

# PHYSICS (GRADUATE FIELD)

Program Website (<http://www.physics.cornell.edu/>)

## Field Description

The graduate physics program is designed to give students an adequate background in the concepts and techniques of theoretical and experimental physics in preparation for careers at the most advanced level in research or teaching.

## Research and Study Opportunities

**Theoretical physics -- condensed matter.** Subjects for study include quantum condensed matter (topological phases, unconventional superconductivity, quantum criticality, strange metals, quantum spin liquids, strongly correlated systems); cold atomic gases (collective properties of Bose and Fermi condensates); density functional theory (novel ab initio approaches to electronic and liquid systems, and quantum Monte Carlo methods for electronic structure); quantum information (entanglement dynamics); statistical mechanics and critical phenomena applied to dynamical systems; complex systems, networks, and pattern formation; inverse problems in image reconstruction and phase retrieval algorithms.

**Experimental condensed matter physics.** Subjects of study include quantum materials & information (including unconventional and high-temperature superconductors, topological materials, two-dimensional materials, artificially engineered heterostructures); nanoscale systems (including nanoscale machines and robotics, atomic-scale kirigami); spintronics (spin torque, spin transport and dynamics in quantum materials); soft condensed matter (complex fluids, colloids, polymer networks); biophysics (single-molecule biophysics, molecular motors, protein crystallography, new x-ray detectors); and low-temperature physics.

**Theoretical physics -- particle and astrophysics.** Flavor physics and neutrino physics; Higgs physics; physics of the TeV scales and the mechanisms for electroweak symmetry breaking; collider phenomenology; lattice gauge theories; particle astrophysics and cosmology including dark matter physics; string theory and holography; string phenomenology and cosmology; field theories including conformal field theories and conformal bootstrap; astrophysics; black holes, entanglement and quantum information; general relativity, gravitational waves and LIGO physics.

**Experimental particle physics.** Our research uses the Large Hadron Collider (LHC) at CERN, which is the first collider to explore the TeV energy scale, where the Standard Model of particle physics must break down unless new phenomena appear. Cornell is a member of CMS, one of two detector collaborations for elementary particle physics at the LHC. Research topics include mechanisms for electroweak symmetry breaking, including the Higgs mechanism and alternatives, scenarios for physics beyond the Standard Model such as dark matter, supersymmetry, extra dimensions and new strong interactions, top quark physics, and dark matter. Cornellians are designing online software for the pixel detector, developing strategies for identifying electrons in the electromagnetic calorimeter, writing analysis software capable of handling petabytes of data distributed world-wide, and ensuring that the trigger will successfully pluck new physics out of the huge background of conventional processes. The group is the lead institution in the construction of hardware for the high-luminosity LHC (HL-LHC) and is

currently working on designing, testing and building the upgrades to the innermost tracking detector and the track trigger.

**Experimental and observational cosmology.** Our research focuses on studying the formation and evolution of the Universe using precision measurements of microwave light. These measurements are helping to address fundamental questions about our Universe, such as the nature of the dark energy and dark matter that dominate our Universe, as we search for evidence of physics beyond the concordance cosmology model. We build novel instrumentation in our laboratories that we deploy on microwave telescopes and analyze the data acquired from years of observations. Our instruments are designed to measure the cosmic microwave background (CMB), characterize emission from early galaxies, improve measurements of galaxy clusters, and enable new searches for time-domain astronomical sources. Cornell researchers are playing significant roles in several microwave observatory projects, including CCAT-prime, Simons Observatory, TIME, Atacama Cosmology Telescope, and CMB-S4.

**Accelerator physics.** Cornell's accelerator physics program is a leader in a broad range of accelerator science and technology research areas that are highly interdisciplinary in nature. These include photocathodes and high brightness electron sources, ultra-fast electron diffraction, beam dynamics and controls, accelerator design, as well as superconducting radio-frequency materials and technology R&D. Cornell University is known world-wide for training accelerator physicists with one of the largest graduate programs in accelerator physics in the US. Extensive on-campus research facilities, including the Cornell Electron Storage Ring (CESR), provide graduate students with unrivaled opportunities to be actively and crucially involved in each and every one of the research and accelerator projects being pursued at Cornell. Cornell's accelerator group is currently deeply involved in the design of the Electron-Ion Collider (EIC) and a future linear lepton collider (e.g., the International Linear Collider, ILC), and is also a member of the Center for Bright Beams, an NSF science and technology led by Cornell.

## Data and Statistics

- Doctoral Program Statistics (<https://gradschool.cornell.edu/about/program-metrics-assessments-and-outcomes/doctoral-program-statistics/?SelectGradField=36>)

## Field Manual

- Manual (<https://physics.cornell.edu/course-of-study/>)

## Subject and Degrees

### Physics

- Physics (PhD) (<https://catalog.cornell.edu/programs/physics-phd/>)

## Concentrations by Subject

### Physics

- experimental physics
- physics
- theoretical physics

## Faculty

James Paul Alexander (<http://physics.cornell.edu/jim-alexander/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental high-energy physics

Nozomi Ando (<http://ando.chem.cornell.edu/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Chemistry and Chemical Biology

Tomas Alberto Arias (<http://physics.cornell.edu/tomas-arias/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** condensed-matter theory

Youn Jue Bae (<http://chemistry.cornell.edu/youn-jue-eunice-bae/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Condensed matter physics, chemistry

Ivan Bazarov (<http://physics.cornell.edu/ivan-bazarov/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental particle physics

Rachel Bean (<http://astro.cornell.edu/rachel-bean/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** astrophysics

Eberhard Bodenschatz (<http://physics.cornell.edu/eberhard-bodenschatz/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed-matter physics

Judy Cha (<http://www.mse.cornell.edu/faculty-directory/judy-cha/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics

Debanjan Chowdhury (<http://physics.cornell.edu/debanjan-chowdhury/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical condensed matter physics

Itai Cohen (<http://physics.cornell.edu/itai-cohen/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed matter physics

Abigail T. Crites (<http://astro.cornell.edu/abigail-crites/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** Astrophysics

Csaba Csaki (<http://physics.cornell.edu/csaba-csaki/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical particle physics

Anil Damle (<http://www.cs.cornell.edu/~damle/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Theoretical Condensed-Matter Physics

James C. Seamus Davis (<http://physics.cornell.edu/jc-seamus-davis/>)

- **Campus:** Ithaca - (Graduate School Professor)
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental solid-state physics

Nils Deppe (<http://physics.cornell.edu/nils-deppe/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** Astrophysics

Jennet Elizabeth Dickinson (<http://as.cornell.edu/node/94528/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** Experimental Elementary Particle Physics

Ankit S Disa (<http://disa.aep.cornell.edu/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Condensed Matter and Material Physics; Optical Physics and Quantum Information Science

Eric Robert Dufresne (<http://www.lassp.cornell.edu/people/eric-dufresne/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** Biophysics

Christopher J. Earls (<http://www.cee.cornell.edu/faculty-directory/christopher-j-earls/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** quantum process tomography

Veit Elser (<http://physics.cornell.edu/veit-elser/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical condensed-matter physics

Valla Fatemi (<http://www.aep.cornell.edu/faculty-directory/valla-fatemi/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Hybrid Quantum Systems with Quantum Materials

Craig J. Fennie (<http://www.engineering.cornell.edu/faculty-directory/craig-j-fennie/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Advanced Materials Processing, advanced materials, condensed matter and material physics.

Eanna E Flanagan (<http://physics.cornell.edu/eanna-flanagan/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** general relativity; theoretical astrophysics; gravitational wave astronomy

Carl Peter Franck (<http://physics.cornell.edu/carl-franck/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental liquid physics; x-ray physics

Gregory Fuchs (<http://physics.cornell.edu/gregory-fuchs/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics

Lawrence K Gibbons (<http://physics.cornell.edu/lawrence-gibbons/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental elementary-particle physics

Paul H. Ginsparg (<http://infosci.cornell.edu/content/ginsparg/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical particle physics

Yuval Grossman (<http://physics.cornell.edu/yuval-grossman/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical particle physics

Sol Michael Gruner (<http://physics.cornell.edu/sol-gruner/>)

- **Campus:** Ithaca - (Graduate School Professor)
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** structure and properties of soft matter; biomaterials; x-ray instrumentation and methods

Thomas Hartman (<http://physics.cornell.edu/thomas-hartman/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: theoretical physics
- **Research Interests:** theoretical particle physics

Georg Hoffstaetter (<http://physics.cornell.edu/georg-hoffstaetter/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental accelerator particle physics

Natasha Grace Holmes (<http://physics.cornell.edu/natasha-holmes/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** physics and science education

Chaoming Jian (<http://www.physics.cornell.edu/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical condensed matter physics

Larry Kidder (<http://astro.cornell.edu/lawrence-kidder/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** Astrophysics

Eun-Ah Kim (<http://physics.cornell.edu/eun-ah-kim/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical physics; condensed matter physics

René Kizilcec (<http://infosci.cornell.edu/content/kizilcec/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Physics Education Research

Michael J. Lawler (<http://physics.cornell.edu/michael-lawler/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical physics; condensed matter theory

Andre Roger Leclair (<http://physics.cornell.edu/andre-leclair/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** high-energy theory

Matthias U. Liepe (<http://physics.cornell.edu/matthias-liepe/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** accelerator physics

Xiaomeng Liu (<http://physics.cornell.edu/xiaomeng-liu/>)

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- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** condensed matter physics

Natalie M. Mahowald (<http://www.eas.cornell.edu/faculty-directory/natalie-m-mahowald/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Global interactions between aerosols, climate and biogeochemistry

Kin Fai Mak (<http://physics.cornell.edu/kin-fai-mak/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed matter physics

Jared Michael Maxson (<http://physics.cornell.edu/jared-maxson/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** accelerator physics

Liam McAllister (<http://physics.cornell.edu/liam-mcallister/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical particle physics

Paul L. McEuen (<http://physics.cornell.edu/paul-mceuen/>)

- **Campus:** Ithaca - (Graduate School Professor)
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experiment solid-state physics

Peter McMahon (<http://www.aep.cornell.edu/faculty-directory/peter-mcmahon/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics

Karan Kartik Mehta (<http://www.engineering.cornell.edu/faculty-directory/karan-mehta/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** optics and photonics, atomic physics and technology, and quantum technologies

Jeffrey Andrew Moses (<http://www.aep.cornell.edu/faculty-directory/jeffrey-moses/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** Optical Physics and Quantum Information Science Biophysics

Erich Mueller (<http://physics.cornell.edu/erich-mueller/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** condensed matter physics

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- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical physics

Matthias Neubert (<http://physics.cornell.edu/matthias-neubert/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical high-energy particle physics

Michael Niemack (<http://physics.cornell.edu/michael-niemack/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** Experimental physics

Katja C. Nowack (<http://physics.cornell.edu/katja-nowack/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed matter physics

Juliet Ritchie Patterson (<http://physics.cornell.edu/ritchie-patterson/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental high-energy physics

Maxim Perelstein (<http://physics.cornell.edu/maxim-perelstein/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical particle physics

Daniel C Ralph (<http://physics.cornell.edu/daniel-ralph/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental nanoscale physics

Brad Jared Ramshaw (<http://bradramshaw.wordpress.com/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed matter physics

Chris Roh (<http://cals.cornell.edu/chris-roh/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** aeroacoustics, fluid mechanics

David L Rubin (<http://physics.cornell.edu/david-rubin/>)

- **Campus:** Ithaca - (Graduate School Professor)
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** high-energy particle accelerators

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- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental article physics

James Patarasp Sethna (<http://physics.cornell.edu/james-sethna/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** plasticity and fracture of materials; dislocation dynamics; crack growth laws and stochastic fracture models; crackling noise and avalanche behavior in magnets, plastic flow and other systems; multiparameter fits to data; statistical mechanics; material science; dynamical systems and quantum physics

Jie Shan (<http://physics.cornell.edu/jie-shan/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics

Kyle Shen (<http://physics.cornell.edu/kyle-shen/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed matter physics

Eric D. Siggia (<http://physics.cornell.edu/eric-siggia/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** evolution of antibiotic resistance, evolution of biological networks, evo-devo, bioinformatics of gene regulation

Andrej Singer (<http://www.engineering.cornell.edu/faculty-directory/andrej-singer/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** experimental condensed matter physics

Steven H Strogatz (<http://math.cornell.edu/steven-strogatz/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics

Saul A Teukolsky (<http://physics.cornell.edu/saul-teukolsky/>)

- **Campus:** Ithaca - (Graduate School Professor)
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** relativity and astrophysics

Julia Thom-Levy (<http://physics.cornell.edu/julia-thom-levy/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental particle physics

Robert Edward Thorne (<http://physics.cornell.edu/robert-thorne/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental condensed-matter physics; biological physics

Michelle D Wang (<http://physics.cornell.edu/michelle-wang/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** biological physics

Zheng Jane Wang (<http://physics.cornell.edu/jane-wang/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical physics

Ira M Wasserman (<http://astro.cornell.edu/ira-wasserman/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics; theoretical physics
- **Research Interests:** theoretical astrophysics

HannsJorg Artur Weber (<http://physics.cornell.edu/hannsJorg-weber/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** Experimental Elementary Particle Physics

Peter Wittich (<http://physics.cornell.edu/peter-wittich/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: experimental physics; physics
- **Research Interests:** experimental particle physics

Huili (Grace) Xing (<http://www.ece.cornell.edu/faculty-directory/huili-grace-xing/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** molecular beam epitaxy, temperature-dependent magnetoresistance, device nanofabrication and characterization.

Kenji Yasuda (<http://www.aep.cornell.edu/faculty-directory/kenji-yasuda/>)

- **Campus:** Ithaca
- **Concentrations:** *Physics*: physics
- **Research Interests:** condensed matter physics, nanotechnology, and quantum science