplanet WASP-39b with JWST NIRISS* *Nature* **614**, 670 (2023)

JWST Transiting Exoplanet Community Early Release Science Team *et al.*, *Identification of carbon dioxide in an exoplanet atmosphere* *Nature* **614**, 649 (2023)

SELECTED SUPPORT

NASA · PI: Exoplanets Research Program, 2017-2020; ADAP, 2013-2018 (CV-reported terms).

NSF · co-I: Astronomy & Astrophysics, 2012-2017 (CV-reported term).

Theodora Karalidi

Exoplanet and brown-dwarf atmospheres

Associate Professor

PhD Leiden University · 2013



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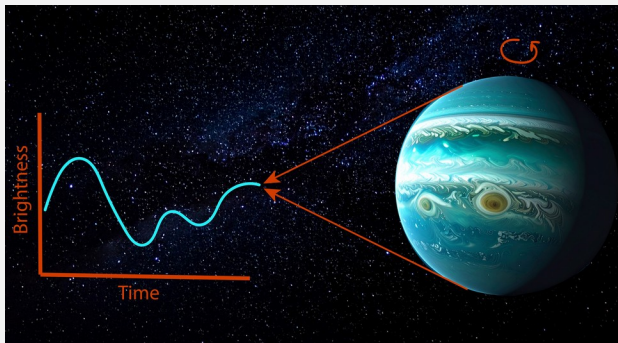
Office: PSB 104

Research website

Faculty profile

Theodora Karalidi models the atmospheres of exoplanets and brown dwarfs. Her research connects clouds, circulation and surface patterns with the light and polarization an observer would measure. Time-dependent signals help reconstruct atmospheric structure as an unresolved world rotates. Work on Earth-like planets explores how heterogeneous surfaces and atmospheres could appear to future observatories. Students combine radiative transfer, atmospheric modeling and inference to develop methods for identifying weather, composition and potentially habitable environments beyond the solar system.

RESEARCH TOOLKIT Polarized radiative transfer · Atmospheric mapping · Time-series inference



Weather on an unresolved world

Even when a planet appears as a single unresolved dot, its changing light can reveal a dynamic atmosphere. As clouds rotate in and out of view, they leave detectable fingerprints that allow us to study weather on alien worlds.

Karalidi group, UCF.

SELECTED PAPERS

- D. Apai *et al.*, *Zones, spots, and planetary-scale waves beating in brown dwarf atmospheres* *Science* **357**, 683 (2017)
- K. E. Goodis Gordon *et al.*, *Polarized Signatures of Variable Worlds: Modeling Heterogeneous Habitable Earth- and Early Mars-like (Exo)planets* *Astrophys. J.* **993**, 36 (2025)
- K. E. Goodis Gordon *et al.*, *Polarized Signatures of the Earth Through Time: An Outlook for the Habitable Worlds Observatory* *Astrophys. J.* **983**, 168 (2025)
- X. Chen *et al.*, *The JWST weather report from the nearest brown dwarfs II: consistent variability mechanisms over 7 months revealed by 1-14 μm NIRSpec + MIRI monitoring of WISE 1049AB* *Mon. Not. R. Astron. Soc.* **539**, 3758 (2025)
- Z. Zhang *et al.*, *Disequilibrium Chemistry, Diabatic Thermal Structure, and Clouds in the Atmosphere of COCONUTS-2b* *Astron. J.* **169**, 9 (2025)

SELECTED SUPPORT

NASA 80NSSC20K1529 · PI, Habitable Worlds: Oct 2020-Sep 2025.
 NASA 80NSSC24K0074 · PI, Habitable Worlds: Oct 2023-Oct 2027.
 NSF 2205913 · PI, collaborative research (AAG): Sep 2022-Aug 2027.
 NSF 2407881 · PI, collaborative research (AAG): Sep 2024-Aug 2027.

Lauren Mc Keown

Experimental planetary surface processes

Assistant Professor

PhD Trinity College Dublin · 2019



lauren.mc.keown@ucf.edu

Office: PSB 435

Group website

Faculty profile

Lauren Mc Keown investigates the processes that shape planetary surfaces, with an emphasis on interactions between ice, gas and sediment. Her research combines laboratory experiments under planetary conditions with spacecraft images and geomorphological analysis. Simulations of carbon-dioxide sublimation help explain the branching araneiform terrain known as Martian spiders. Related work explores icy landscapes and surface processes on other worlds. Students connect controlled experiments with geological evidence to test how recognizable landforms can emerge under unfamiliar environmental conditions.

RESEARCH TOOLKIT Thermal-vacuum experiments · Planetary image analysis · Ice and granular physics



Making planetary landscapes in the lab

Laboratory experiments recreate branching, spider-like textures under Martian conditions, testing how carbon-dioxide ice and escaping gas reshape the surface.

Mc Keown *et al.*, *Planet. Sci. J.* **5**, 195 (2024), Fig. 9.

SELECTED PAPERS

- L. E. Mc Keown *et al.*, *Lake Stars as an Earth Analog for Europa's Manannán Crater Spider Feature* *Planet. Sci. J.* **6**, 279 (2025)
- L. E. Mc Keown *et al.*, *A Lab-scale Investigation of the Mars Kieffer Model* *Planet. Sci. J.* **5**, 195 (2024)
- L. E. Mc Keown *et al.*, *Martian Araneiforms: A Review* *J. Geophys. Res. Planets* **128**, e2022JE007684 (2023)
- L. Mc Keown *et al.*, *The formation of araneiforms by carbon dioxide venting and vigorous sublimation dynamics under martian atmospheric pressure* *Sci. Rep.* **11**, 6445 (2021)
- S. Diniega *et al.*, *Modern Mars' geomorphological activity, driven by wind, frost, and gravity* *Geomorphology* **380**, 107627 (2021)

SELECTED SUPPORT

UCF start-up funds · supports the group's laboratory and graduate students.
 NASA ROSES Mars Data Analysis · co-I; three-year award listed in 2021 (before UCF).

Ryan Ogliore

Cosmochemistry and sample-return science

Associate Professor

PhD California Institute of Technology · 2007



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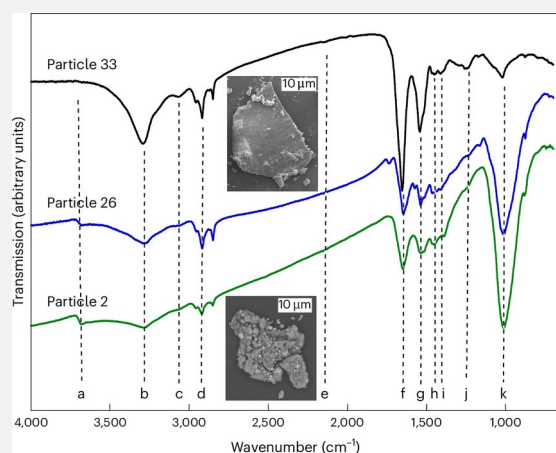
Office: PSB 438

Research website

Faculty profile

Ryan Ogliore studies extraterrestrial samples to reconstruct the formation and evolution of the solar system. His research examines cometary dust, asteroid material and presolar grains using microscopy, microanalysis and isotopic measurements. A tiny grain can retain evidence of stellar nucleosynthesis, chemical processing and the environment in which it formed. Work with material returned by space missions connects laboratory-scale observations to planetary history. Students develop measurements and analysis methods for extracting that record from rare, complex and often microscopic samples.

RESEARCH TOOLKIT Microanalysis · Isotope measurements · Electron microscopy



Solar-system history in a grain

Infrared spectra identify molecular bonds in nitrogen-rich organic particles returned from Bennu, alongside signatures of the minerals mixed with them.

Sandford *et al.*, *Nat. Astron.* **9**, 1803 (2025), Fig. 1.

SELECTED PAPERS

S. A. Sandford *et al.*, *Nitrogen- and oxygen-rich organic material indicative of polymerization in pre-aqueous cryochemistry on Bennu's parent body* *Nat. Astron.* **9**, 1803 (2025)

T. Stephan *et al.*, *The Presolar Grain Database. I. Silicon Carbide* *Astrophys. J. Suppl. Ser.* **270**, 27 (2024)

R. C. Ogliore, *Comet 81P/Wild 2: A record of the Solar System's wild youth* *Geochemistry* **83**, 126046 (2023)

P. Koefoed *et al.*, *The potassium isotopic composition of CI chondrites and the origin of isotopic variations among primitive planetary bodies* *Geochim. Cosmochim. Acta* **358**, 49 (2023)

E. Shi *et al.*, *Gamma-CaSO₄ With Abnormally High Stability From a Hyperarid Region on Earth and From Mars* *J. Geophys. Res. Planets* **127**, e2021JE007108 (2022)

SELECTED SUPPORT

NASA 80NSSC22K1692 · collaborative support, Sep 2022-23 Sep 2026; award to CSU San Marcos.

Ramses Ramirez

Planetary climate and habitability

Assistant Professor

PhD Pennsylvania State University · 2014



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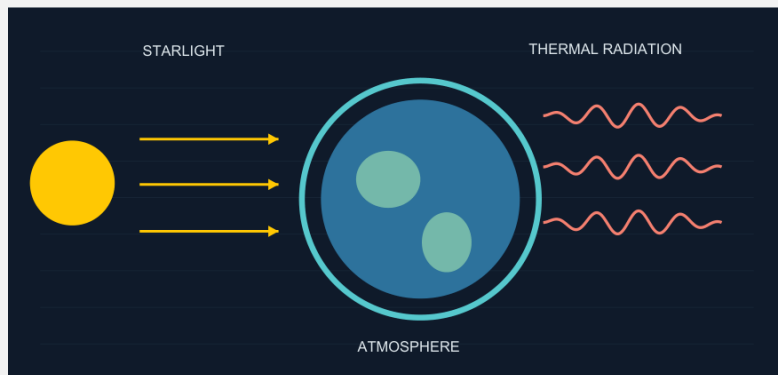
Office: PSB 106

Group website

Faculty profile

Ramses Ramirez models planetary climates and the conditions that allow surface liquid water. His research examines early Mars, terrestrial exoplanets and the physical limits of habitability. Atmospheric composition, stellar radiation, clouds and the exchange of heat across a planet enter models ranging from radiative-convective calculations to spatially resolved energy-balance simulations. These tools connect geological or astronomical evidence with possible climate histories. Students explore how a planet's environment evolves and which combinations of physical conditions can sustain a temperate surface.

RESEARCH TOOLKIT Planetary climate models · Radiative transfer · Comparative planetology



Where liquid water could last

A planet's climate depends on absorbed starlight and escaping thermal radiation. Atmospheric composition controls this balance and the conditions for liquid water.

SELECTED PAPERS

- S. Ansari *et al.*, *Feasibility of keeping Mars warm with nanoparticles* Sci. Adv. **10**, eadn4650 (2024)
 E. A. DeBenedictis *et al.*, *The case for Mars terraforming research* Nat. Astron. **9**, 634 (2025)
 A. Begum and R. M. Ramirez, *Interpretable Transfer Learning for Classifying Exoplanet Atmospheric Stability* IEEE Int. Conf. on AI and Data Analytics (ICAD), 1 (2026)
 R. M. Ramirez, *A New 2D Energy Balance Model for Simulating the Climates of Rapidly and Slowly Rotating Terrestrial Planets* Planet. Sci. J. **5**, 2 (2024)
 R. Deitrick *et al.*, *Functionality of Ice Line Latitudinal EBM Tenacity (FILLET). Protocol Version 1.0. A CUISINES Intercomparison Project* Planet. Sci. J. **4**, 39 (2023)

SELECTED SUPPORT

NASA 80NSSC26K0346 · PI, FINESST: Feb 2026-Feb 2029.
 NASA 80NSSC24K0162 · PI, Exoplanets Research Program: Jan 2024-Jan 2028.
 NSF Graduate Research Fellowship · advisor of fellow Carlos Ortiz Quintana: Aug 2024-Jul 2027.

Aniket Bhattacharya

Soft matter, polymers and biological physics

Professor; Chair, Graduate Curriculum Committee

PhD University of Maryland, College Park · 1992



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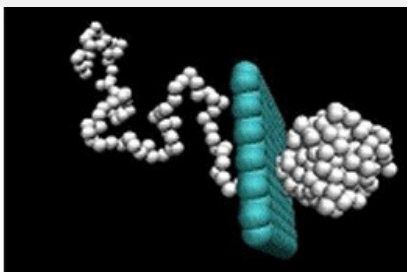
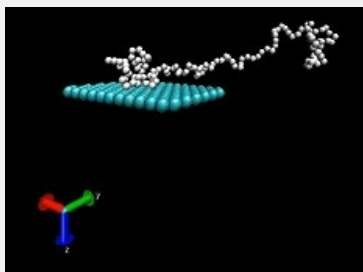
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Group website

Faculty profile

Aniket Bhattacharya uses statistical physics and computer simulation to investigate polymers, disordered proteins and transport through nanoscale pores. His group studies how molecular flexibility, confinement and interactions govern structure and motion. Research on DNA and protein translocation connects fundamental polymer dynamics with approaches to molecular sensing. Related work combines simulations and machine learning to characterize intrinsically disordered proteins. Students develop computational models that link the behavior of individual chains with collective properties and experimentally accessible signals.

RESEARCH TOOLKIT Polymer physics · Brownian dynamics · Coarse-grained simulation



A long molecule in a narrow world

A polymer chain threads through a nanoscale pore. Simulations track its changing shape and motion to understand how long molecules move through confinement.

Bhattacharya group, UCF.

SELECTED PAPERS

D. Linares Gonzalez *et al.*, *Prediction of Physical Characteristics of Disordered Proteins Using Molecular Simulation and Physics-Informed Multiple Machine Learning Strategies* Biomacromolecules **26**, 7595 (2025)

S. Seth *et al.*, *Accelerated Missense Mutation Identification in Intrinsically Disordered Proteins Using Deep Learning* Biomacromolecules **26**, 2106 (2025)

S. Seth *et al.*, *Fine structures of intrinsically disordered proteins* J. Chem. Phys. **160**, 014902 (2024)

J. Bair *et al.*, *Universality in conformations and transverse fluctuations of a semi-flexible polymer in a crowded environment* J. Chem. Phys. **158**, 204902 (2023)

S. Seth *et al.*, *Discriminating protein tags on a dsDNA construct using a Dual Nanopore Device* Sci. Rep. **12**, 11305 (2022)

SELECTED SUPPORT

NSF 2623026 · PI: Oct 2026-Sep 2029 (starts Oct 2026).

DARPA Biotechnology Office · PI: Dec 2024-Jun 2025 (CV-reported term).

NIH subcontract via McGill · PI: Sep 2020-May 2024 (CV-reported term).

Bo Chen

Structural biophysics and solid-state NMR

Associate Professor; Chair, Graduate Written Candidacy Exam

PhD Northwestern University · 2007



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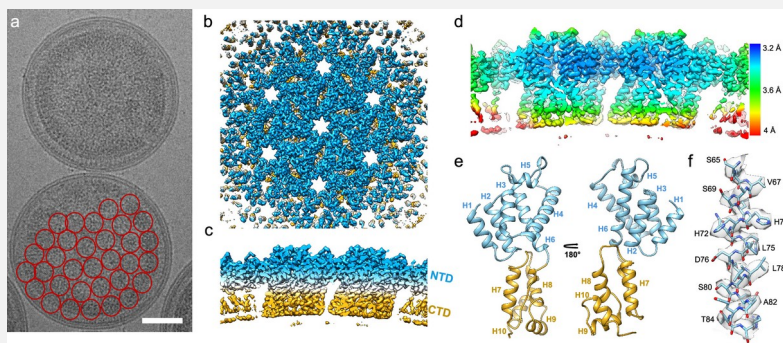
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Research profile

Faculty profile

Bo Chen investigates the structures formed when proteins assemble into larger molecular systems. His group combines solid-state nuclear magnetic resonance, transmission electron microscopy, molecular modeling and simulation to study viral capsids and amyloid proteins. Measurements resolve local environments and collective architecture; models connect those structures with assembly mechanisms and dynamics. The research examines how interactions between protein building blocks produce a functional or disease-associated structure. Students work across experimental biophysics and computation to understand organization at the molecular scale.

RESEARCH TOOLKIT Solid-state NMR · Electron microscopy · Molecular modeling



How proteins build larger structures

Cryo-electron microscopy resolves the protein lattice inside immature HTLV-1 particles, connecting the architecture of a viral shell to its molecular building blocks.

Arndt *et al.*, Nat. Commun. **17**, 444 (2026), Fig. 1.

SELECTED PAPERS

- W. G. Arndt *et al.*, *High-resolution analysis of the human T-cell leukemia virus capsid protein reveals insights into immature particle morphology* Nat. Commun. **17**, 444 (2026)
- H. Lu *et al.*, *Structure and Dynamics of Lipid-Stabilized Amyloid Beta A β 1-42 Oligomers Aggregate* **7**, e70266 (2026)
- T. Thames *et al.*, *Curvature of the Retroviral Capsid Assembly Is Modulated by a Molecular Switch* J. Phys. Chem. Lett. **12**, 7768 (2021)
- J. Jeon *et al.*, *Structural Model of the Tubular Assembly of the Rous Sarcoma Virus Capsid Protein* J. Am. Chem. Soc. **139**, 2006 (2017)
- B. Chen, *ASAP: An automatic sequential assignment program for congested multidimensional solid state NMR spectra* J. Magn. Reson. **361**, 107664 (2024)

SELECTED SUPPORT

NSF 1856055 · PI: Jun 2019-May 2024.
NSF 2121953 · co-PI: Sep 2021-May 2026.

Ellen Hyeran Kang

Molecular biophysics and soft matter

Associate Professor; Associate Chair for Academics & Operations

PhD Brown University · 2010



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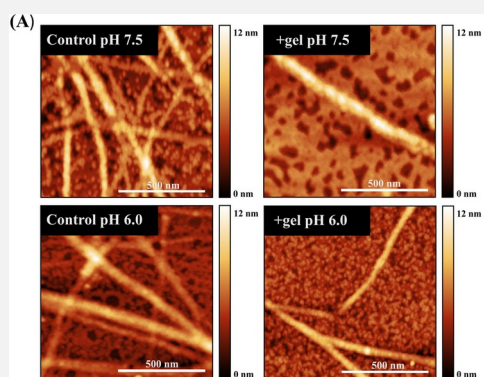
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Group website

Faculty profile

Ellen Hyeran Kang studies the mechanics and organization of the actin cytoskeleton, the dynamic network of protein filaments that helps cells maintain shape and exert force. Her group uses fluorescence and atomic-force microscopy, biochemical measurements and simulation to connect molecular interactions with filament stiffness, assembly and remodeling. Experiments examine how binding proteins and the surrounding chemical environment alter these properties. Students bring statistical physics and quantitative imaging to questions about how living materials carry stress and respond to change.

RESEARCH TOOLKIT Fluorescence microscopy · Atomic force microscopy · Fluctuation analysis



The mechanics inside a cell

Atomic-force microscopy compares actin filaments with and without gelsolin at two acidity levels, revealing how the protein reshapes the cellular scaffold.

Douglas *et al.*, *Front. Soft Matter* **5**, 1530439 (2025), Fig. 4A.

SELECTED PAPERS

T. V. Douglas *et al.*, *Gelsolin-mediated actin filament severing, mechanics, and conformational changes at neutral and acidic pH* *Front. Soft Matter* **5**, 1530439 (2025)

J. Park *et al.*, *Magnesium Cations Modulate Actin Bundles Formed by α -actinin Cytoskeleton*, e70188, advance online publication (2026)

B. Demosthene *et al.*, *Small organic osmolytes accelerate actin filament assembly and stiffen filaments* *Cytoskeleton* **82**, 281 (2025)

J. Manrique Castro *et al.*, *Microfluidic Biosensor for the In Vitro Electrophysiological Characterization of Actin Bundles* *J. Microelectromech. Syst.* **33**, 350 (2024)

B. Demosthene *et al.*, *Molecular Basis for Actin Polymerization Kinetics Modulated by Solution Crowding* *Biomolecules* **13**, 786 (2023)

SELECTED SUPPORT

NSF **CAREER** 1943266 · PI: Aug 2020-Jul 2026.

NSF 2534342 · co-PI: Oct 2025-Mar 2027.

Alfons Schulte

Soft matter, nano-spectroscopy and high pressure

Professor

PhD Technical University of Munich · 1985

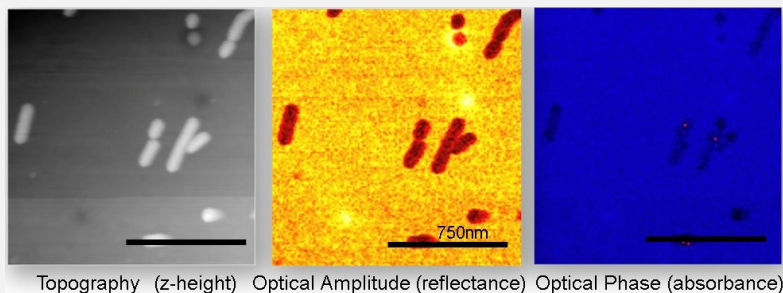


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Research profile
Faculty profile

Alfons Schulte's laboratory studies the structure and dynamics of soft matter using micro- and nano-spectroscopic probes, neutron scattering and high-pressure methods. Current research investigates responsive polymers and bio-assemblies, with a focus on hydration and the interactions that drive conformation and aggregation. Temperature and pressure provide controlled ways to probe these processes. Related optical studies characterize semiconductor materials and their response to light and radiation. Students connect their experiments with microscopic models of molecular motion, collective behavior and novel material properties.

RESEARCH TOOLKIT Light and neutron scattering · High-pressure methods · Micro- and nano-spectroscopy



Infrared nanoscopy of bio-assemblies

Near-field optical imaging at 1670 cm^{-1} resolves the rod-like shapes of tobacco mosaic virus particles with chemical specificity. Panels show topography, optical amplitude and optical phase.

Schulte group, UCF.

SELECTED PAPERS

- C. M. Papadakis *et al.*, *Hydration Dynamics of Perdeuterated PNIPAM in Aqueous Solution* *Macromolecules* **59**, 4124 (2026)
- P. A. Alvarez Herrera *et al.*, *Effect of pressure on the micellar structure and aggregation behavior of PMMA-*b*-PNIPAM diblock copolymers in a water/methanol mixture* *Soft Matter* **21**, 4681 (2025)
- B.-J. Niebuur *et al.*, *PNIPAM Mesoglobules in Dependence on Pressure* *Langmuir* **40**, 22314 (2024)
- C. M. Papadakis *et al.*, *Thermoresponsive Polymers under Pressure with a Focus on Poly(N-isopropylacrylamide) (PNIPAM)* *Langmuir* **40**, 1 (2024)
- A. Schulte *et al.*, *Impact of Solid-State Charge Injection on Spectral Photoresponse of NiO/Ga₂O₃ p-n Heterojunction* *Condens. Matter* **8**, 106 (2023)

SELECTED SUPPORT

NATO SPS G6072 · PI: 2024-2027.
NSF 2216239 · co-PI: Sep 2022-Aug 2024.
NASA 80NSSC21K1958 · co-PI: Jan 2022-Dec 2024.

Suren Tatulian

Protein structure, membranes and molecular biophysics

Professor

PhD Institute of Cytology, Leningrad · 1979



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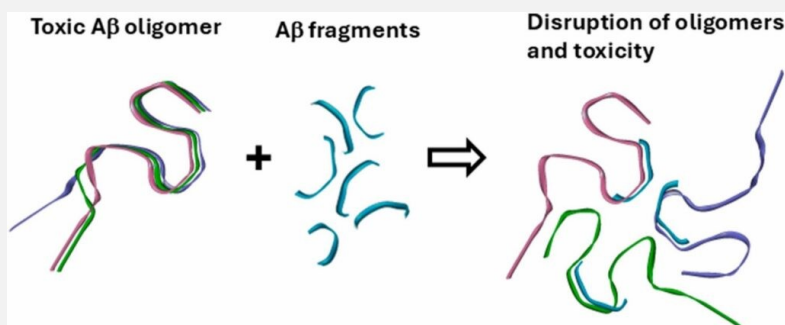
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Research profile

Faculty profile

Suren Tatulian explores how the structure and motion of proteins govern their interactions with biological membranes. His laboratory combines spectroscopy, biochemical experiments and molecular models to study membrane-active proteins, enzymes and amyloid assemblies. Recent work examines how amyloid beta forms toxic oligomers and membrane pores, and how short peptide fragments influence those processes. The research links molecular structure to cell damage and develops physical insight into potential strategies for intervening in protein aggregation.

RESEARCH TOOLKIT Infrared and fluorescence spectroscopy · Protein biochemistry · Molecular modeling



Disrupting toxic amyloid assemblies

Fragments of amyloid beta interact with larger assemblies in a proposed mechanism for disrupting toxic oligomers, linking molecular structure to potential therapeutic strategies.

Zabala-Rodriguez *et al.* (2025), graphical abstract via UCF College of Sciences.

SELECTED PAPERS

M. C. Zabala-Rodriguez *et al.*, *Amyloid β fragments that suppress oligomers but not fibrils are cytoprotective* Arch. Biochem. Biophys. **768**, 110386 (2025)

H. Lu *et al.*, *Structure and Dynamics of Lipid-Stabilized Amyloid Beta A β 1-42 Oligomers* Aggregate **7**, e70266 (2026)

F. Abedin *et al.*, *Effects of A β -derived peptide fragments on fibrillogenesis of A β* Sci. Rep. **11**, 19262 (2021)

N. Kandel *et al.*, *Structure of amyloid β 25-35 in lipid environment and cholesterol-dependent membrane pore formation* Sci. Rep. **9**, 2689 (2019)

S. A. Tatulian *et al.*, *Probing peptide-mediated membrane pore formation by fluorescence, infrared spectroscopy, and atomic force microscopy* Front. Biophys. **4**, 1870174 (2026)

SELECTED SUPPORT

NIH R03AI097591 · PI: May 2012-Oct 2015.

NIH R01HL065524 · PI: Apr 2001-Mar 2006 (Kansas/UCF).

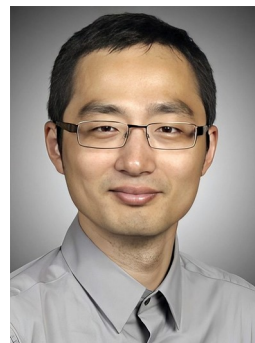
Florida DOH 21A06 · PI: FY 2020-21 award; ended Jun 2025.

Zhongzhou Chen

Physics education and learning analytics

Associate Professor

PhD University of Illinois Urbana-Champaign · 2012



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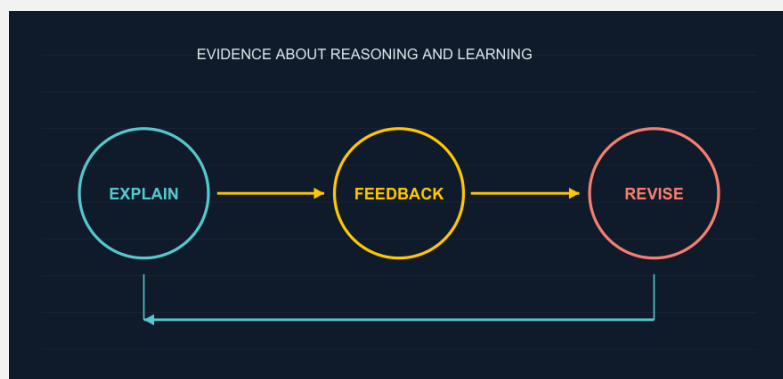
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Group website

Faculty profile

Zhongzhou Chen investigates how students learn physics and how educational technology can support that learning. His research uses assessment, learning analytics and analysis of written explanations to study reasoning, self-regulation and course design. Current projects evaluate generative AI as a tool for feedback and assessment. Data from real learning environments help test the effectiveness and limitations of an intervention. Students combine quantitative analysis and education research methods to develop evidence-based approaches to teaching and learning physics.

RESEARCH TOOLKIT Learning analytics · Assessment design · Quantitative education research



Making learning a measurable science

Students explain, receive feedback and revise. Studying how their reasoning changes through this cycle helps test and refine physics teaching methods.

SELECTED PAPERS

- Z. Chen *et al.*, *Grading explanations of problem-solving process and generating feedback using large language models at human-level accuracy* Phys. Rev. Phys. Educ. Res. **21**, 010126 (2025)
- T. Wan *et al.*, *Exploring generative AI assisted feedback writing for students' written responses to a physics conceptual question with prompt engineering and few-shot learning* Phys. Rev. Phys. Educ. Res. **20**, 010152 (2024)
- Z. Felker *et al.*, *Reducing procrastination on introductory physics online homework for college students using a planning prompt intervention* Phys. Rev. Phys. Educ. Res. **19**, 010123 (2023)
- Z. Chen *et al.*, *Opportunities and Challenges in Harnessing Digital Technology for Effective Teaching and Learning* Trends High. Educ. **4**, 6 (2025)
- Z. Chen *et al.*, *How Does a Data-Informed Deliberate Change in Learning Design Impact Students' Self-Regulated Learning Tactics?* J. Learn. Anal. **11**, 174 (2024)

SELECTED SUPPORT

- NSF 2421299 · PI: Aug 2024-Jul 2028.
- NSF 2121953 · co-PI: Sep 2021-May 2026.
- NSF CAREER 1845436 · PI: Apr 2019-Mar 2026.

Costas Efthimiou

Physics education and scientific reasoning

Associate Professor

PhD Cornell University · 1994



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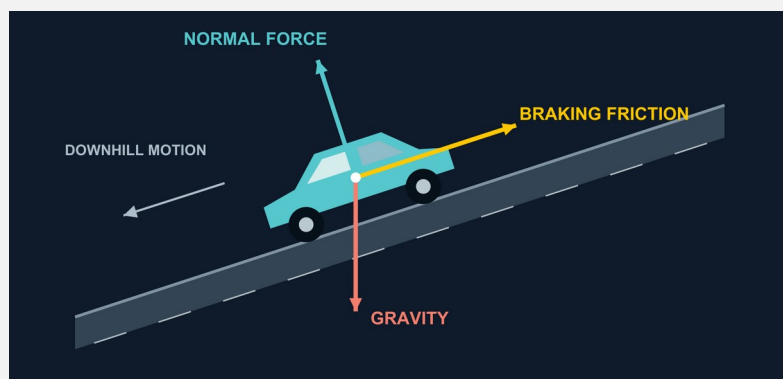
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Education projects

Faculty profile

Costas Efthimiou explores how students build physical intuition and quantitative reasoning. His Physics in Films work turns cinematic scenes into problems in mechanics, estimation and scientific literacy. Collaborative studies examine interactive lecture demonstrations, laboratory curricula and service learning, including road-safety projects that connect forces and energy to everyday decisions. Concept inventories, student interviews and classroom assessments provide evidence of how learners understand and apply physics. With a background in mathematical physics, he brings analytical depth to questions about the teaching and learning of science.

RESEARCH TOOLKIT Concept inventories · Classroom assessment · Quantitative modeling



The physics behind the wheel

Students use forces, friction and energy to analyze stopping on a sloping road. Connecting mechanics to road safety creates a practical setting for investigating how students reason with physics.

Based on Flitsiyan *et al.* (2019).

SELECTED PAPERS

E. Flitsiyan *et al.*, *Assessment of the Effect of Service Learning in Introductory Physics Course on Students Learning and Critical Thinking* ATINER Conf. Pap. Proc. Ser., PHY2019-0135 (2019)

C. Efthimiou *et al.*, *Implementing elements of The Physics Suite at a large metropolitan research university* Phys. Educ. **46**, 421 (2011)

C. J. Efthimiou *et al.*, *Cinema, Fermi problems and general education* Phys. Educ. **42**, 253 (2007)

C. J. Efthimiou *et al.*, *Avatars of Hollywood in Physical Science* Phys. Teach. **44**, 28 (2006)

S. C. Gandhi *et al.*, *The ascending double cone: a closer look at a familiar demonstration* Eur. J. Phys. **26**, 681 (2005)

SELECTED SUPPORT

NSF 0963146 · I3 STEM integration · co-PI; award May 2010-Apr 2016.

NSF 0633157 · RealTime Physics Labs · PI; award Jul 2007-Oct 2009.

NSF 0649159 · REU in differential equations · PI; award Jun 2007-Sep 2009.

Debashis Chanda

Nano-Optics Group

Trustee Chair Professor

PhD University of Toronto · 2008



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Office: NSTC 417

Group website

Faculty profile

Debashis Chanda's Nano-Optics Group designs structures that control light at dimensions below its wavelength. The group combines nanofabrication, optical measurements and device development to create structural color, infrared detectors and chemical or biological sensors. Metallic nanostructures can select and concentrate particular wavelengths, linking geometry to a material's visible appearance and sensing response. Recent demonstrations include ultralight structural-color paint and plasmonic biosensors. Students work across optics, materials and engineering to turn a physical mechanism into a functioning device.

RESEARCH TOOLKIT Nanofabrication · Plasmonics and metasurfaces · Optical characterization



Light-matter interactions for sensing, detection and imaging

Plasmonic structural-color paint on metal butterflies (left), near-field optical probing of a nanostructured surface (top right) and an infrared focal-plane-array imaging module (bottom right).

Chanda group, UCF.

SELECTED PAPERS

M. Karmakar *et al.*, *Selective Ultrafast Excitation and Dephasing of Gap Plasmons into Hot Carriers in Structural Color Generation* ACS Nano (2026)

A. Biswas *et al.*, *Dynamic control of phase for tunable structural colors* Proc. Natl. Acad. Sci. U.S.A. **122**, e2520990122 (2025)

A. Biswas *et al.*, *Multispectral Molecular Chiral Barcoding* Adv. Mater. **36**, 2409565 (2024)

A. Biswas *et al.*, *Nanoplasmonic aptasensor for sensitive, selective, and real-time detection of dopamine from unprocessed whole blood* Sci. Adv. **10**, eadp7460 (2024)

P. Cencillo-Abad *et al.*, *Ultralight plasmonic structural color paint* Sci. Adv. **9**, eadf7207 (2023)

SELECTED SUPPORT

ARO · PI: Jul 2026-Jun 2029.

NSF 2015722 · PI: May 2020-Aug 2025.

NSF 1808045 · PI: Aug 2018-Jul 2024.

NSF 1920840 · PI: Jul 2019-Jun 2024.

DARPA · PI: Oct 2021-Sep 2024.

Hanieh Fattahi

Femtosecond fieldoscopy and ultrafast photonics

Incoming Associate Professor · CREOL & Physics · Anticipated start: January 2027

PhD Ludwig Maximilian University of Munich · 2015



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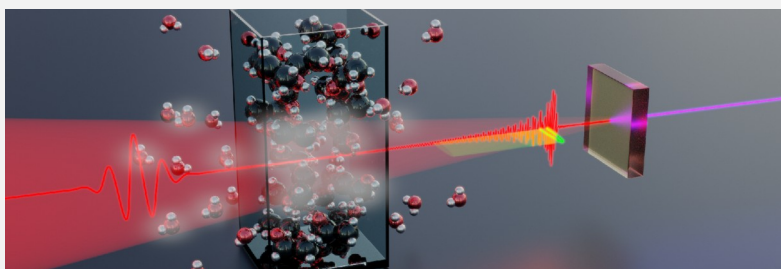
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Group website

Max Planck profile

Hanieh Fattahi develops ultrafast light sources and fieldoscopy: techniques that trace the electric-field oscillations of light as it interacts with matter. Her group uses these measurements to reveal molecular responses in liquids and the rapid optical behavior of nanomaterials. Projects connect laser physics with label-free spectroscopy, imaging and new approaches to generating light. Students encounter the full experimental chain, from building and stabilizing light sources to extracting a material's response from a measured waveform.

RESEARCH TOOLKIT Ultrafast laser development · Electric-field sampling · Coherent spectroscopy



Reading the light from molecules

An ultrashort pulse excites molecular vibrations in a liquid. A second pulse samples the emitted field in a crystal, resolving the molecules' optical fingerprint.

Illustration © Florian Sterl / MPL (2024).

SELECTED PAPERS

- A. Srivastava *et al.*, *Near-petahertz fieldoscopy of liquid* Nat. Photonics **18**, 1320 (2024)
- S. Jun *et al.*, *Nonlinear dynamics of femtosecond laser interaction with the central nervous system in zebrafish* Commun. Phys. **7**, 161 (2024)
- C. Li *et al.*, *Generating quantum entanglement from sunlight* Optica **13**, 1508 (2026)
- A. Herbst *et al.*, *Ultrafast Nonlinear Dynamics of Indium Tin Oxide Nanocrystals Probed via Fieldoscopy* Adv. Sci. **13**, e16818 (2026)
- M. Küblböck *et al.*, *Solar lasers: Why not?* APL Photonics **9**, 050903 (2024)

SELECTED SUPPORT

ERC Consolidator Beyondvisible 101125670 · PI at MPL: Jan 2025-Dec 2029.
 EIC APACE 101161312 · MPL consortium research: Oct 2024-Sep 2028.
 UCF start-up funds · from January 2027; supports the group's laboratory and graduate students.

Arkadiy Lyakh

Quantum cascade lasers and infrared photonics

Professor

PhD University of Florida · 2007

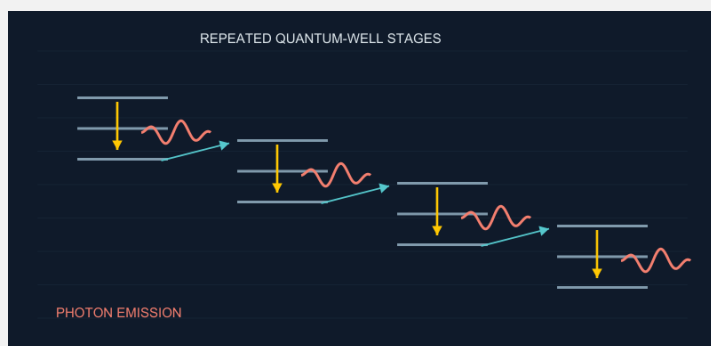


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Group website
Faculty profile

Arkadiy Lyakh develops quantum cascade lasers and related infrared photonic devices. These semiconductor lasers use engineered sequences of quantum wells to generate light as electrons move through repeated active regions. His group studies device designs, fabrication and characterization aimed at controlling wavelength, efficiency, output power and beam quality. Research includes integration with silicon and compact sources for spectroscopy and sensing. Students connect quantum transport and optical design with the practical challenges of building reliable semiconductor laser systems.

RESEARCH TOOLKIT Semiconductor heterostructures · Device fabrication · Infrared spectroscopy



A staircase that produces infrared light

Electrons descend through a sequence of engineered quantum wells, emitting photons at successive stages of a quantum cascade laser.

SELECTED PAPERS

- E. Cristobal *et al.*, *High-performance mid-infrared InP-based quantum cascade lasers monolithically integrated onto silicon* AIP Adv. **16**, 095104 (2026)
- A. Villalobos Meza *et al.*, *Cathodoluminescence-integrated electron microscopy for failure analysis of long-wave ridge waveguide quantum cascade lasers* Appl. Phys. Lett. **127**, 203301 (2025)
- L. Milbocker *et al.*, *Design of High Brightness Tree-Array Quantum Cascade Lasers With Broad Area Ridge Waveguides and Multimode Interference Couplers* IEEE J. Sel. Top. Quantum Electron. **31**, 1 (2025)
- E. S. Cristobal *et al.*, *Epitaxial-Material Characterization Data for InP-Based Quantum Cascade Lasers Grown on Silicon Substrate* IEEE J. Sel. Top. Quantum Electron. **31**, 1 (2025)
- A. M. Villalobos Meza *et al.*, *Electron microscopy study of thermal stress-induced damage in long-wave quantum cascade lasers* Appl. Phys. Lett. **125**, 221103 (2024)

SELECTED SUPPORT

AFOSR FA95501910107 · research support acknowledged: Apr 2019-Sep 2022.
ONR N000141912489 · research support acknowledged: Jun 2019-Apr 2024.
NAVAIR N6893621C0015 · collaboration; award to IRGLARE: Mar 2021-Mar 2026.

More faculty to work with

These nine faculty hold secondary joint appointments in Physics. Based at CREOL, the Florida Space Institute, the NanoScience Technology Center, Materials Science and Engineering and the Department of Mathematics, they supervise Physics PhD students and can serve as your advisor. Names and portraits link to their faculty pages.



Julie Brisset

Dust, planet formation and small-body surfaces

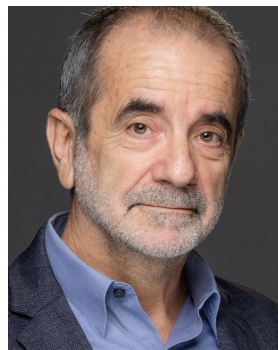
Florida Space Institute



Peter Delyett

Semiconductor lasers and optical frequency combs

CREOL · Optics and Photonics



Aristide Dogariu

Statistical optics and light in complex media

CREOL · Optics and Photonics



Sidong Lei

Two-dimensional materials and semiconductor interfaces

Materials Science and Engineering



Phillip Metzger

Regolith physics and planetary surface technology

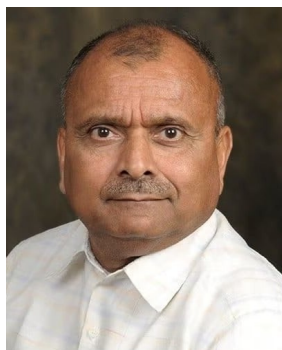
Florida Space Institute



Martin Richardson

Ultrafast lasers, filamentation and laser plasmas

CREOL · Optics and Photonics



Bhimsen Shivamoggi

Fluids, plasmas and nonlinear dynamics

Mathematics



Jayan Thomas

Nanomaterials for energy storage and photonics

NanoScience Technology Center



Konstantin Vodopyanov

Mid-infrared frequency combs and spectroscopy

CREOL · Optics and Photonics

Orlando, the City Beautiful



A spring concert at the Walt Disney Amphitheater, Lake Eola Park. Photo: N. Caetano Salmeron, CC BY 4.0.

A PhD unfolds over years, and where you spend them matters. Orlando is a young, international city of lakes and oak-lined neighborhoods, with a serious cultural calendar and an economy that keeps drawing people from every continent.

2.96 million

people call the Orlando metro home, the fastest-growing large metropolitan area in the United States (US Census, 2024–25).

3,100 hours

of sunshine a year, with January highs near 71 °F / 22 °C. Winter here is the season everyone back home will envy.

MCO + Brightline

Florida's busiest airport flies nonstop to Europe and Latin America, and Brightline trains link Orlando to Miami.

Two downtowns, a world next door



Grand lobby of the Dr. Phillips Center. Photo: Farragutful, CC BY-SA 4.0.

Culture, any night

The Dr. Phillips Center hosts Broadway seasons, Opera Orlando, the Orlando Ballet and the Philharmonic. The Morse Museum keeps the world's finest Tiffany glass collection a few blocks from Rollins, the Orlando Museum of Art and the Orlando Science Center anchor Loch Haven Park, and the county's libraries are genuinely superb.



Rollins College, Winter Park. Photo: Rizka, CC BY-SA 4.0.

Neighborhoods

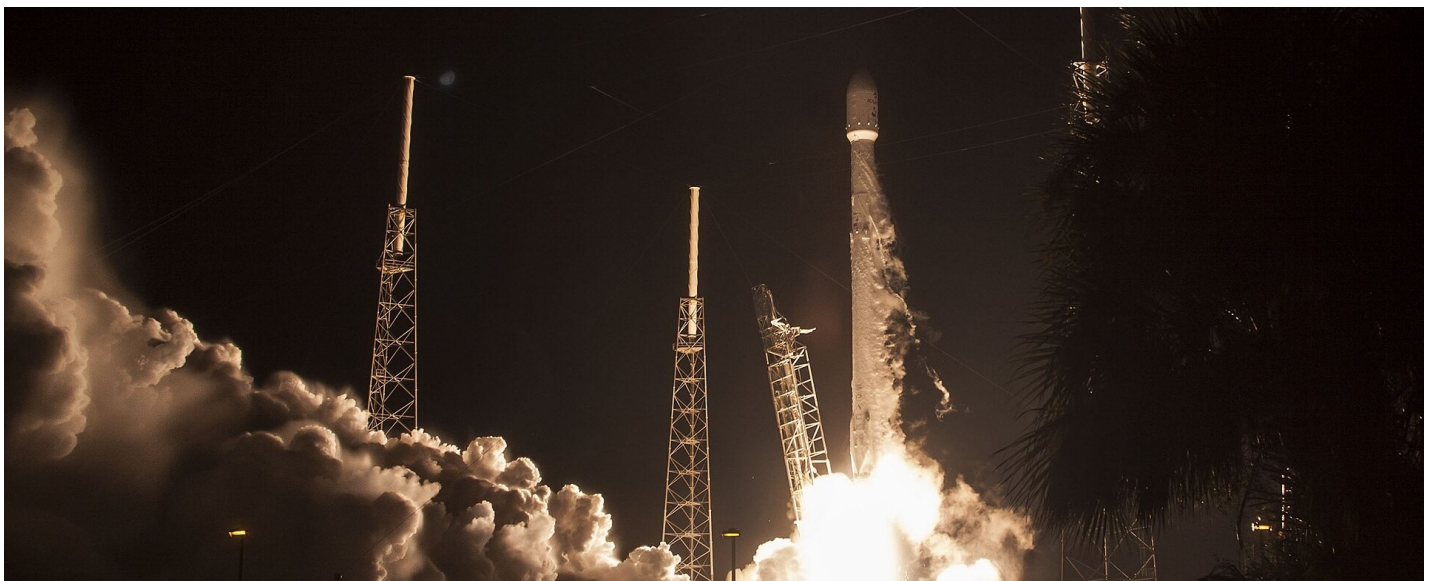
Downtown Orlando wraps around Lake Eola: restaurants and rooftop bars, Sunday markets, Magic basketball and Orlando City soccer a short walk apart. Ten minutes away, Winter Park's oak-shaded Park Avenue lines up cafés, galleries and bookshops, with the pho counters and craft breweries of Mills 50 in between.



Swans on Lake Eola. Photo: LeonidasB, CC BY-SA 4.0.

The world next door

Walt Disney World, Universal's Epic Universe and SeaWorld are your visitors' first request, and your occasional Saturday. Rockets rise from Cape Canaveral most weeks, visible from town. Beaches on both coasts are under an hour away, and Kennedy Space Center makes any launch day unforgettable.

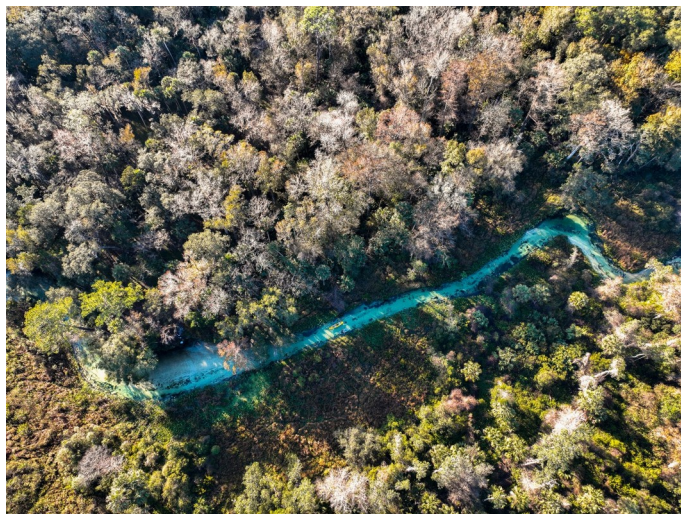


A Falcon 9 climbs out of Cape Canaveral, an hour east of campus. Photo: SpaceX.

Springs, forests and the Atlantic



Dunes meet the Atlantic at Canaveral National Seashore. Photo: NPS / Lord.



Rock Springs Run. Photo: Get Up and Go Kayaking, via Visit Orlando.

Clear water, green trails

Paddle the Wekiva River, swim at Wekiwa Springs, or follow forest trails where white-tailed deer may appear. On campus, the Arboretum brings nature into an ordinary afternoon.



Reddish egret, Merritt Island National Wildlife Refuge. Photo: James Lyon / USFWS.

A landscape alive with birds

Coastal wetlands shelter ibises, herons and sandhill cranes; peregrine falcons pass through seasonally. At Canaveral, dunes, ocean and lagoon make a day outside feel expansive.

A university built for discovery



UCF's main campus: laboratories, lakes and green spaces. Photo: UCF.

Physics sits at the heart of a university with a technological vocation. Founded in 1963 as Florida Technological University to supply scientists and engineers to the space program, UCF has grown into one of the largest research universities in the country without losing that founding purpose.

Scale and ambition

UCF enrolled 70,674 students in fall 2025, the largest enrollment in Florida and among the largest in the nation, and awards more degrees each year than any other Florida university. It is a Carnegie R1 research university, a classification held by about 2.5 percent of U.S. institutions.

Research with momentum

UCF researchers received \$237.4 million in funded research in fiscal year 2025, across the sciences, engineering, medicine and simulation. For a physics student that means a campus where instrumentation, computing and partnerships are built at scale, and where fundamental science meets invention every day.

A place to spend your PhD

UCF's main campus combines a large research university with lakes, shaded walks and natural lands. The Arboretum's trails provide an everyday connection to Florida's landscape, while metropolitan Orlando supplies the cultural life of a growing city.

Sources: UCF Facts 2025–26 (ucf.edu/about-ucf/facts); Carnegie Classification of Institutions of Higher Education.

Science in a region that builds

Space systems. Energy. Photonics. Semiconductors. Simulation.



Crew-7 on Launch Complex 39A, Kennedy Space Center, 2023. Photo: NASA.

Built for the space age

UCF opened in 1968 to supply the space program at Kennedy Space Center, an hour east of campus. The connection endures: Kennedy and Cape Canaveral Space Force Station form one of the busiest launch sites in the world, and launches are a routine sight from Orlando. The aerospace companies of the Space Coast are a short drive away.

Explore the region's technical landscape

Aerospace and defense

Lockheed Martin, Northrop Grumman and L3Harris anchor a Central Florida and Space Coast cluster working on sensing, communications, spacecraft and complex systems.

Chips, optics and photonics

NeoCity's semiconductor community includes imec and SkyWater. LightPath Technologies adds an Orlando base for infrared optics, imaging and advanced optical manufacturing.

Energy and infrastructure

Siemens Energy and Mitsubishi Power Americas connect the Orlando region with power generation, turbines, energy conversion and the changing electric grid.

Computation and finance

BNY and Charles Schwab have substantial regional operations. Alongside simulation and digital-technology companies, they broaden the local landscape for quantitative and computational careers.

Physics travels well. Modeling, measurement, coding and the ability to solve unfamiliar problems are skills that connect doctoral research with many technical fields. Use faculty conversations to explore specific collaborations and career paths.

Apply to UCF Physics

Admission considers your preparation, past work, recommendations, research fit and available funding. Use your application to show how you are ready to develop as a physicist.

FALL PRIORITY DEADLINES

December 1

International applicants and Planetary Sciences

January 15

Other domestic Physics applicants

Apply by your priority deadline for fellowship consideration. Check dates for your entry term.

Prepare your application

1. Complete UCF's online application.
2. Upload your CV and statement of purpose.
3. Arrange three recommendation letters.
4. Arrange for each college or university attended to send official transcripts directly to UCF.
5. Supply English-proficiency evidence and international documents when required.

Your CV. Include education, research projects, relevant skills, presentations, publications and honors. Make your own contributions clear.

The GRE is not required, and the Physics GRE is optional. No cover letter is needed; your statement of purpose serves that role.

Make the scientific case

Statement of purpose. Explain what you want to investigate and how your preparation has led you there. Use the final one or two paragraphs to identify UCF research areas and faculty whose work fits your interests.

Research experience. Describe the question, your own contribution, the methods you used, a challenge you addressed and what you learned. Include relevant projects even if they have not produced a paper.

Recommendations. Choose people who know your work. Give them several weeks, your CV and a summary of your research interests.

Put your transcript in context. Show your preparation in mechanics, electromagnetism, quantum and statistical physics. If a core grade needs explanation, give brief relevant context and evidence of subsequent mastery, such as advanced coursework or research. Ask referees who know your work to assess your readiness.



Get program information

Scan UCF's request form and select Physics (PhD).



Physics open house

Virtual Open House, November 3, 2026, 2:30–4:30 PM EST. Scan to register.

Start your application · Admissions guidance · Graduate events

Graduate Admissions Coordinator II: Esperanza Soto · soto@ucf.edu · 407-823-5146