2023 Undergraduate Research Fair

Friday, November 10, 2023, at 3:30 pm
in SPL 3rd Floor Lounge

Hosted by the Department of Physics, the Yale Society of Physics Students, and Women in Physics

Keith Baker

Department of Physics

Contact: Keith Baker (oliver.baker@yale.edu)

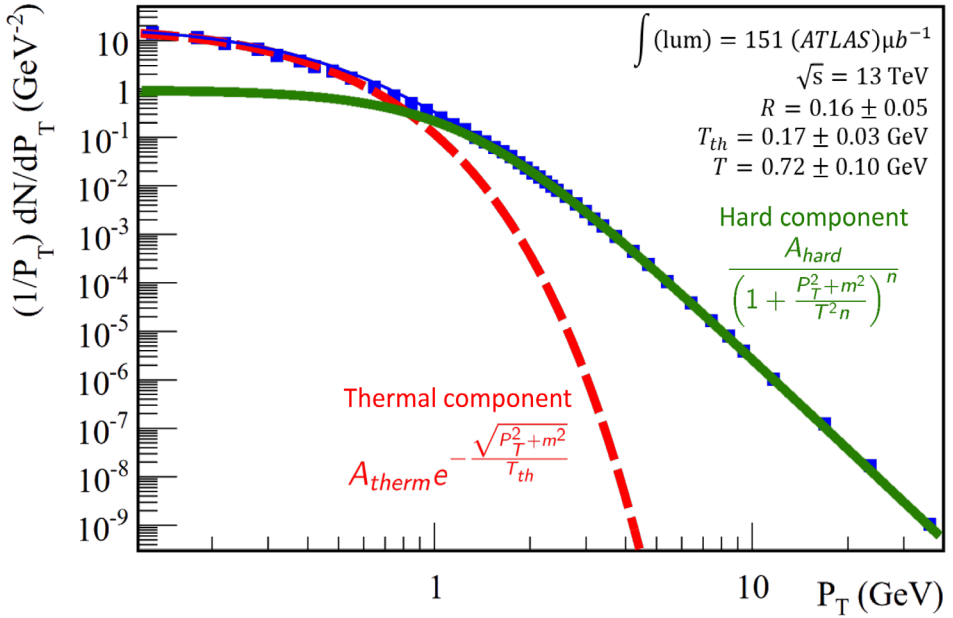
Website: https://hep.yale.edu/people/faculty/oliver-k-baker

In-lab and remote opportunities

Quantum Information Science in High Energy Physics. Evidence for Quantum Entanglement, Entanglement Entropy, and Bell's Inequality at high energies, and vector boson masses at tens of GeV. Previous research: Axions, Dark Photons, Nuclear Physics.

Experimental Particle Physics

Example: charged hadrons



Claim: nonzero thermal component corresponds to probe of sub-region

O. K. Baker and D. E. Kharzeev, Phys. Rev. D98, 054007(2018), arXiv:1712.04558 [hep-ph]

Sean Barrett

Department of Physics

Contact: Sean Barrett (sean.barrett@yale.edu)

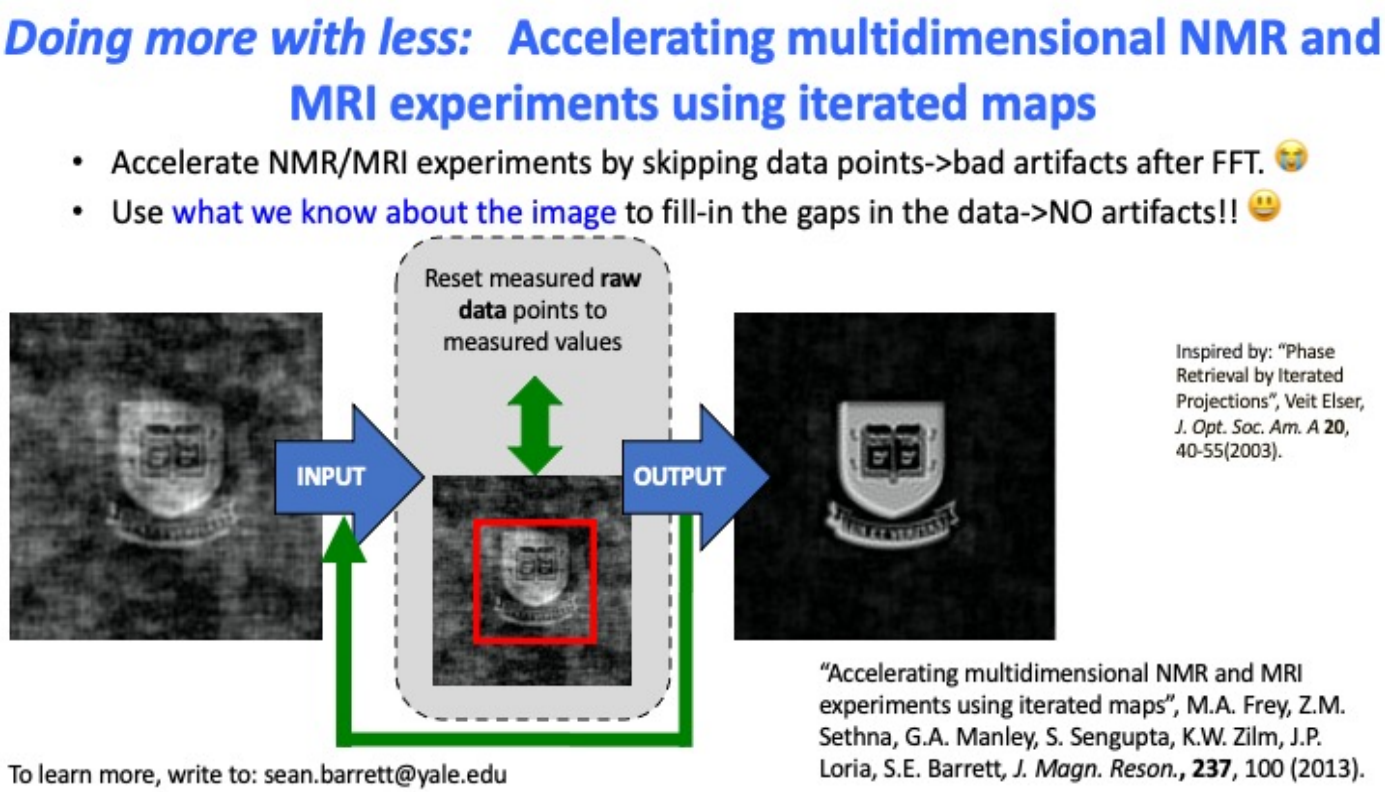
Website: https://opnmr.physics.yale.edu/

Remote opportunity

Doing more with less: Accelerating multidimensional NMR and MRI experiments using iterated maps.

Research Areas: Biophysics; Experimental Condensed Matter Physics; Quantum Physics

Normally, NMR (or MRI) experiments take raw s(t) data on a regular grid. This raw data is converted to a spectrum (or image) of the form S(f) using the fast Fourier transform. If you try to speed up the slow experiments by skipping points, this leads to bad artifacts in the final S(f)...normally. For the past decade, my students and I have found ways to get around this problem in NMR and MRI, applying an 'iterated maps' algorithm developed by Veit Elser (Cornell Physics). We are interested in extending this work to 3D NMR data sets of interest to our colleagues in Chemistry (e.g., in the Zilm and Loria groups), and beyond.



Helen Caines

Department of Physics

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

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

In-lab opportunity

Working with group members on hands-on detector development for the future Electron-Ion collider that will soon be constructed at Brookhaven National Laboratory.

Experimental Nuclear Physics

Helen Caines

Department of Physics

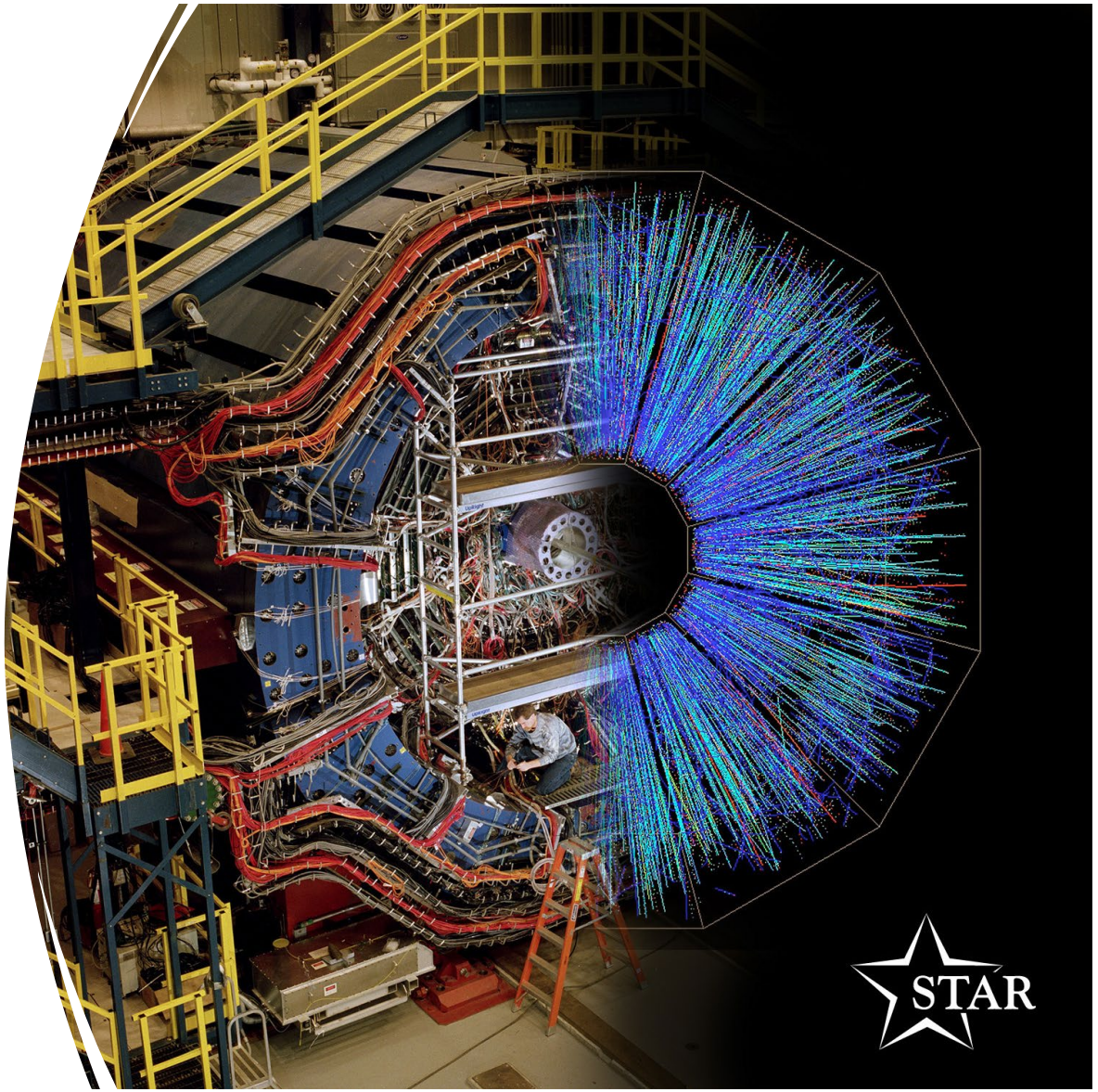
Contact: Helen Caines (helen.caines@yale.edu)

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

In-lab opportunity

Software analysis to help us understand the matter created when we collide Au and Pb nuclei at ultra-relativistic speeds. Either simulations or analyzing data taken at our experiments, STAR and ALICE.

Experimental Nuclear Physics



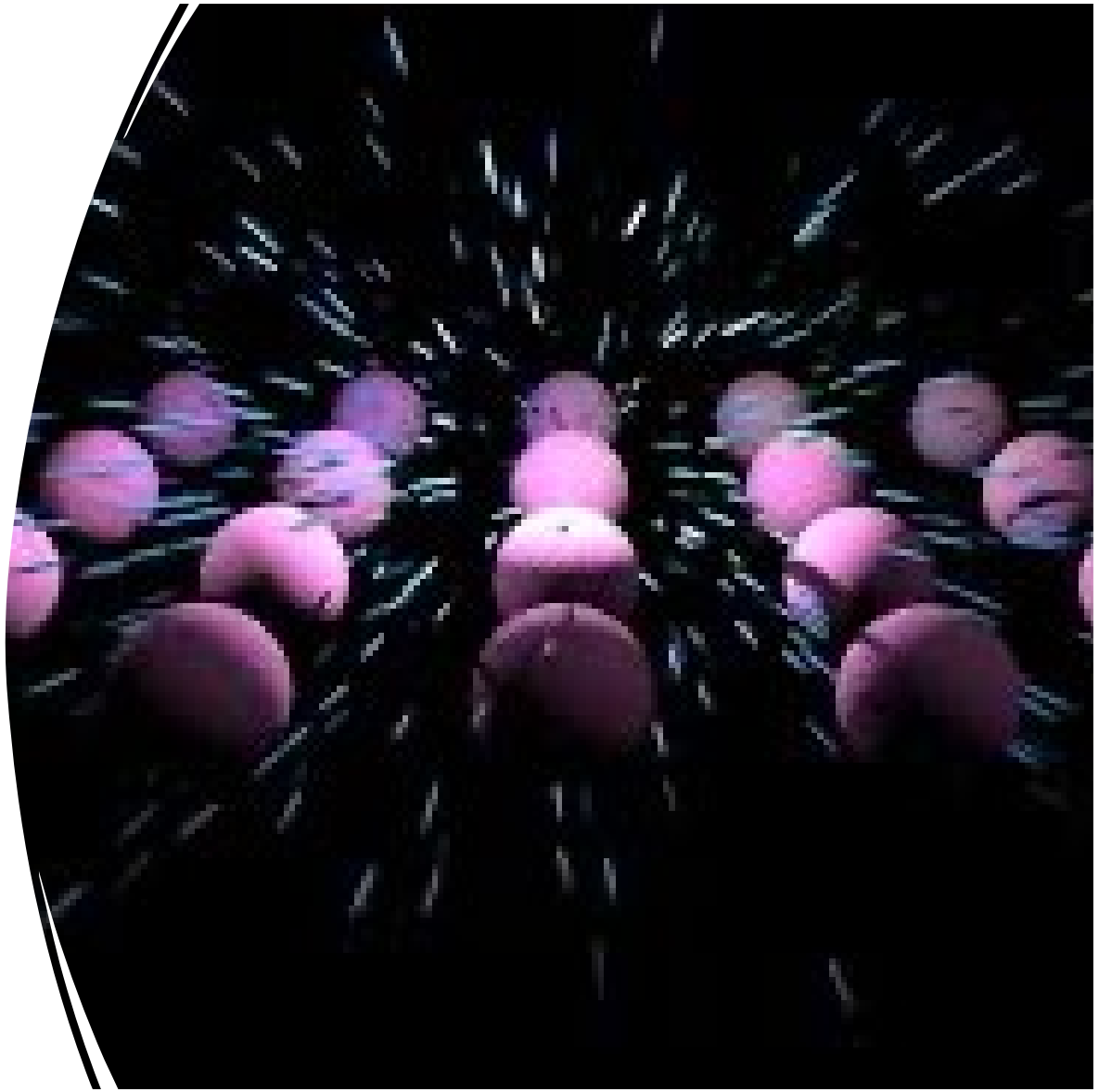
Meng Cheng

Department of Physics

Contact: Meng Cheng (m.cheng@yale.edu)

In-lab or Remote opportunity

Professor Meng Cheng's group in theoretical condensed matter physics studies quantum criticality, fractonic phases and symmetric topological. Students who are interested should reach out to Professor Cheng. Helpful backgrounds include quantum mechanics and statistical mechanics, so a project could be a good fit for an advanced undergraduate



Theoretical Condensed Matter Physics

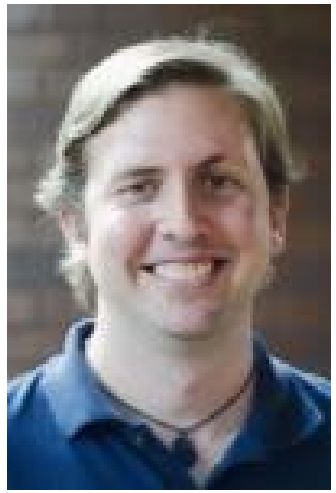
Damon Clark

Department of Molecular, Cellular and Developmental Biology

Contact: Joseph Shomar (joseph.shomar@yale.edu)

Website: http://clarklab.commons.yale.edu/

In-lab opportunity



Our lab aims to figure out how small networks of neurons perform basic computations, using the fruit fly visual system as a model. We have experimental projects measuring quantitative fly behavior and computational ones examining giant datasets and modeling neural networks.

Biophysics

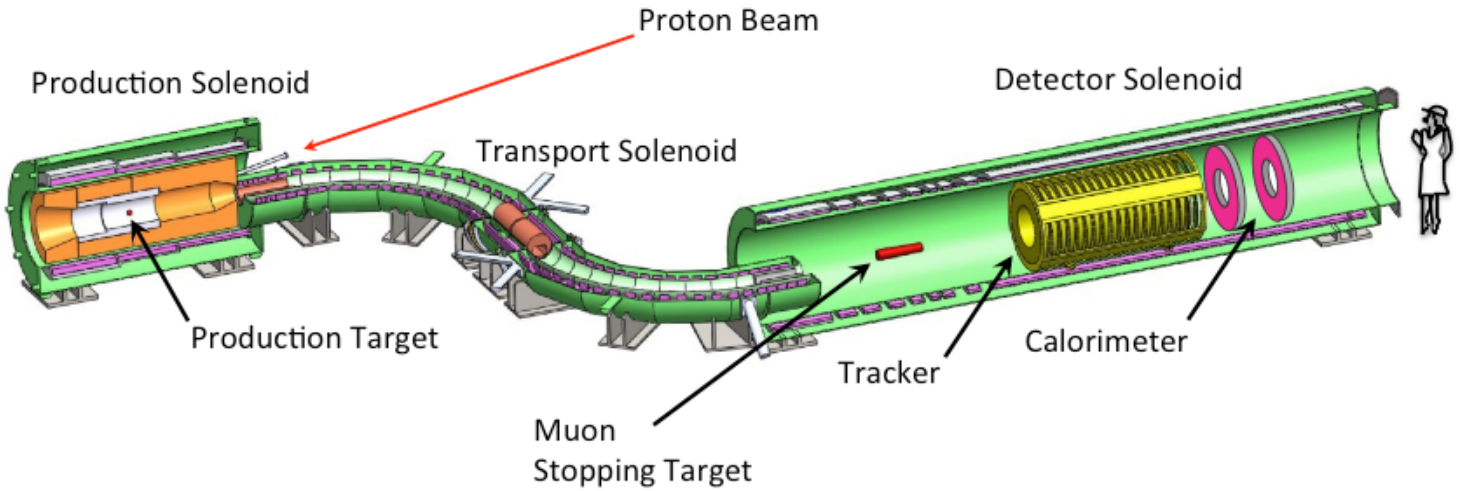
Sarah Demers

Department of Physics

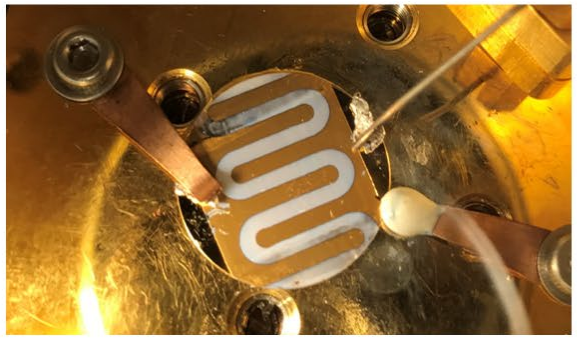
Contact: Sarah Demers (sarah.demers@yale.edu)

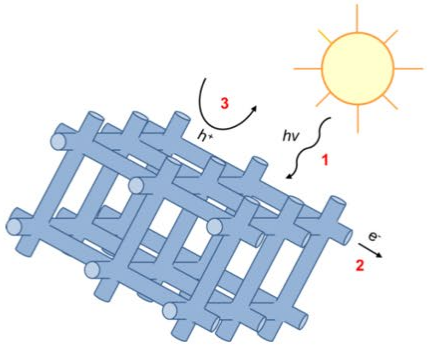
In-lab or Remote opportunity

The Mu2e experiment involves a search for lepton flavor violation through the conversion of a muon to an electron. This would be a clear signal of physics beyond the standard model. Located at Fermilab, outside of Chicago, the experiment is getting ready for an upcoming run in the next few years, so commissioning studies are well underway. The Demers group contributes to the "trigger" for the experiment, choosing the potentially interesting events that could contain the signal process.



Experimental Particle Physics





Steve Konezny

Department of Physics

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

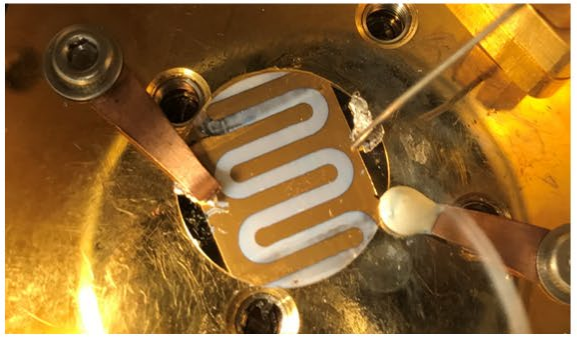
Website: https://konezny.sites.yale.edu/

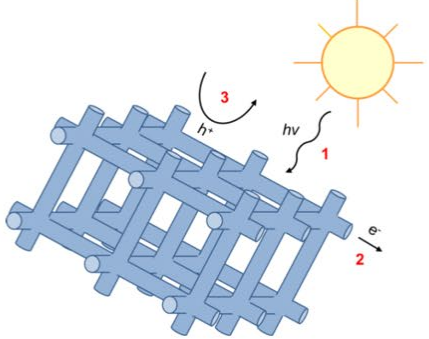
In-lab opportunities

Experimental Condensed Matter Physics

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.





Steve Konezny

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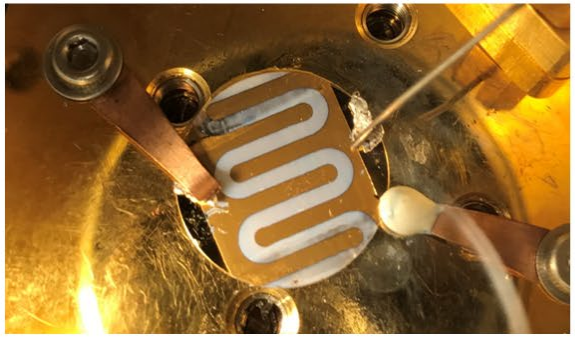
Website: https://konezny.sites.yale.edu/

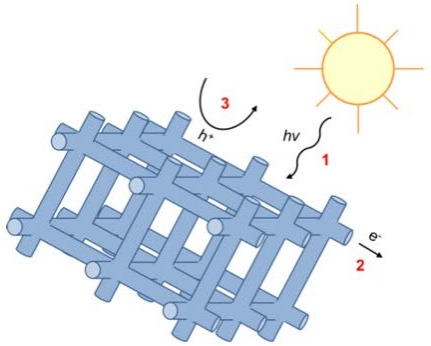
In-lab opportunities

Experimental Condensed Matter Physics

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.





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

In-lab opportunities

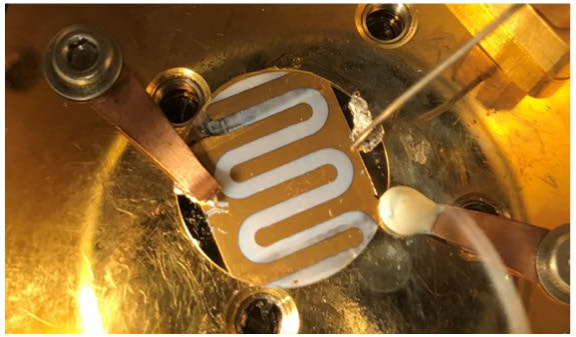
Temperature-Dependent Charge Transport Measurements in Energy Materials

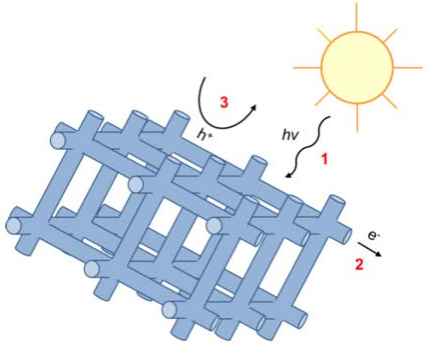
Experimental

Condensed Matter

Physics

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.





Steve Konezny

Department of Physics

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

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

In-lab opportunities

Experimental Condensed Matter Physics

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.

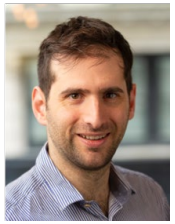
Ben Machta

Department of Physics

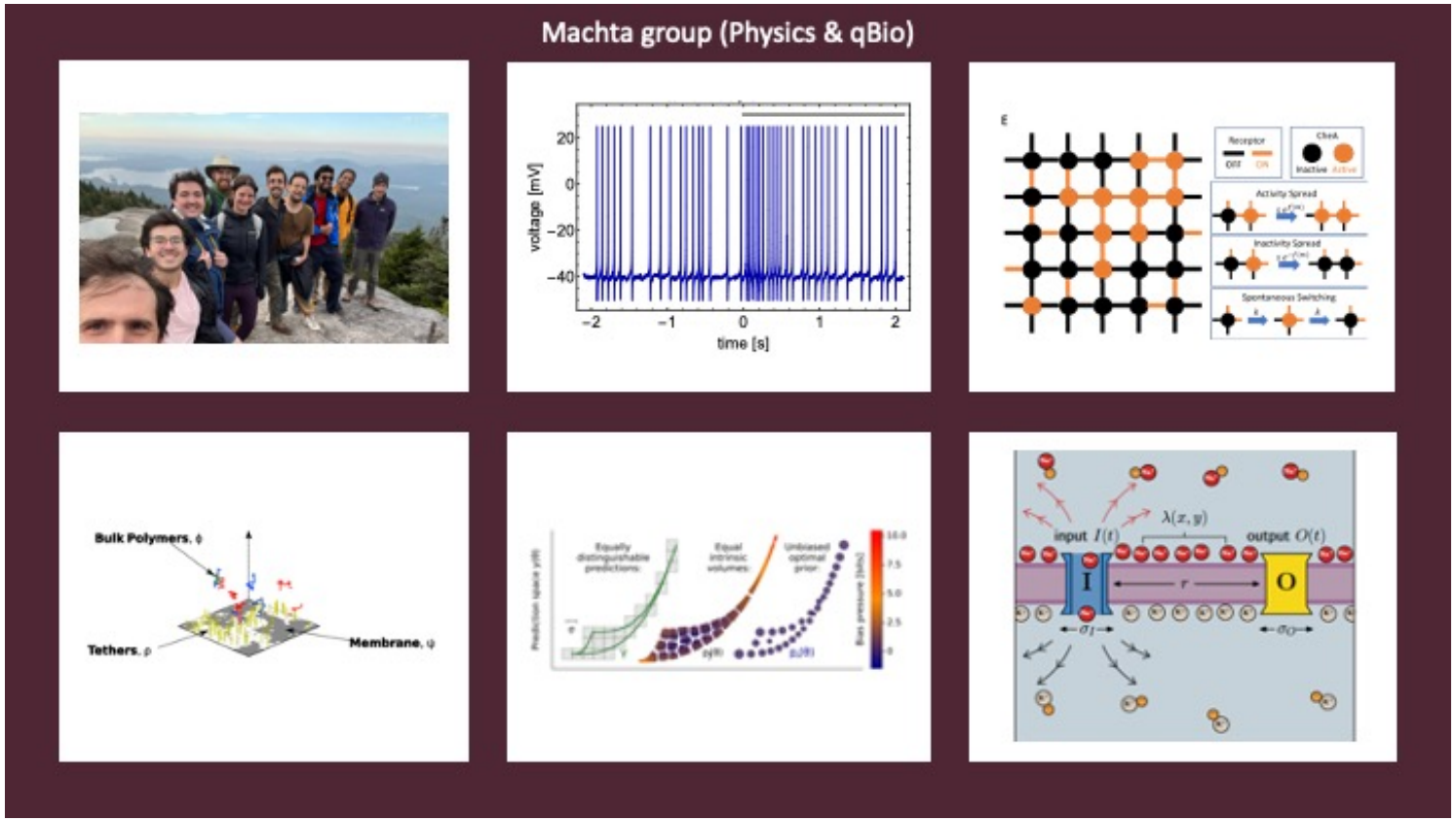
Contact: Michael Abbott (michael.abbott@yale.edu)

Website: https://machtagroup.yale.edu/

In Lab opportunities



Project Description: In the Machta group, we use tools from Statistical Physics, Nonlinear Dynamics, and Information Theory to understand how biological systems operate and what broad principles underlie their self-organization. We are particularly interested in questions of sensing and information integration (e.g., how can biological systems detect small changes in their environment?), structure and function of biological membranes (under what conditions do membranes phase separate and how could this be used for signaling?), and principles of sensory systems more broadly (how do symmetries affect optimal design?).



Biophysics

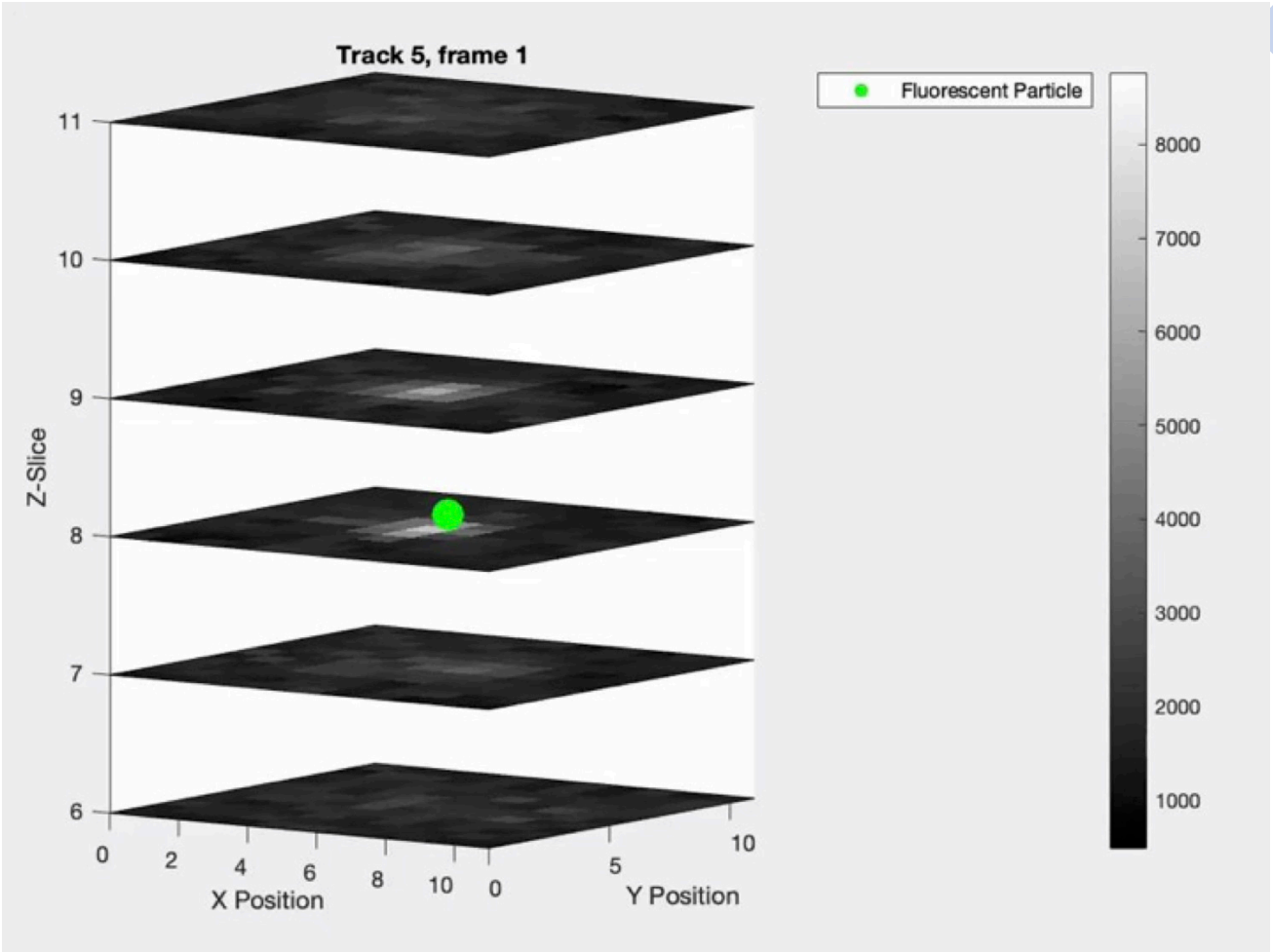
Simon Mochrie

Department of Physics / Department of Applied physics

Contact: Simon Mochrie (simon.mochrie@yale.edu)

Remote opportunity

Hone your coding skills in a computational project to track multiple fluorescently-labeled gene loci in the same nucleus.



Biophysics

David Moore

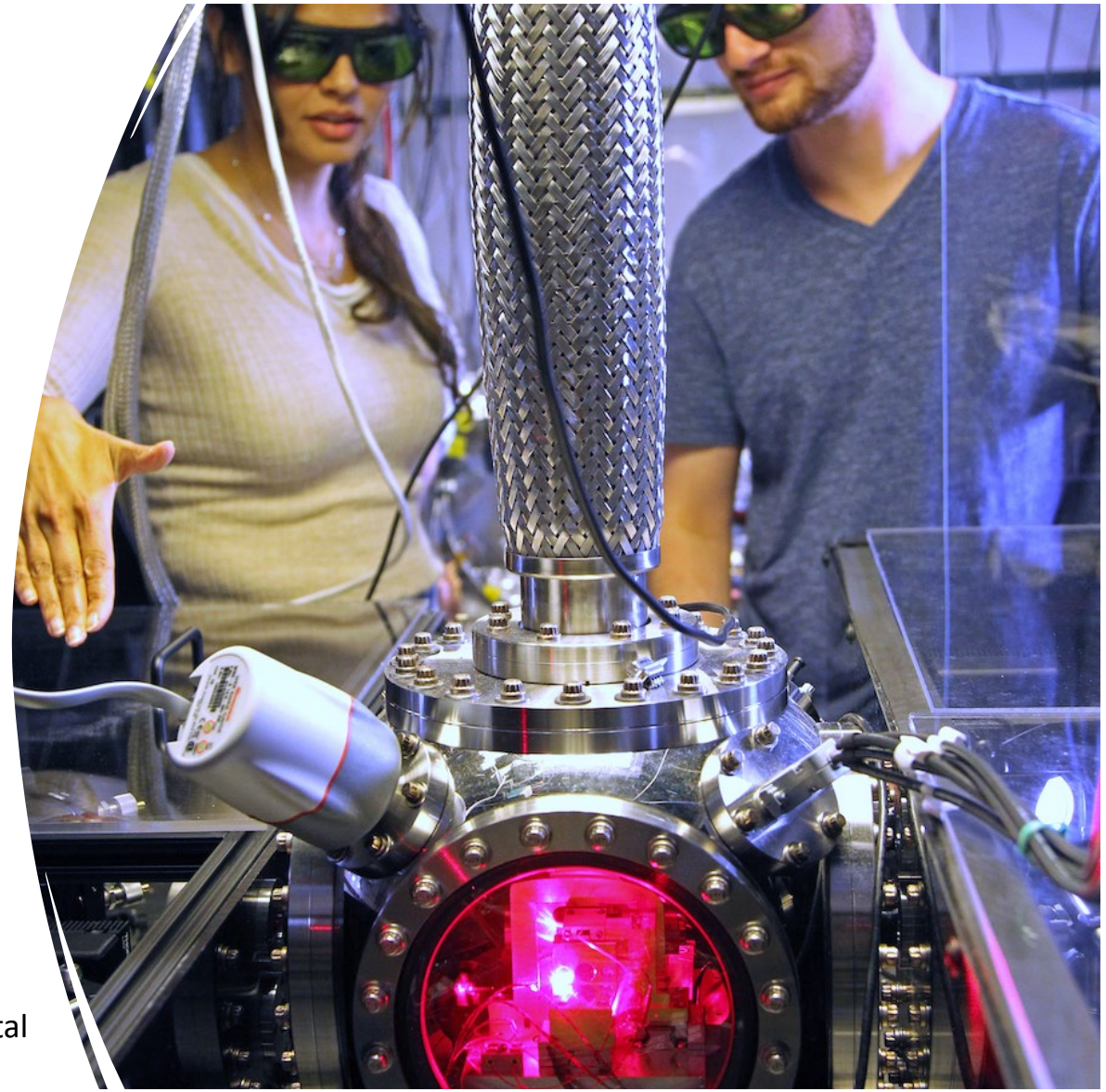
Department of Physics

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

Website: https://campuspress.yale.edu/moorelab/

In Lab opportunity

We have open projects aiming to test fundamental physics at the precision frontier of nuclear and particle physics. Ongoing projects are in either searching for neutrinoless double beta decay (nEXO) or using levitated optomechanical sensors as probes of new physcs (SIMPLE).



Research areas: Atomic, Molecular and Optical Physics; Experimental Nuclear Physics; Experimental Particle Physics, and Quantum Physics

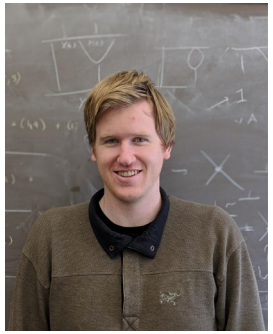
Ian Moult

Department of Physics

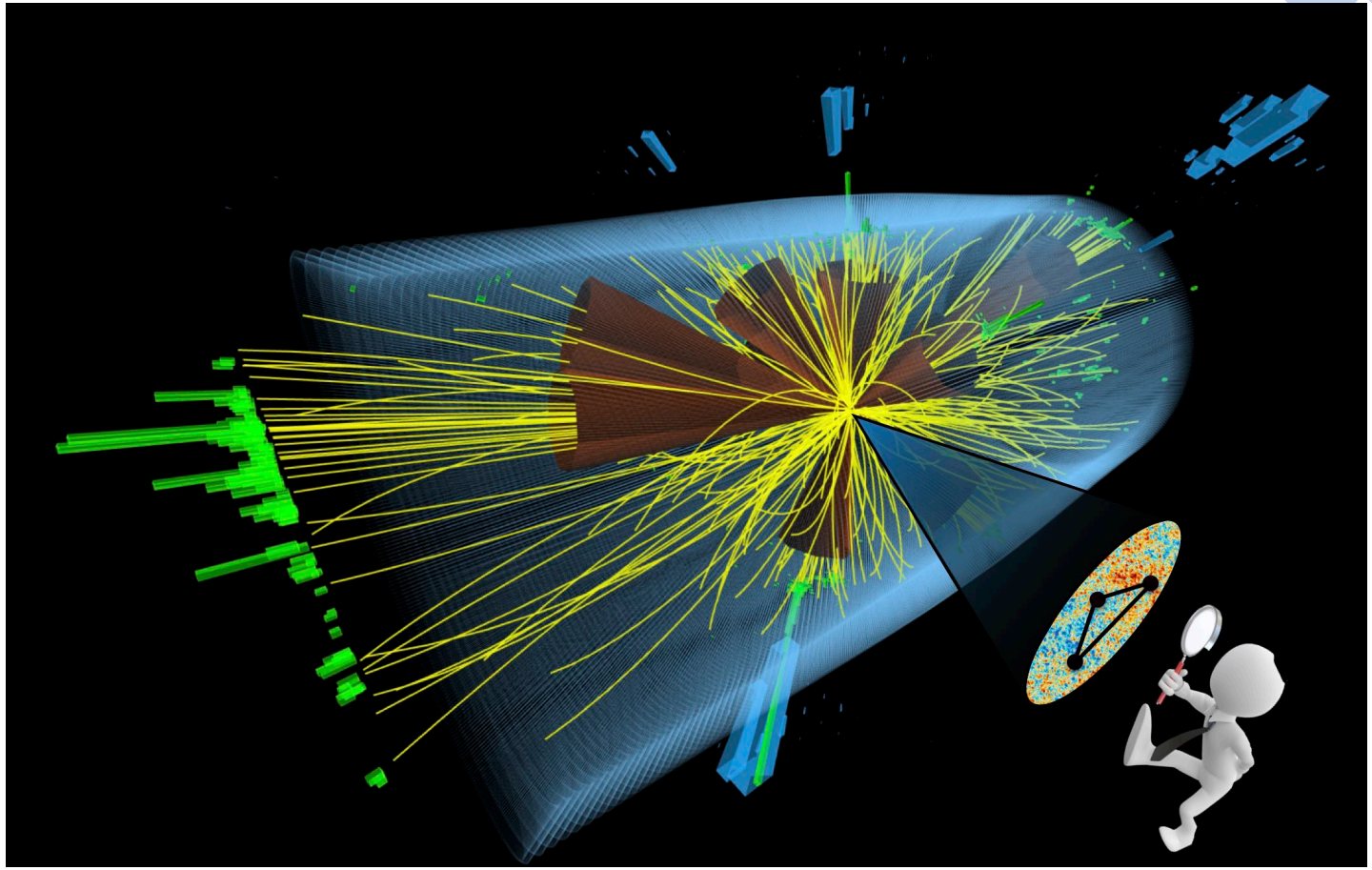
Contact: Ian Moult (ian.moult@yale.edu)

Website: https://physics.yale.edu/people/ian-moult

In-lab opportunity



Develop field theory techniques to better understand collider physics experiments. Depending on the interests of the student, this could involve more simulation and interaction with experimentalists, or more formal field theory and interaction with theorists.



Theoretical Particle Physics

Daisuke Nagai

Department of Physics

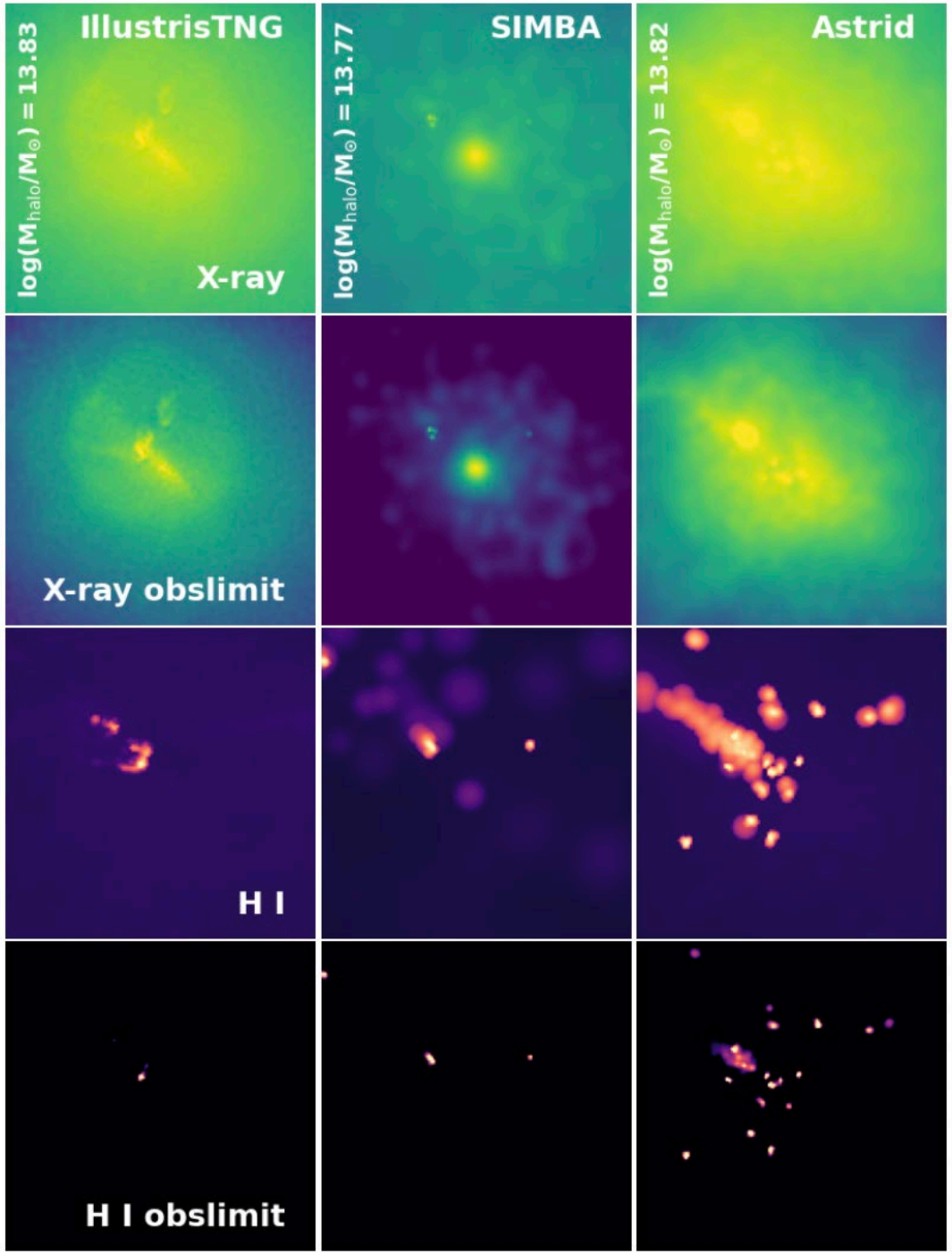
Contact: Naomi Gluck (naomi.gluck@yale.edu)

Website: http://www.astro.yale.edu/nagai/Welcome.html

In-lab opportunity

Nagai's lab focuses on computational and data-driven modeling of multi-wavelength cosmological surveys, with the goal of understanding the nature of dark matter, dark energy, and gravity on the largest scales. The primary goals of our project is to understand the nature of dark matter, dark energy, and gravity on the largest scales. To achieve this goal, our current research is focused on developing and analyzing large hydrodynamical cosmological simulations of the Universe. Additionally, emerging machine learning techniques are being applied to forward-model multi-wavelength cosmological datasets, specifically those from microwave, optical, and X-ray observations. In this project, we will analyze the outputs of CAMELS simulations to understand the physics of dark matter halo formation and evolution, as well as the observable properties of gas and stars embedded in these halos. An interpretable machine-learning model based on Convolutional Neutral Network (CNN) is being developed in order to predict the observable properties of dark matter halos and create an accurate and fast simulation-based inference for upcoming cosmological surveys.

Astrophysics and Cosmology



Nir Navon

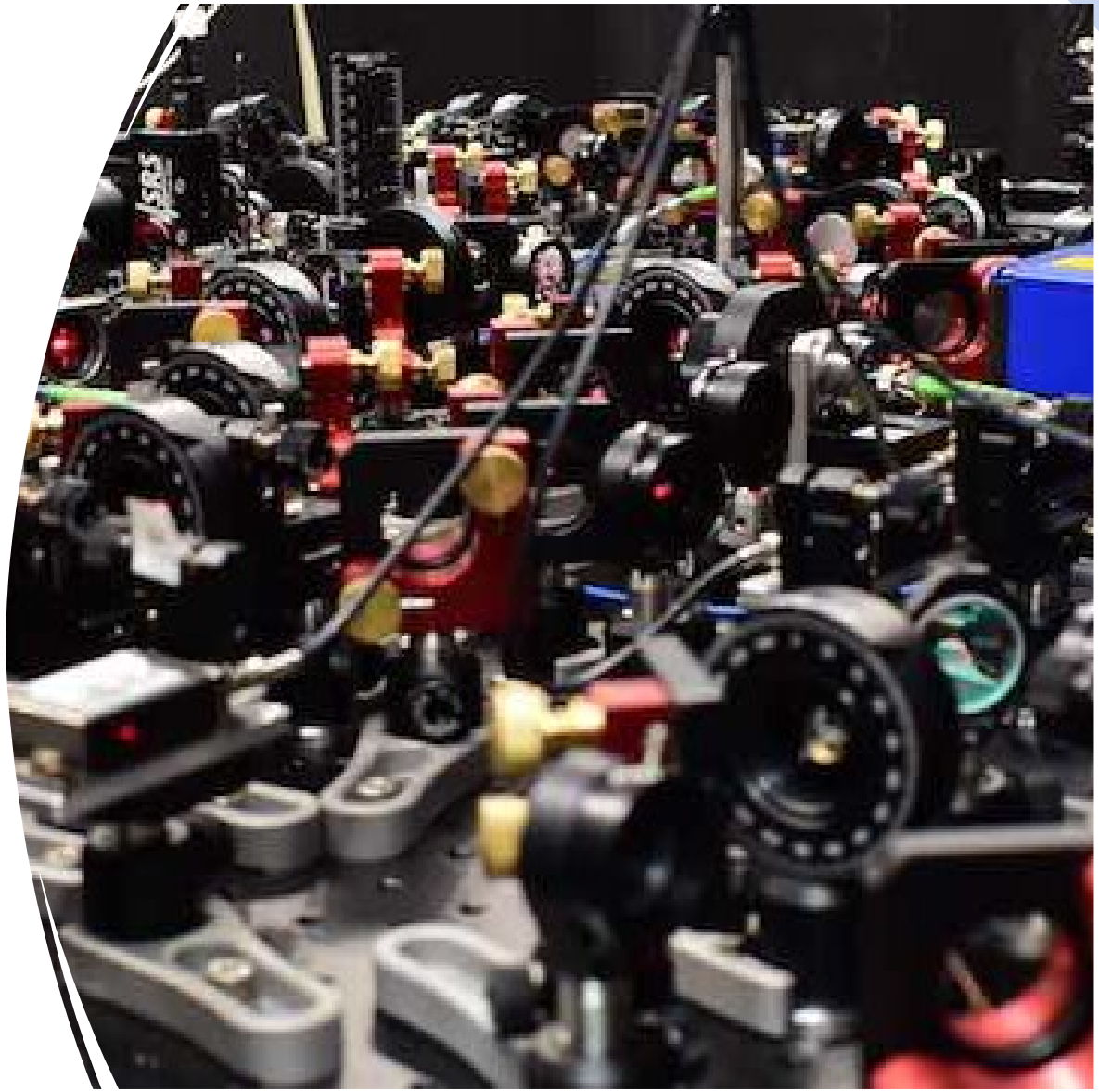
Department of Physics

Contact: Grant Schumacher (grant.schumacher@yale.edu)

Website: https://uqm.yale.edu/

In-lab opportunity

Some of the most puzzling open problems in modern physics involve the behavior of assemblies of many interacting quantum particles. Our research group at Yale University specializes in the study of this quantum many-body problem using highly-controllable ultracold quantum matter. We aim at improving our understanding of quantum phases of strongly-correlated matter, and explore the emergence of universal states in far-from-equilibrium quantum dynamics



Atomic, Molecular, and Optical Physics

Laura Newburgh

Department of Physics

Contact: Laura Newburgh (laura.newburgh@yale.edu)

Website: https://campuspress.yale.edu/newburgh/

In Lab opportunity

We use quadcopter drones to measure the beam shape of telescopes. You would analyze data, participate in drone flights, and possibly travel to radio telescope for these mapping campaigns.

Astrophysics and Cosmology

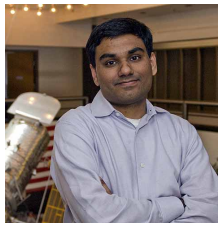
Nikhil Padmanabhan

Department of Physics

Contact: Nikhil Padmanabhan (nikhil.padmanabhan@yale.edu)

Website: https://campuspress.yale.edu/newburgh/

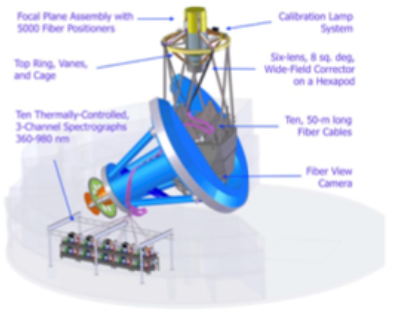
In Lab opportunity

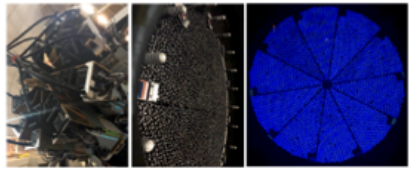


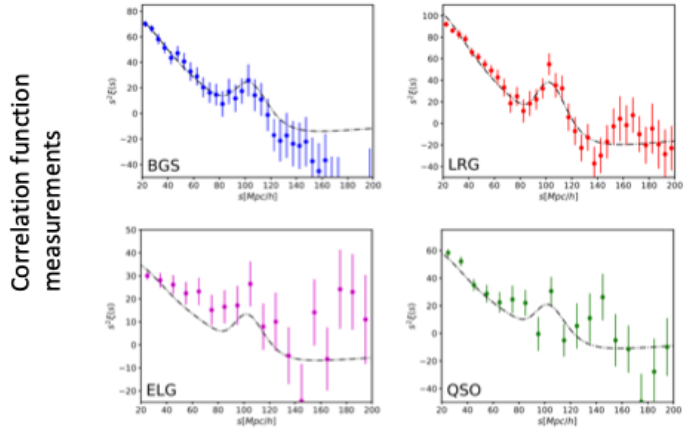
The projects I imagine are all related to the DESI survey (which is linked in the URL above).

Science with the Dark Energy Spectroscopic Instrument

The DESI telescope and instrument







Possible cosmology projects (motivated by DESI)

- Techniques for covariance matrix estimation
- Weighted correlation functions for optimized dark energy measurements
- Applying new reconstruction techniques to DESI data
- Machine learning to understand connections between dark matter and galaxies/protohalos

Astrophysics and Cosmology

Paul Tipton

Department of Physics

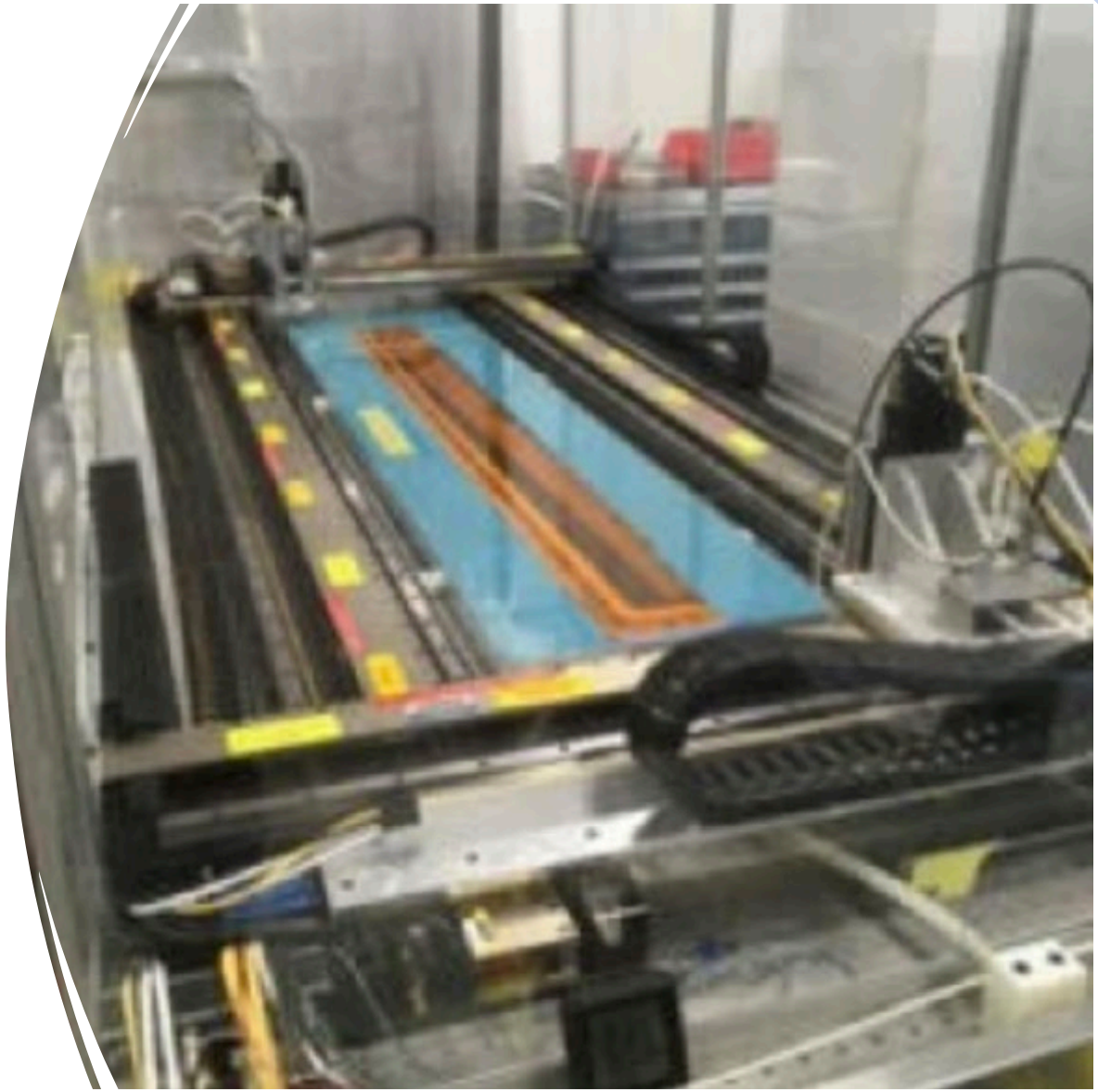
Contact: Brandon Ramirez (brandon.ramirez@yale.edu)

Website: https://hep.yale.edu/people/faculty/paul-l-tipton/research

In-Lab opportunity

We are building particle detectors (a particle tracker) to go into an upgrade of the atlas detector to take data at the LHC at cern. We have a (very) small-scale "factory" in the WL clean room where we assemble and test precision sub-assemblies for the new tracker.

We need two students for summer of 2024 to help us perfect and use QA testing equipment used to make sure these sub-assemblies meet our strict electrical and mechanical specifications. We use robotics, we use IR inspection and image analysis, we use smart scope inspection equipment, so someone with an engineering background or engineering interests/skills in addition to physics interests would be perfect.

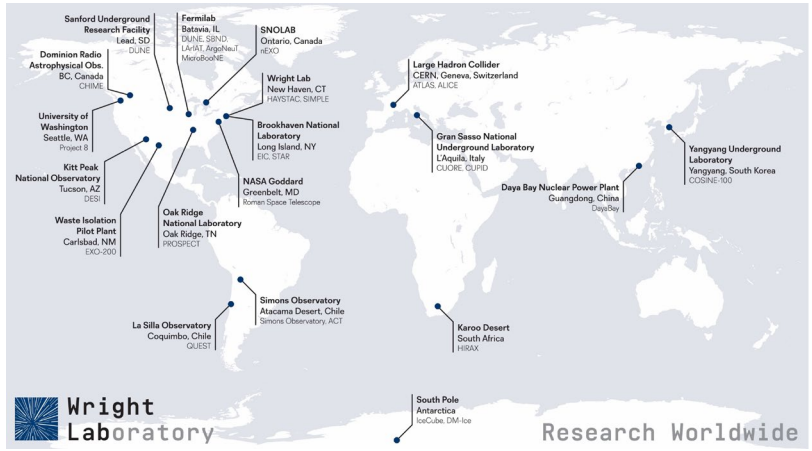


Experimental Particle Physics

Discover the invisible Universe

Wright Laboratory

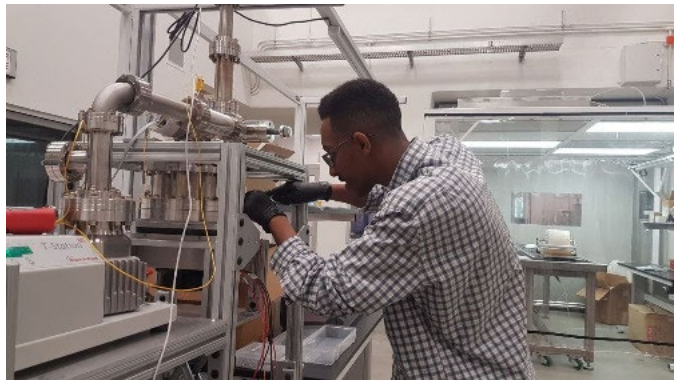
Explore the frontiers of fundamental physics as you become an integral part of Wright Lab's broad research program in nuclear, particle, and astrophysics that includes precision studies of **neutrinos**; searches for **dark matter**; investigations of the **building blocks and interactions of matter**; exploration of **quantum science** and its applications for fundamental physics experiments; and observations of **the early Universe**.



Wright Lab provides undergraduates

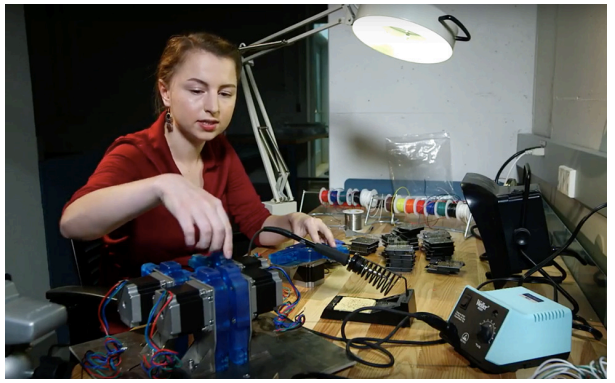
- hands-on research experiences
- mentoring from Yale researchers
- training workshops
- professional development
- immersion in WL and Yale research communities
- networking with national nuclear physics community
- participate in and/or lead outreach activities

Become part of **an international scientific community** as you undertake fundamental physics experiments around the world.



Develop, build, and use **advanced instrumentation and technologi**es for research; **analyze data**; and acquire skills for **successful careers** in graduate school and beyond.

Find out more & apply at wlab.yale.edu/opportunities

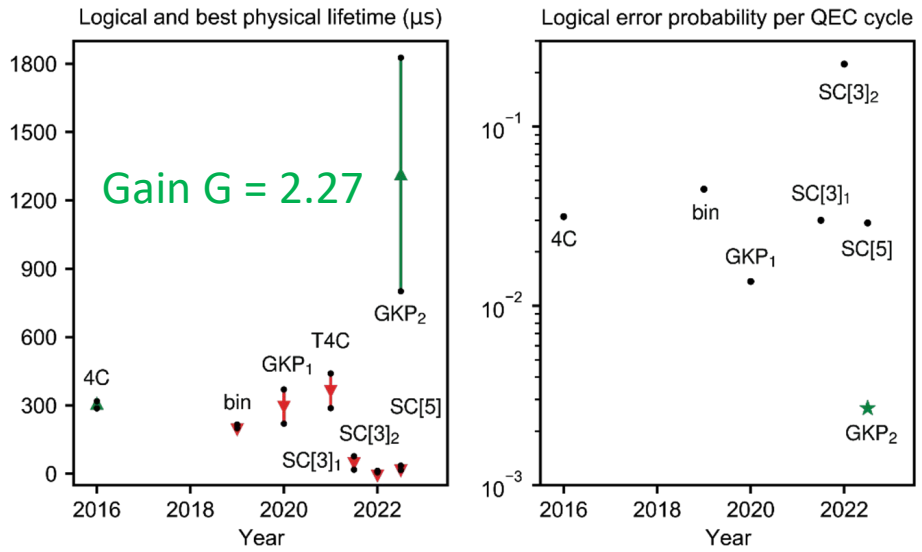


Research Fellowships & Employment

- **Yale Physics Department Undergraduate Research Opportunities**: https://physics.yale.edu/academics/undergraduate-studies/undergraduate-research
- **STARS Summer Research Program**: https://science.yalecollege.yale.edu/stem-fellowships/funding-stem-opportunities-yale/stars/stars-summer-research-program (deadline: February 10, 2023 at 3:00pm)
- **Yale College Dean's Research Fellowship & Rosenfeld Science Scholars Program**: https://science.yalecollege.yale.edu/yale-undergraduate-research/fellowship-grants/yale-college-deans-research-fellowship (deadline: February 23, 2023 at 3:00 pm)
- **Tetelman Fellowship for International Research in the Sciences AND the Robert C. Bates Summer Fellowship**: https://science.yalecollege.yale.edu/yale-undergraduate-research/fellowship-grants/tetelman-fellowship-international-research-sciences (deadline: March 2, 2023 at 3:00pm)
- **Yale College First-Year Summer Research Fellowship in the Sciences and Engineering**: https://science.yalecollege.yale.edu/stem-fellowships/funding-stem-opportunities-yale/yale-college-first-year-summer-research-fellowship (deadline: March 8, 2023 at 3:00 pm)
- **Further information and other opportunities can be found at**: https://science.yalecollege.yale.edu/yale-undergraduate-research/fellowship-grants/tetelman-fellowship-international-research-sciences
- **Yale Young Global Scholars – Instructional Staff Role**: https://globalscholars.yale.edu/employment

Sampling of faculty with Yale Quantum Institute connections:
https://quantuminstitute.yale.edu/people/members

Experiment:	Theory:
Michel Devoret (AP)	Shruti Puri (AP)
Rob Schoelkopf (AP)	Doug Stone (AP)
Peter Rakich (AP)	Steven Girvin (P)
Hui Cao (AP)	Leonid Glazman (P)
Hong Tang (EE)	Meng Cheng (P)
Jack Harris (P)	Nicholas Read (P)
Nir Navon (P)	Victor Batista (Chem)
Lin Zhong (CS)	Yongshan Ding (CS)
	Daniel Spielman (CS, Data Science)



World Record Quantum Error Correction Gain

Devoret Lab

http://arxiv.org/abs/2211.09116