We seek to facilitate undergraduates with a physics interest to obtain research positions, and to facilitate faculty in their search for capable undergraduate researchers. Faculty with primary and secondary appointments are invited.

Please RSVP by Tuesday, November 5th if you plan to attend.

Hosts: Simon Mochrie (DUS) & Karsten Heeger (Department Chair)

Light refreshments will be served

Sponsored by the Department of Physics, Yale Society of Physics Students, and Yale Women in Physics
# Undergraduate Research Fair 2019

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Sean Barrett

**Contact:** Sean Barrett ([sean.barrett@yale.edu](mailto:sean.barrett@yale.edu))

**URL:** [https://opnmr.physics.yale.edu/](https://opnmr.physics.yale.edu/)

**Research Area:** Condensed Matter Experiment, Quantum Info, Biophysics

**Research Description:** Basic Areas of Interest: Condensed Matter Experiment, Quantum Control, Biophysics, Novel Forms of Image Processing, Developing Novel Equipment

Current and/or Imminent Research Projects:

1. Experimental probes of Time Crystal Physics
2. Using a novel form of MRI to create higher resolution images of a broader range of samples in less time.
3. Developing new forms of control for interacting quantum spin systems.
4. Developing new approaches to get better spectra/images in less time.
Helen Caines

Contact: Helen Caines (helen.caines@yale.edu)

URL: https://rhig.physics.yale.edu/

Research Area: Nuclear Experiment

Research Description: Relativistic heavy ion physics is of international and interdisciplinary interest to nuclear physics, particle physics, astrophysics, condensed matter physics and cosmology. The primary goal of this field of research is to recreate in the laboratory a new state of matter, the quark-gluon plasma (QGP), which is predicted by the Standard Model of particle physics (Quantum Chromodynamics) to have existed ten millionths of a second after the Big Bang (origin of the Universe) and may exist in the cores of very dense stars.

The research activities of the Relativistic Heavy Ion Group at Yale are centered at Yale, but involve experimental research on the STAR experiment at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) on Long Island, New York, and on the ALICE experiment with heavy ions at the Large Hadron Collider (LHC) located at the Center for European Nuclear Research (CERN) in Geneva, Switzerland. Both experiments seek to form and investigate hot, dense QCD matter (the QGP) at several trillion degrees absolute temperature (Kelvin).
Damon Clark

**Contact:** Damon Clark ([damon.clark@yale.edu](mailto:damon.clark@yale.edu))

**URL:** [https://clarklab.yale.edu/](https://clarklab.yale.edu/)

**Research Area:** Neuroscience and computational neuroscience

**Research Description:** We want to understand how a small neural circuit performs basic computations to guide behavior. We perform experiments to test models of neural function, and use models to understand how processing in the brain relates to natural inputs and to natural behavior.

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Sarah Demers

**Contact:** Sarah Demers ([sarah.demers@yale.edu](mailto:sarah.demers@yale.edu))

**URL:** [https://demerslab.yale.edu/](https://demerslab.yale.edu/)

**Research Area:** High Energy Particle Physics

**Research Description:** We study the Higgs boson using data from the ATLAS Experiment and CERN's Large Hadron Collider and use the Mu2e experiment at Fermilab to search for rare decays of the muon, which would be a sign of
physics beyond the standard model. (I am looking for undergraduate researchers on Mu2e right now.)

George Fleming

Contact: George Fleming (George.fleming@yale.edu)

URL: http://lsd.physics.yale.edu

Research Area: Theoretical Particle Physics

Research Description: Studying composite mechanisms of physics beyond the standard model arising from strongly-coupled quantum field theories, including composite Higgs bosons, composite dark matter, and early universe stochastic gravitational radiation arising from confining phase transitions which generate composites. Also, development of methods for calculations in strongly-coupled field theories in curved spacetimes, leading to important connections to conformal field theories.
Steve Konezny

Contact: Steve Konezny (steven.konezny@yale.edu)

URL: https://konezny.sites.yale.edu/

Research Area: Materials for solar energy conversion applications

Research Description: We use theoretical, experimental, and computational methods to study the mechanisms of charge transport and structure-electronic property relationships in materials that are the backbone of many renewable energy strategies such as solar cells, batteries, and fuel cells. These studies inform the design of materials and devices with optimal performance and energy conversion efficiency. By combining low-temperature high-sensitivity electrical measurements with computational modeling and theory, our work is focused on the characterization and mechanistic studies of electron transport in important materials for energy applications.

Open Projects: I have 4 research projects that are focused on fabrication, measurement, and/or theory, depending on student interest and experience:

Device Design and Characterization for Energy-Related Materials
This project involves studying charge transport in materials for solar energy conversion using various device architectures and methods. The student will learn thin-film fabrication and microscopy characterization methods, how to design and deposit electrodes, and useful techniques in the west campus clean room such as photolithography and optical profilometry.

Theory of Charge Transport in Nanostructured Materials
Studying charge transport is important from a fundamental physics perspective, but also can provide guidance for material design. This project involves studying the mechanisms of charge transport important to nanostructured materials used for solar energy conversion. The student will learn how to apply these models to temperature-dependent electrical data. Programming experience recommended.
Temperature-Dependent Charge Transport Measurements in Energy Materials

Our lab on west campus has a cryostat capable of accessing temperatures between ~7 and 315 K. By measuring the conductivity of materials in this range, one can decipher the mechanism of charge transport and learn valuable information about improving device performance. Because important materials for energy applications are often highly porous by design for achieving high surface area, conductivities are often very low. The cryostat is therefore equipped with highly sensitive electrical equipment capable of measuring currents on the order of femtoamps. This project is a study of charge transport as a function of temperature under various light and ambient gas conditions. Prior experience in LabView and Python would be helpful, though experience can be swapped for an interest to learn.

Impedance Spectroscopy for Studying Materials for Energy Applications

Studying the resistance and capacitance properties of a material upon application of an ac signal can potentially provide much more information than dc methods. These data can be fit with an equivalent circuit model, each component of which corresponding to a particular physical process in the device. This project is an application of this powerful method, which allows complicated systems such as thin-film devices or electrochemical cells to be studied systematically. Some programming experience will be useful.

Shelly Lesher

Contact: Shelly Lesher (shelly.lesher@yale.edu)
URL: https://www.uwlax.edu/profile/slesher/
Research Area: nuclear structure
Research Description: Using experimental methods to study rotations and vibrations in nuclei
Transfer Reactions on Rare-Earth Nuclei
Analyze a dataset from an accelerator experiment and learn about low-energy nuclear structure and transfer reactions. Datasets include 174,176Yb(p,t),
162Dy(p,t) and 180Hf(p,t). You will need to know or learn how to program in root1, be self-motivated, and willing to learn. Knowledge of computer languages (C++, Python or R) is a plus. This analysis will be published in a peer-review journal.

Reina Maruyama

Contact: Reina Maruyama (reina.maruyama@yale.edu)

URL: https://maruyama-lab.yale.edu

Research Area: Experiments in Neutrinos and Dark Matter

Research Description: We are looking for/studying the identity of dark matter and neutrinos. Keywords: WIMPs, Axions, Quantum Computing-inspired detectors, neutrinoless double beta decay, lepton number violation, lasers, particle physics, nuclear physics, atomic physics, inclusivity and diversity of ideas and people.
David Moore

Contact: David Moore (david.c.moore@yale.edu)

URL: http://campuspress.yale.edu/moorelab/

Research Area: Nuclear, Particle, AMO

Research Description: Neutrino physics, precision tests of the Standard Model

Nir Navon

Contact: Nir Navon (nir.navon@yale.edu)

URL: https://uqm.yale.edu/

Research Area: Ultracold matter, quantum many-body physics, quantum simulation

Research Description: Using ultracold atoms to study collective quantum phenomena and strongly correlated phases of matter

Open Projects: See attached flyer
Laura Newburgh

**Contact:** Laura Newburgh ([laura.newburgh@yale.edu](mailto:laura.newburgh@yale.edu))

**URL:** [http://campuspress.yale.edu/newburgh/](http://campuspress.yale.edu/newburgh/)

**Research Area:** Experimental Cosmology

**Research Description:** I work on radio and millimeter telescopes to study Dark Energy, inflation, and particles

Corey O’Hern

**Contact:** Corey O’Hern ([corey.ohern@yale.edu](mailto:corey.ohern@yale.edu))

**URL:** [https://jamming.research.yale.edu](https://jamming.research.yale.edu)

**Research Area:** Theoretical and Computational Studies of Soft and Biological Materials

**Research Description:** The O’Hern group tackles a broad range of fundamental questions in soft matter and biological physics using a combination of theoretical and computational techniques. In soft matter, the group seeks a predictive understanding of glass and jamming transitions, in which materials such as granular
media, dense colloidal systems, and foams, develop solid-like properties in the absence of crystallization over a narrow range of control parameters. In the area of biological physics, the O'Hern group is interested in the dynamics of protein folding, unfolding, and aggregation, the organization and dynamics of DNA, and the structural and mechanical properties of cells and tissues.

Alison Sweeney

**Contact:** Alison Sweeney ([alison.sweeney@yale.edu](mailto:alison.sweeney@yale.edu))

**URL:** [https://physics.yale.edu/people/alison-sweeney](https://physics.yale.edu/people/alison-sweeney)

**Research Area:** biological physics

**Research Description:** biological self-assembly
Research Opportunities

Within Yale

- Yale Science & Quantitative Reasoning Opportunities Page
- Yale College Dean’s Research Fellowship & Rosenfeld Science Scholars Program
- Yale College First-Year Summer Research Fellowship in the Sciences & Engineering
- Yale Science & Quantitative Reasoning: STARS
- Yale Science & Quantitative Reasoning: Tetelman Fellowship

Outside Opportunities

- CMS Summer Research Experience in Germany at the University of Hamburg
- Perimeter Institute for Theoretical Physics Undergraduate Theoretical Physics Summer Program.
## Appendix

### Research Areas in Physics

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<th>Name</th>
<th>Rank</th>
<th>Astro</th>
<th>JAMO</th>
<th>Biophysics</th>
<th>Condensed Matter</th>
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<th>Gravitation</th>
<th>Nuclear Experiment</th>
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Associated Centers and Departments

The Yale Physics Department fosters cross-disciplinary research collaborations worldwide and across Yale University:

Yale Physics in on-campus centers, programs and institutes:

- [Center for Research on Interface Structures and Phenomena (CRISP)](http://www.yale.edu/crisp)
- [Integrated Program in Physical and Engineering Biology (PEB)](http://www.yale.edu/peb)
- [Program in Solar and Terrestrial Physics](http://www.yale.edu/solar)
- [Yale Center for Astronomy & Astrophysics (YCAA)](http://www.yale.edu/yCAA)
- [Yale Center for Quantum Information Physics (CQuIP)](http://www.yale.edu/cquip)
- [Yale Center for Microelectronic Materials and Structures](http://www.yale.edu/mems)
- [Yale Institute for Nanoscience and Quantum Engineering (YINQE)](http://www.yale.edu/yinqe)
- [Yale Quantum Institute](http://www.yale.edu/yqin)
• Yale Wright Laboratory

Affiliated departments and schools

• Astronomy
• Applied Physics
• Chemistry
• Computer Science
• Geology & Geophysics
• Mathematics
• Mechanical Engineering
• Molecular Biophysics & Biochemistry
• Molecular, Cellular, and Developmental Biology
• Neuroscience
• School of Engineering

For further information on research in the physics department please see https://physics.yale.edu/research