

# 2022 Undergraduate Research Fair

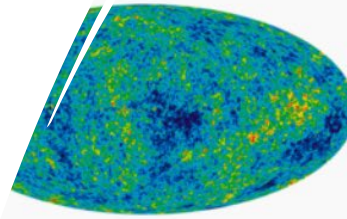
Thursday, November 17, 2022, at  
4:00 pm in SPL 3<sup>rd</sup> Floor Lounge

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

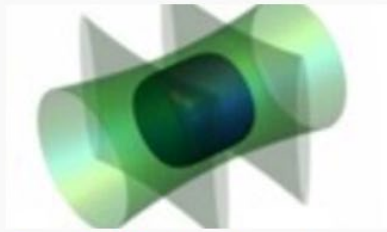


# Research in the Physics Department

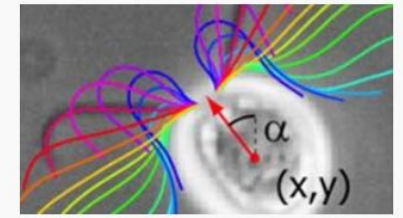
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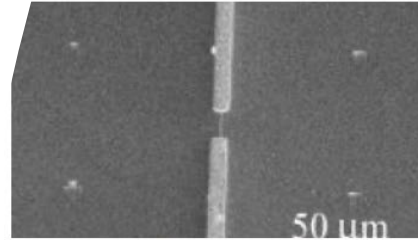
[Astrophysics and Cosmology](#)



[Atomic, Molecular, and  
Optical Physics](#)



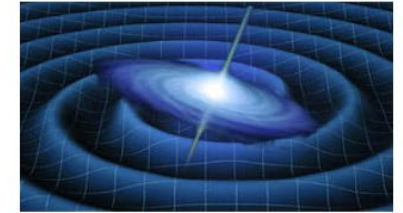
[Biophysics](#)



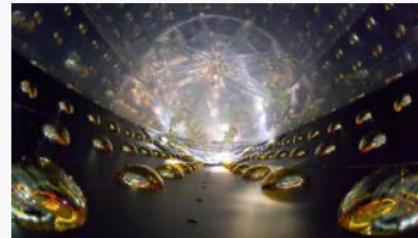
[Condensed Matter Physics  
Experimental](#)



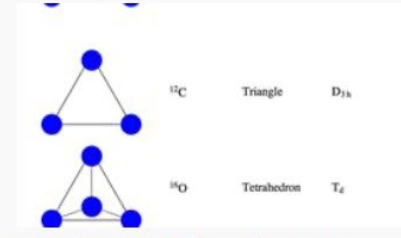
[Condensed Matter Physics  
Theory](#)



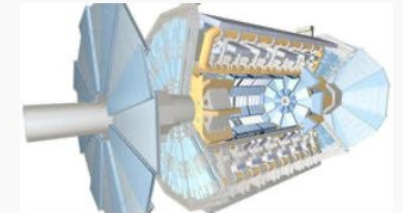
[Gravitational Physics](#)



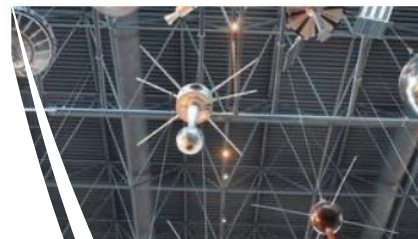
[Nuclear Physics Experimental](#)



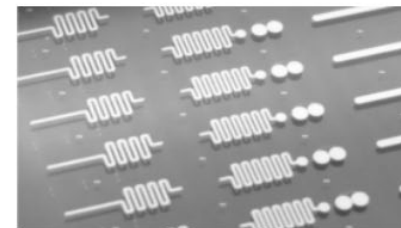
[Nuclear Physics Theory](#)



[Particle Physics  
Experimental](#)



[Particle Physics Theory](#)



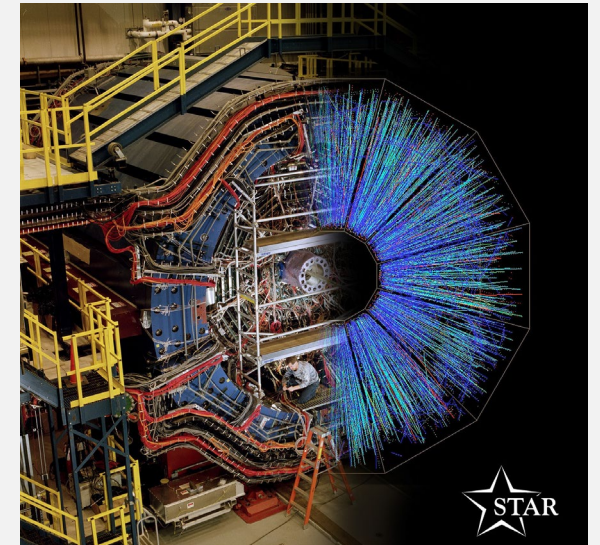
[Quantum Physics](#)

# Helen Caines

Department of Physics

- **Email:** [helen.caines@yale.edu](mailto:helen.caines@yale.edu)
- **Website:** <https://wlab.yale.edu/research/relativistic-heavy-ions>
- **Research Area:** Experimental Nuclear Physics
- **Research Opportunity Type:** In Lab

Data analysis working with group members on the STAR experiment or ALICE experiment to learn more about the properties of nuclear matter when it's heated to extreme temperatures. Additionally, there's the possibility for some hands-on hardware projects.



# Damon Clark

Department of Molecular, Cellular and Developmental Biology

- **Email:** [damon.clark@yale.edu](mailto:damon.clark@yale.edu)
- **Website:** <http://clarklab.common.yale.edu/>
- **Research Area:** Biophysics
- **Research Opportunity Type:** In Lab

Our lab is interested in understanding how small neural circuits perform basic computations. We do this with experiments in the visual system of the fruit fly. We tie these experiments closely to computational and theoretical models for visual processing. Past projects for undergraduates have involved measuring fly behavior, modeling the responses of a neural circuit, and tracking human eye movements. If you're interested, please send me an email and we can arrange to talk!





# Sarah Demers

Department of Physics

- **Email:** [sarah.demers@yale.edu](mailto:sarah.demers@yale.edu)
- **Website:** <http://demerslab.yale.edu/>
- **Research Area:** Experimental Particle Physics
- **Research Opportunity Type:** In Lab and remote

Work on the ATLAS Experiment (Higgs physics and tau lepton identification)

Work on the Mu2e Experiment (event selection - trigger - studies)



# Thierry Emonet

Department of Molecular, Cellular and Developmental Biology

- **Email:** [thierry.emonet@yale.edu](mailto:thierry.emonet@yale.edu)
- **Contact Email:** [samuel.brudner@yale.edu](mailto:samuel.brudner@yale.edu)
- **Website:** <https://emonet.biology.yale.edu/>
- **Research Area:** Biophysics
- **Research Opportunity Type:** In Lab

We combine theory and experiments to understand the biological computations that enable organisms to sense and navigate chemical signals. We work with both bacteria and fruit flies.

On the neurobiology side we just discovered that flies can smell the motion of odors!

<https://doi.org/10.1038/s41586-022-05423-4> and News and Views:

<https://www.nature.com/articles/d41586-022-03561-3> and Yale News:

<https://news.yale.edu/2022/11/09/flies-smell-motion-odors-and-use-it-nav...>

Join us to discover how flies use this newly discovered sense to navigate. We have theoretical projects involving solving optimization problems to discover the optimal strategy to use odor motion in navigation, and experimental projects in which we put flies in a virtual environments to measure how they combine odor motion and other information to navigate.

On the microbiology side we are examining how groups of bacteria with diverse navigational capabilities nevertheless manage to migrate as coherent groups. we are also measuring how efficiently do bacteria and group of bacteria process information. Both theoretical and experimental projects are available.

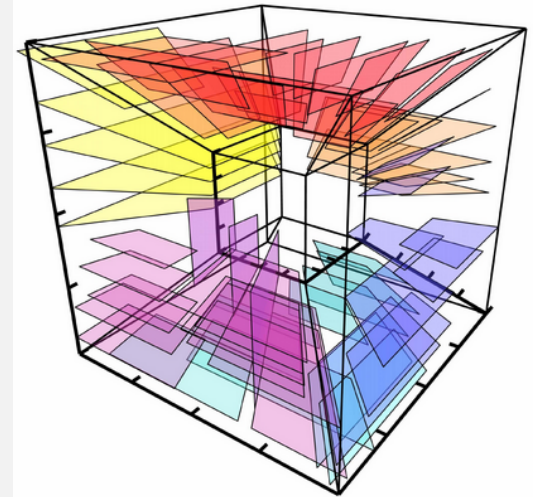


# Jack Harris

Department of Physics

- **Email:** [jack.harris@yale.edu](mailto:jack.harris@yale.edu)
- **Website:** <https://harrislab.yale.edu/>
- **Research Areas:** Quantum Physics
- **Research Opportunity Type:** In Lab

A variety of projects in support of our experiments on quantum effects in macroscopic objects, the interplay between light & sound at the quantum level, and the rich topological structure of coupled resonators. Student projects might involve finite element simulations, data analysis, coding, laser optics, mechanical design, or coding.



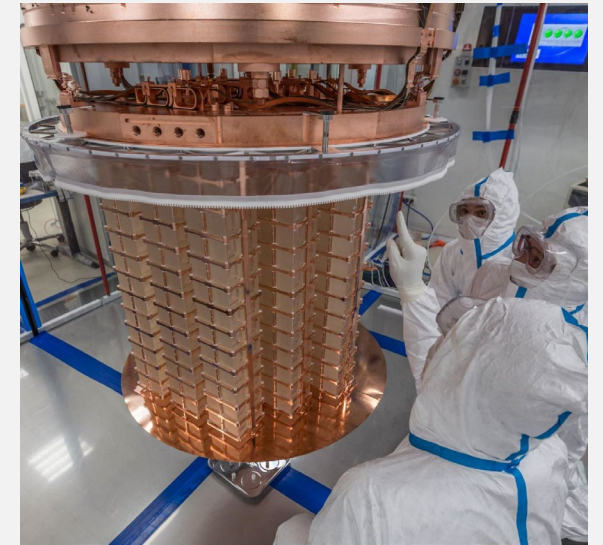


# Karsten Heeger

Department of Physics

- **Email:** [karsten.heeger@yale.edu](mailto:karsten.heeger@yale.edu)
- **Website:** <http://heegerlab.yale.edu/>
- **Research Areas:** Experimental Particle Physics, Experimental Nuclear Physics, Quantum Science
- **Research Opportunity Type:** In Lab and remote

Heeger's group is interested in understanding the properties of neutrinos and dark matter in the Universe. We conduct experiments at various facilities around the world to measure the mass of neutrinos, determine if neutrinos are their own antiparticles, and measure neutrino oscillations. Research opportunities exist in the CUORE/CUPID, Project 8, and PROSPECT experiments.





# Joe Howard

Department of Molecular Biophysics & Biochemistry

- **Faculty Email:** [jonathon.howard@yale.edu](mailto:jonathon.howard@yale.edu)
- **Contact Email:** [carol.martin@yale.edu](mailto:carol.martin@yale.edu)
- **Website:** <https://howardlab.yale.edu>
- **Research Area:** Biophysics
- **Research Opportunity Type:** In Lab

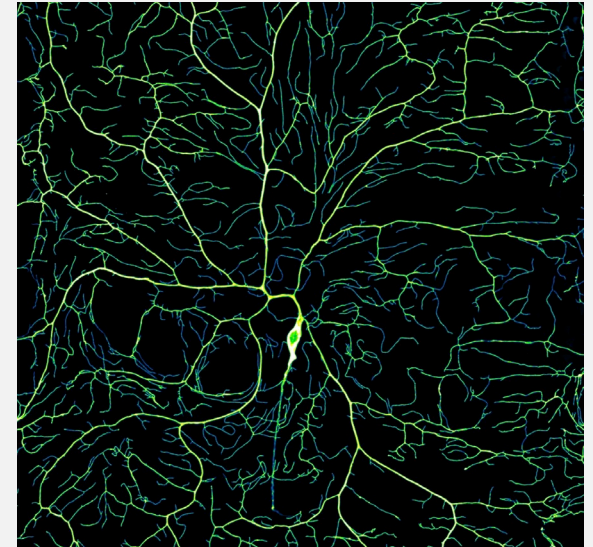
We have theoretical projects for those without biological research experience and laboratory projects for those that do.

**Theory project:**

Mean and computational field models of branching morphogenesis. We have a very interesting experimental system in which the fly neurons undergo what we call "branching morphogenesis" in which lateral branching from existing branches creates a cell with up to 2000 branches in 5 days. While we have an "agent-based" model that recapitulates the morphology, we are currently seeking a "mean-field" model in which we formulate the growth process as a reaction-diffusion partial differential equation. You would be working with a PhD student and a postdoc testing out the predictions of several formulations of the model in order to fit experimental data.

**Experimental project.**

Depending on the research experience, the project could be on measuring development of neurons in flies using confocal microscopy or the diffusion of proteins on microtubules using single-molecule fluorescence microscopy.

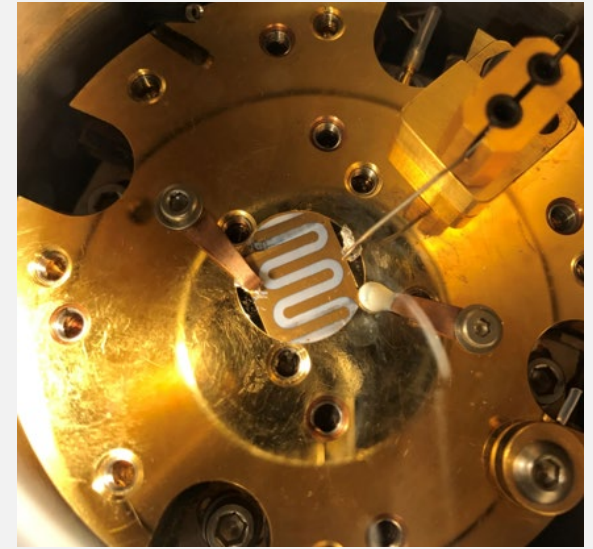


# Steven Konezny

Department of Physics / Department of Chemistry

- **Faculty Email:** [steven.konezny@yale.edu](mailto:steven.konezny@yale.edu)
- **Website:** <http://konezny.sites.yale.edu/>
- **Research Area:** Experimental Condensed Matter Physics
- **Research Opportunity Type:** In Lab

We 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. I have a few research projects that are focused on fabrication, measurement, and/or theory, depending on student interest and experience.



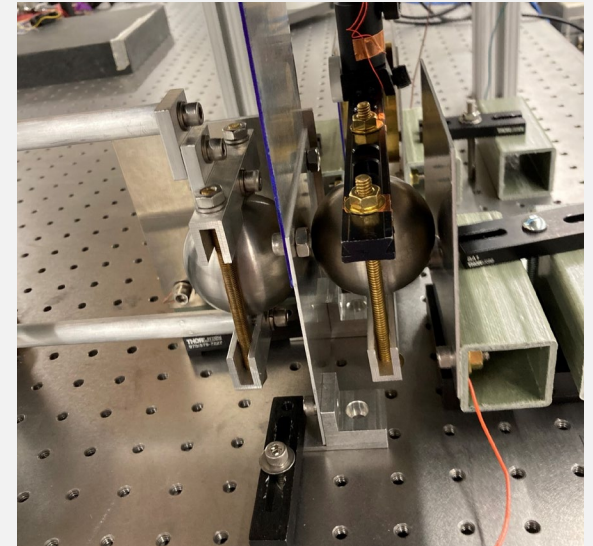
# Steve Lamoreaux

Department of Physics

- **Faculty Email:** [steve.lamoreaux@yale.edu](mailto:steve.lamoreaux@yale.edu)
- **Website:** <https://haystac.yale.edu/>
- **Research Area:** Astrophysics and Cosmology
- **Research Opportunity Type:** In Lab

Over the last year, an apparatus to measure the gravitation constant  $G$  has been assembled. This apparatus is different from most that have been used in recent measurements of  $G$  which show excessive scatter, making it the least accurately known fundamental constant. These experiments were based on dynamic measurements for which properties of the system, including anelastic relaxation response, are difficult to control.

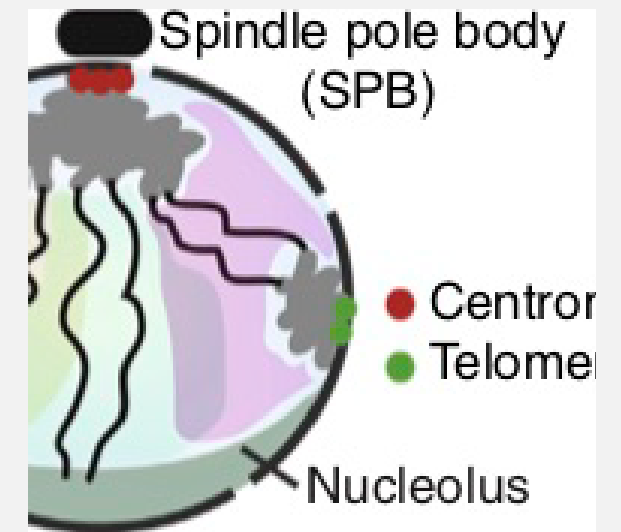
Tasks include analyzing existing data, setting up a laser interferometric position measurement system, and improving the torsion pendulum vibrational modes.



# Simon Mochrie

Department of Physics / Department of Applied Physics

- **Email:** [simon.mochrie@yale.edu](mailto:simon.mochrie@yale.edu)
- **Website:** <https://mochrielab.yale.edu/>
- **Research Area:** Biophysics
- **Research Opportunity Type:** In Lab and Remote
  - (1) Particle tracking and cross-correlation using video microscopy data to understand chromatin dynamics
  - (2) Implementation of a spatial-light-modulator(SLM)-based light beam profiling optical system for spatially-resolved fluorescence microscopy
  - (3) Simulations of the dynamic organization of chromatin loops using genomic "big data" inputs



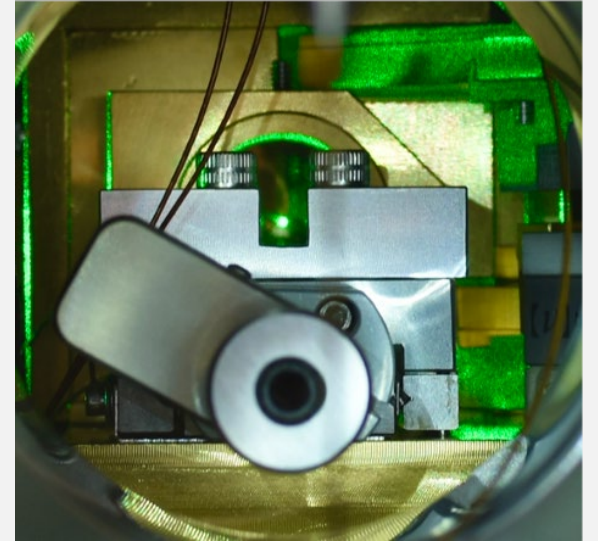


# David Moore

Department of Physics

- **Email:** [david.c.moore@yale.edu](mailto:david.c.moore@yale.edu)
- **Website:** <http://campuspress.yale.edu/moorelab/>
- **Research Area:** Experimental Nuclear Physics
- **Research Opportunity Type:** In Lab

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 physics (SIMPLE).

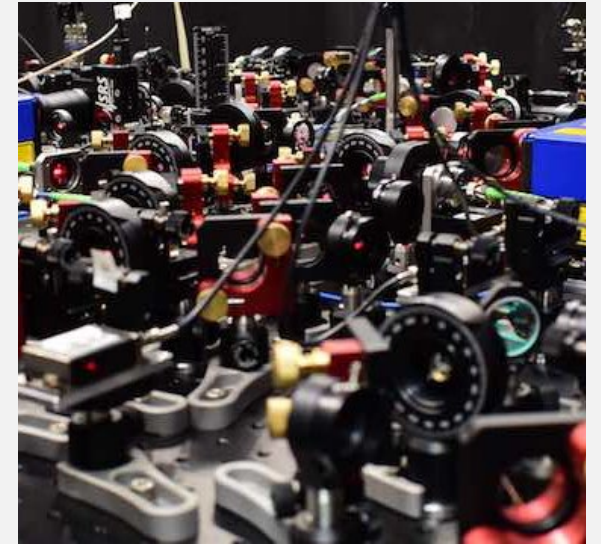


# Nir Navon

Department of Physics

- **Email:** [nir.navon@yale.edu](mailto:nir.navon@yale.edu)
- **Website:** <https://uqm.yale.edu/>
- **Research Area:** Ultracold Quantum Matter / Quantum simulations
- **Research Opportunity Type:** In Lab and Remote

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 their collective excitations), and explore the emergence of universal states in far-from-equilibrium quantum dynamics. We have ongoing opportunities for undergraduate research, both in-lab and theoretical/numerical simulations.

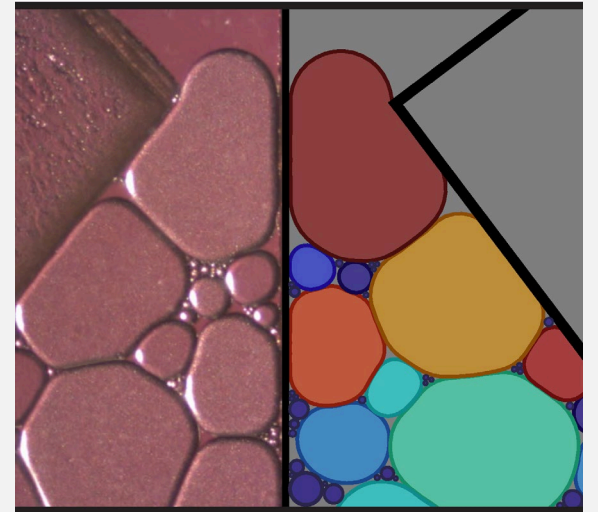


# Corey O'Hern

Department of Mechanical Engineering & Materials Science

- **Email:** [corey.ohern@yale.edu](mailto:corey.ohern@yale.edu)
- **Website:** <https://jamming.research.yale.edu>
- **Research Area:** Biophysics
- **Research Opportunity Type:** In Lab

The O'Hern research group carries out research in theoretical and computational studies of soft matter and biological physics. The group currently has open research projects in predicting the glass forming ability and mechanical properties of alloys, erosion in fluid driven granular beds, clogging in microfluidic channels, structure prediction of protein-protein interfaces, and collective cell motion in wound healing, zebrafish tail bud development, and breast cancer invasion.



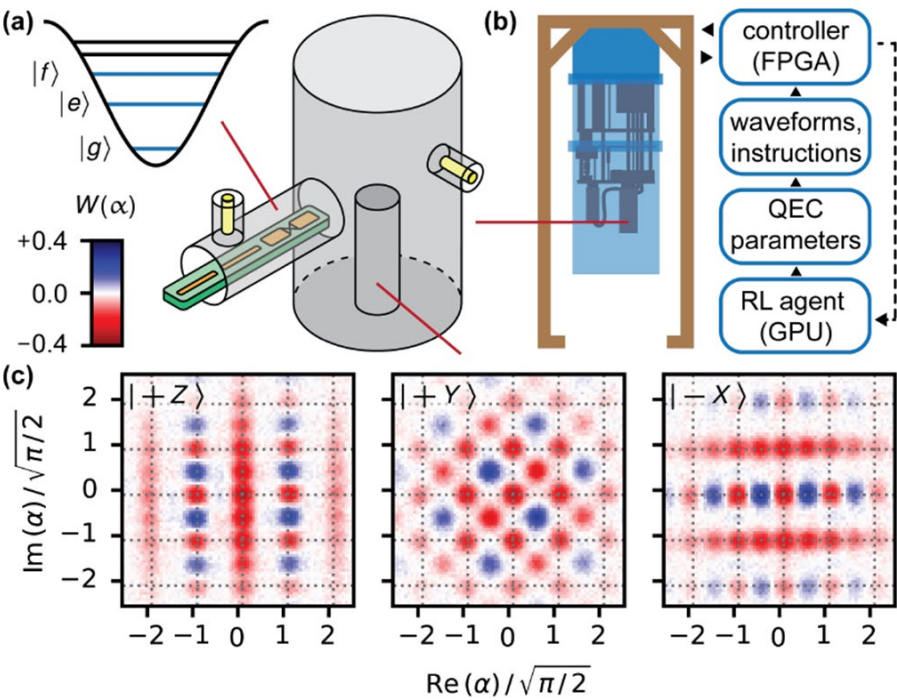
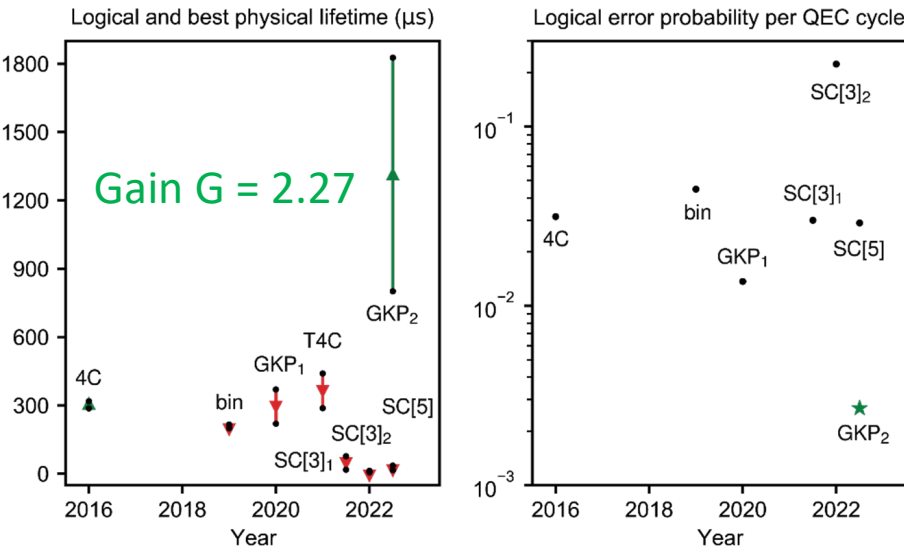
Sampling of faculty with Yale Quantum Institute connections:

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>





# Research on West Campus

## Yale Energy Sciences Institute

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- **Physics People on West Campus:**

- Adrian Gozar
- Eduardo Higino da Silva Neto
- Steven Konezny

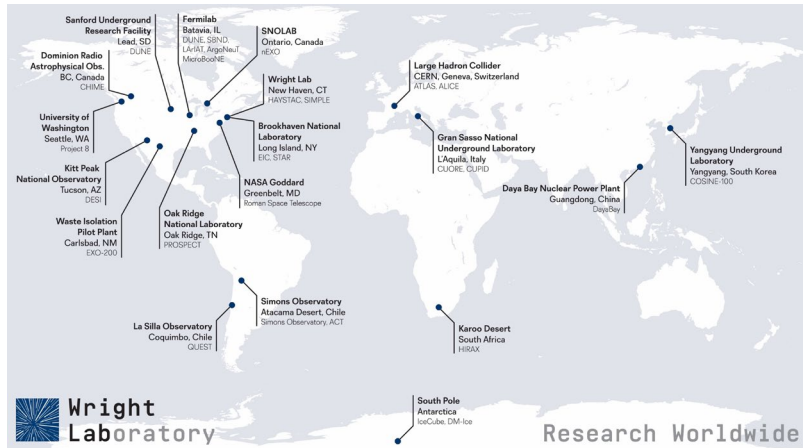


**Yale Energy Sciences Institute**

# Discover the invisible Universe



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**.



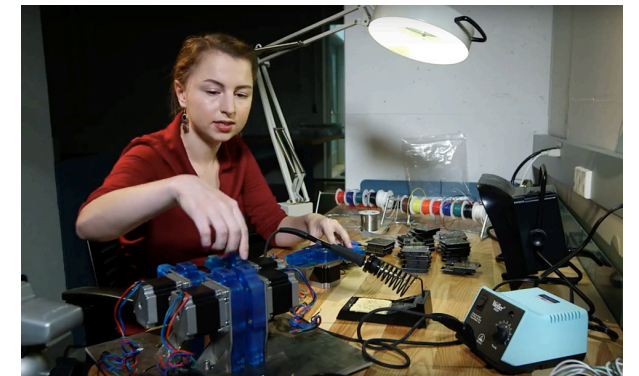
## Wright Lab provides undergraduates

- 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 technologies** for research; **analyze data**; and acquire skills for **successful careers** in graduate school and beyond.



# 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>
  - **Information Sessions:**
    - November 4: 4 – 6PM WLH 309
    - November 18: 12 – 1:30PM (Virtual)
    - December 12: 3-5PM Poorvu Center CTL 121