Nuclear/Particle/Astrophysics

Relativistic Heavy Ions

Neutrinos & Fundamental Symmetries

Elementary Particles

Astrophysics & Cosmology

Quantum Physics & Devices

Faculty, PIs
16 faculty
4 adjunct/research faculty

Scientists, Staff, Students
12 research scientists
13 postdocs
43 graduate students
~120 total personnel

Synergies
- Yale Center for Astronomy and Astrophysics (YCAA)
- Yale Center for Research Computing (YCRC)
- Yale Quantum Institute (YQI)

https://wlab.yale.edu
State-of-the-Art Facilities

https://wlab.yale.edu
New Tools for Discovery

Li scintillator detectors for reactor ν

coldest cubic meter of Universe to study 0νββ

low-background NaI detectors for dark matter search at South Pole

zero point motion close to zero K

Nanoparticle dark matter and ν searches

axion searches

LXe TPCs for 0νββ
Research in Maruyama Group

http://maruyama-lab.yale.edu

Research

- Physics Beyond the Standard Model of Particle Physics
- Neutrinos and Dark Matter

Direct detection dark matter experiment at Yale, South Pole and South Korea.

Is DAMA really seeing dark matter?

Neutrinoless double beta decay

Are neutrinos their own anti-particles? Are they Majorana particles?
Why is the Universe made of matter and not anti-matter?

What are neutrinos?

What is dark matter?
Relativistic Heavy-Ions at Yale
Caines-Harris Group
Studying the Quark-Gluon Plasma - Nature’s Most Extreme Liquid

What makes the Quark Gluon Plasma Extreme?

- **Nature’s first liquid** - existed $10^{-6}$ second after the Big Bang
- **Most perfect liquid** - 10 times less viscous than water
- **Hottest Liquid** - $T \sim 10^{12}$ Kelvin - We hold a Guinness World record
- **Most vortical liquid** - spins 10 billion trillion times faster than powerful tornadoes
- **Smaller liquid** - evidence for QGP creation when only the size of a proton

All occurring in the most intense magnetic field ever created!

+ Improving our studies of the strong force and the role of gluons in matter at the
Electron Ion Collider - New accelerator approved for construction at BNL
Relativistic Heavy-Ions at Yale
Caines-Harris Group

Studying the Quark-Gluon Plasma - Nature’s Most Extreme Liquid

- 2 Faculty - Helen Caines & John Harris + Recruiting a new faculty member right now
- 2 Adjunct Faculty - Jurgen Schukraft (CERN), Thomas Ullrich (BNL)
- 2 Research Scientist (Hardware R&D focus) - Prakhar Garg, Nikolai Smirnov
- 5 Post Docs - Mesut Arslandok (ALICE), Fernando Flor (STAR), Laura Havener (ALICE), Isaac Mooney (STAR), Michael Oliver (ALICE)
- 8 Graduate students - Caitie Beattie (ALICE), Hannah Bossi (ALICE), Tong Liu (STAR), Dan Nemes (STAR), Youqi Song (STAR), Ananya Rai (ALICE), Andrew Tamis (STAR), Sierra Weyhmiller (ALICE)
- Undergraduate students - usually over the summer

Hoping to recruit new students into either STAR, ALICE or the EIC

Will work on mixture of data analysis (our focus is on jets and their interaction with the QGP) and hardware R&D

Based at Yale, travel to BNL and CERN as needed
Higgs boson decays to tau leptons, Dark sector searches with the Higgs, Lepton-flavor-violating Higgs searches, CP of the Higgs, quantum entanglement at the LHC...
Mu2e

The Mu2e Experiment

Fermilab
Motivations for these models come from measurement hints or attempts to make progress with the standard model’s shortcomings...
Neutrinos and the Invisible Universe

Is there new physics beyond 3 neutrinos?
Are neutrinos their own antiparticles?
What is the absolute neutrino mass?

heegerlab.yale.edu

Synergies with groups of Maruyama and Fleming
Neutrinos and the Invisible Universe

Postdocs/Scientists

Pranava Surukuchi  Luis Saldana  James Nikkel  Penny Slocum

Graduate Students

Ben Foust  Samantha Pagan  Iris Ponce  Talia Weiss  Arina Telles

student distinctions: NSF fellowships, co-founder of Yale Physics Professional Development Organization; Poorvu teaching fellow
alumni: faculty, national labs, industry

heegerlab.yale.edu
Experimental nuclear and particle physics at the precision frontier

David Moore, david.c.moore@yale.edu
campuspress.yale.edu/moorelab

Our group is developing technologies to search for new physics through precision experiments for extremely rare or weakly coupled phenomena:

**Extremely rare events (EXO):** Searching for 0νββ with half-life sensitivity up to $10^{28}$ years (and beyond?) with large liquid Xe detectors:
- Are neutrinos Majorana fermions?
- Is lepton number conserved in nature?
- What is the origin of the matter/antimatter asymmetry?

**Extremely tiny forces (SIMPLE):** Developing levitated optomechanical force sensors to search for forces $< 10^{-21}$ N:
- Searching for deviations from Newton’s or Coulomb’s law a micron distances
- New techniques to detect dark matter scattering using quantum optomechanical sensors
- Tests of the neutrality of matter and searches for millicharged particles
- Mechanical detection (and spectroscopy) of single nuclear decays and searches for sterile $\nu$
Our group @ Wright Lab
http://campuspress.yale.edu/moorelab/

- We are looking for students to join us on both nEXO and SIMPLE
- These are small scale experiments, and graduate students play a major role in the design, construction, data taking, and analysis!