

# Graduate Program

**I** ILLINOIS

Physics

GRAINGER COLLEGE OF ENGINEERING

## WELCOME TO ILLINOIS PHYSICS

Selecting the right graduate school program to fit your career aspirations, your interests and work style, and where you'd like to live—it's a weighty decision that will define a good portion of your daily life for the next five to seven years. Beyond that, the work you'll do, the courses you'll take, and the relationships you'll form will all influence your career opportunities after graduate school.

The overall objective of our PhD degree program is to enable our graduates to pursue successful advanced technical careers in academia, business and industry, or national laboratories, by providing outstanding training in academics, research, and teaching methodologies, in a supportive, collaborative environment. We currently have about 274 physics graduate students working toward their PhD degrees, with roughly 50 percent engaged in theoretical/computational research and another 50 percent doing primarily experimental research. All of our graduate students are financially

supported through fellowships, teaching assistantships, or research assistantships. Illinois Physics graduate students enjoy the advantages that come from being part of a large research institution having state-of-the-art facilities. With roughly 70 faculty members engaged in leading-edge computational, experimental, and theoretical physics research, we offer incoming students a diverse range of research opportunities.

Finding a doctoral adviser who is a good match for your research interests and style is essential to your ultimate success. Your adviser will help guide

and provide resources for your original research and will work with you to edit your PhD thesis. Your doctoral adviser will also help you to establish the relationships within and outside the scientific community that will further your intellectual and career goals.

To help you find a research adviser, we offer first-year graduate students a required orientation course in which faculty members describe research opportunities in their groups. This course additionally offers basic training in scientific communications and ethics—to fully prepare you for research.

Our grad school curriculum includes an extensive range of courses that provide foundational training in advanced physics. An important part of our PhD program is one-on-one advising and mentoring to help students identify the best set of courses to take, given their varied background preparations.

Our program is dedicated to maintaining an environment that is conducive to the success of our graduate students. Each year, we graduate 35 to 40 PhD candidates, making our program one of the top producers annually of physics PhDs in the United States. Over the last 10 years, more than 96 percent of

our PhD graduates had job placements or had been admitted to postgraduate educational programs immediately following graduation. We are proud that many of our PhD graduates have gone on to make major contributions in science, industry, and government. The success of our graduates is a testament to the quality of our program—and to the caliber of our students.

We are looking for PhD students who not only have an aptitude for physics research but have demonstrated through their coursework and other activities a firm foundation in undergraduate physics and the ability to work hard. For that

reason, our applicant review process is holistic, giving individual attention to all components of the graduate application. We believe diversity among our student body and faculty contributes to a richer intellectual environment, and so we welcome applications by students from groups historically underrepresented in physics.

We invite you to explore our program more deeply to find out how Illinois Physics might fit your aspirations.

**PROFESSOR LANCE COOPER**  
**Associate Head for Graduate Programs**

# PHYSICS RESEARCH “URBANA STYLE”

Illinois Physics—ranked among the top ten physics departments in the U.S. by the National Research Council of the National Academy of Sciences—is world renowned for its traditional “Urbana style” of research. Defined by its collegial spirit and open collaboration across areas of expertise—where theorists and experimentalists work together to drive discovery—the “Urbana style” continues to foster innovation in an atmosphere of intellectual freedom.

It’s in this unique academic environment that we train future generations of scientists and leaders. The doctoral thesis—the presentation of original research by a PhD degree candidate—is the culmination of many years’ preparation.

Our graduate students work with preeminent faculty in traditional physics disciplines, including astrophysics/cosmology, condensed matter physics, gravitation, high energy physics, and nuclear physics, and in younger fields of study, such as atomic, molecular, and optical physics, biological physics, physics education research, and quantum information. Additionally, some of our graduate students conduct research with faculty in other departments, including astronomy, bioengineering, chemistry, electrical and computer engineering, materials

science and engineering, math, and mechanical science and engineering—many also ranked among the top ten U.S. programs in their fields.

At Illinois, great research facilities enable collaborative, interdisciplinary projects. In addition to state-of-the-art research laboratories, physics faculty and students make use of specialized research infrastructure and equipment at campus-wide facilities. Some faculty also carry out research at two national labs within two hours’ driving distance of campus, Argonne National Laboratory and Fermi National Accelerator Laboratory.

Here, you will learn research methodologies and be exposed to research opportunities starting your first semester. You should be ready to join a lab or research group by the summer

## CORE RESEARCH AREAS

Astrophysics, Gravitation, and Cosmology

Atomic, Molecular, and Optical Physics

Biological Physics

Condensed Matter Physics

High Energy Physics

Nuclear Physics

Physics Education Research

Quantum Information

before your second year. When ready to engage in independent research in collaboration with a physics faculty member (or, with departmental approval, on a physics topic with a faculty member in a related department), you will earn coursework hours through *Physics 599 Thesis Research*.

The original research you conduct at Illinois Physics will prepare you for a career at the forefront and in the intersections of physics.



## COLLABORATIVE RESEARCH FACILITIES AT ILLINOIS

Beckman Institute for Advanced Science & Technology

Carl R. Woese Institute for Genomic Biology (IGB)

Center for the Physics of Living Cells (CPLC)

Illinois MRSEC (Materials Research Science and Engineering Center)

Illinois Quantum Information Science and Technology Center (IQUIST)

Institute for Condensed Matter Theory (ICMT)

Micro and Nanotechnology Laboratory (MNTL)

National Center for Supercomputing Applications (NCSA)

NCSA Petascale Computing Facility

NIH Center for Macromolecular Modeling & Bioinformatics



## COURSEWORK

Our graduate program provides a firm foundation in physics, mathematics, and advanced research topics through a variety of advanced course offerings, including research-level special topics courses.

Since our graduate programs are highly specialized, there are very few specific course requirements. Student advising is tailored to individual interests and proficiencies, to ensure readiness for requisite milestones: the qualifying exam in the second year, the preliminary exam in the third year, and the thesis defense prior to graduation.

First-year students typically take two to three courses per semester and prepare for the qualifying exam. Many serve as teaching assistants while they look into research opportunities. By the first summer after enrollment, most students formally join a research group.

### FIRST YEAR

First-year students typically take two to three courses per semester and prepare for the qualifying exam. Many serve as teaching assistants while they look into research opportunities. By the first summer after enrollment, most students formally join a research group.

Courses commonly taken by students in their first year include *Physics 580/581 Quantum Mechanics I/II*, *Physics 508/509 Mathematical Methods A and B*, *Physics 505 Electricity and Magnetism*, and *Physics 504 Statistical Physics*.

A breadth requirement is satisfied by completing two introductory graduate-level courses in any of the following: biophysics, nuclear and particle physics, astrophysics, quantum optics and information or atomic physics, or condensed matter physics.

### SECOND YEAR

Second-year students sit for their qualifying exam at the start of the year. The “qual” tests foundational knowledge in four key areas: classical mechanics, electricity and magnetism, quantum mechanics, and statistical physics. Second-year students typically enroll in one or two advanced courses each semester in preparation for research and spend the balance of their time doing research. Many serve as research assistants in this and subsequent years.

### THIRD YEAR

In the third year, students focus more intently on research, taking perhaps one specialized course per year. This is the year students typically prepare and present their preliminary examination. The “prelim” consists of a 15-page paper and research presentation describing the PhD student’s proposal for thesis research, which is evaluated by a committee of four or five faculty members.

### FOURTH YEAR

During the fourth year and up to the thesis defense, students focus entirely on research, taking only an occasional seminar course.

## SCIENTIFIC WRITING & PRESENTATION

Training in scientific communications and ethics is invaluable to success in graduate school—and to aspirations beyond the PhD.

We offer several professional development opportunities to help our graduate students become better communicators of science.

All first-year students are required to take *Physics 596 Graduate Physics Orientation*, which covers scientific writing, scientific presentation, research collaborations, scientific ethics, and more.

Beyond that, students may elect to take *Physics 598 PEN Communicating Physics Research*, which provides more advanced instruction and practice in scientific writing and presentation, as well as grant proposal writing.

Optional instruction in proposal writing is also offered in a yearly Graduate Fellowship Workshop and in an NSF Graduate Fellowship Precompetition. These provide basic training in proposal writing to students interested in submitting NSF, DOE, or other graduate research fellowship applications.



```
Tophat2 : error type1

[2018-09-13 22:36:52] Beginning Tophat run (v2.1.1)
[2018-09-13 22:36:52] Checking for Bowtie
  Bowtie version: 2.3.2.8
[2018-09-13 22:36:52] Checking for Bowtie index files (genome)..
[2018-09-13 22:36:52] Checking for reference FASTA file
[2018-09-13 22:36:52] Generating SAM header for /home/mirror/igenome/Homo_sapiens/UCSC/hg19/Sequence/Bowtie2Index/genome
[2018-09-13 22:36:53] Preparing reads
  left reads: min. length=35, max. length=42, 26215872 kept reads (18664 discarded)
  right reads: min. length=35, max. length=42, 26154495 kept reads (71261 discarded)
Warning: you have only one segment per read.
  If the read length is greater than or equal to 45bp,
  we strongly recommend that you decrease --segment-length to about half the read length because Tophat will work better with multiple segments
[2018-09-13 22:44:57] Mapping left_kept_reads to genome genome with bowtie2
[2018-09-13 23:04:25] Mapping right_kept_reads to genome genome with Bowtie2
[2018-09-13 23:23:23] Searching for junctions via segment mapping
  Coverage-search algorithm is turned on, making this step very slow
  Please try running tophat again with the option (--no-coverage-search) if this step takes too much time or memory.
[2018-09-14 18:03:37] Retrieving sequences for splices
[2018-09-14 18:05:38] Indexing splices
Building a SMALL index
[2018-09-14 18:10:58] Mapping left_kept_reads_unmapped to genome segment_juncs with Bowtie2 (1/1)
[2018-09-14 18:11:29] Joining segment hits
[2018-09-14 18:23:43] Mapping right_kept_reads_unmapped to genome segment_juncs with Bowtie2 (1/1)
[2018-09-14 18:24:31] Joining segment hits
[2018-09-14 18:37:07] Reporting output tracks
[FAILED]
Error: [Errno 2] No such file or directory: /home/groups/song/songlab2/somangk2/Leio_Myo_paired/MYO_PT728_S12/tmp/accepted_hits0_sorted.bam!
Found 0 junctions from happy spliced reads
```



## TEACHING ASSISTANTSHIPS

Teaching is a core mission of Illinois Physics, and we are nationally recognized as leaders in physics education. In our TA training program, new TAs learn specific pedagogical techniques to become effective teachers, entrusted to maintain and contribute to the high quality of our undergraduate instruction.

Training begins with a “boot camp” for all new teaching assistants the week before fall semester begins. Experienced TAs share best practices and provide feedback while new TAs engage in various practice-run teaching scenarios. Training continues throughout the first year; each introductory physics course is assigned an experienced TA to serve as a mentor to guide new TAs.

As a measure of the success of our training program, each semester many of our TAs are ranked “Excellent” by their students in the university’s formal instructor-evaluation program.

## STUDENT LIFE

Illinois Physics is a vibrant, inclusive, and collegial community of scholars, set within the rich cultural backdrop of the twin cities of Urbana and Champaign.

Our graduate students work hard. To help relieve the typical stress associated with research and teaching and to help foster a collegial environment among students and faculty, we organize a number of social activities for graduate students each year.

We host a picnic for all graduate students, faculty, and staff early each fall semester to welcome the first-year physics graduate students. And Illinois Physics graduate students run an annual Illinois Physics Physical Revue, a departmental talent show, each December, which features graduate student and faculty musical acts, comedy skits, movie shorts, and more.



We support several graduate student organizations, which contribute to the supportive climate at Illinois.

### PHYSICS GRADUATE STUDENT ASSOCIATION (PGSA)

The PGSA is active throughout the academic year and runs a variety of social and academic activities for our graduate students, including Physics Fridays Ice Cream Socials, brown-bag lunches with faculty members, a biweekly movie night, a physics graduate student colloquium, a PGSA picnic each semester, a barbecue for incoming students at the beginning of the year, and a basketball tournament. The PGSA also sponsors a department softball team, the “Wild Bohrs,” which plays in a Champaign-Urbana city league.

### ILLINOIS GPS

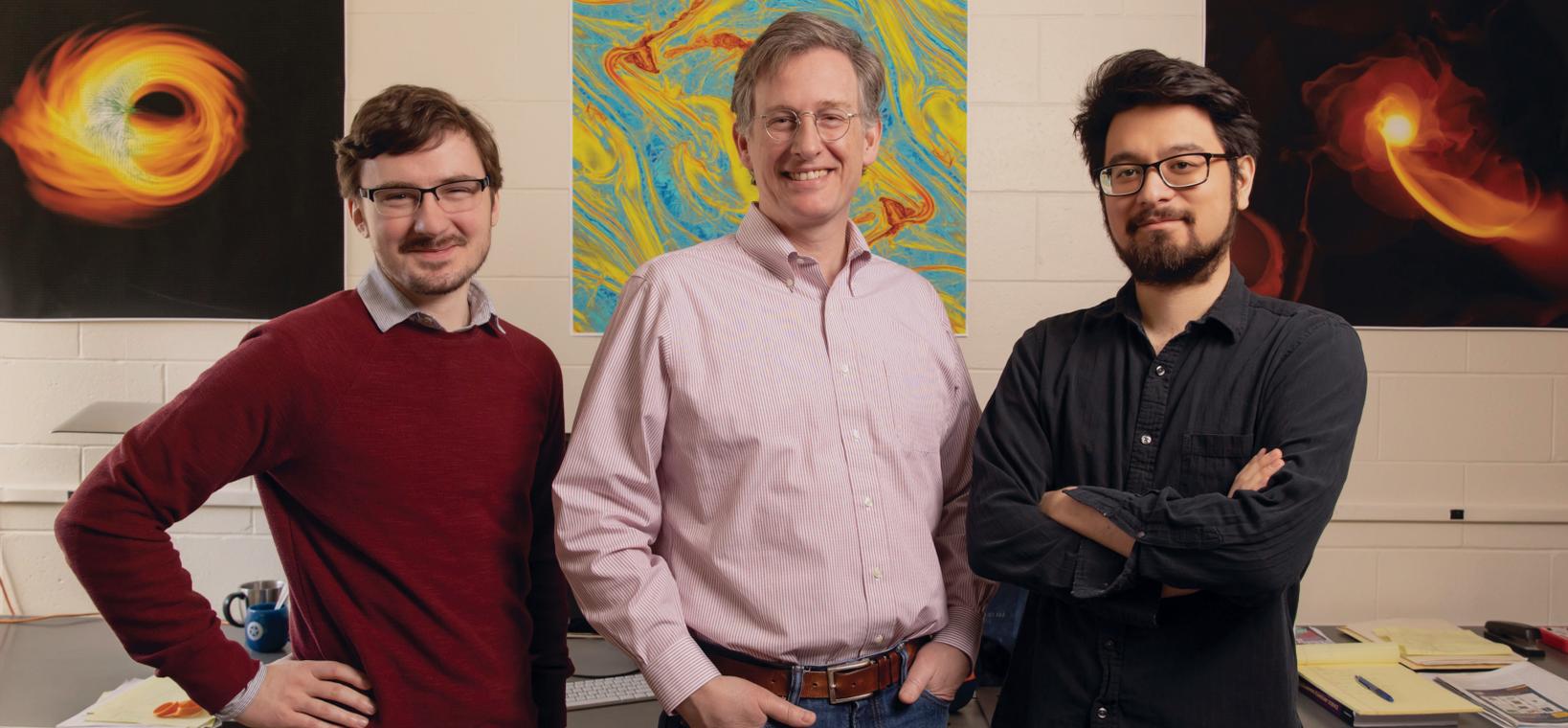
Illinois GPS, a member organization of the multi-campus ACCESS Network, provides physics-grad-to-physics-undergrad student mentorship. This voluntary program matches students based on personal profiles and preferred style of mentoring.

### THE GRADUATE STUDENT DIVERSITY COMMITTEE

The Graduate Student Diversity Committee, appointed by the associate head for graduate programs, helps guide graduate-driven initiatives that support inclusion and equity and serves as a sounding board for the Physics Faculty Diversity Committee.

### WOMEN IN PHYSICS

Women in Physics holds regular meetings and lunches for women faculty, postdocs, and graduate students.



## CAREER PLACEMENT

As our graduate students approach the thesis defense—both the apex and the terminus of their doctoral program—their futures loom large. An integral part of our training of the next generation of great scientists is preparing them for their successful transitions to productive careers.

To enhance the visibility of our graduate students' research and improve their ability to network and find job opportunities, we run a Physics Graduate Student Travel Award Program for our students interested in attending scientific conferences and workshops.

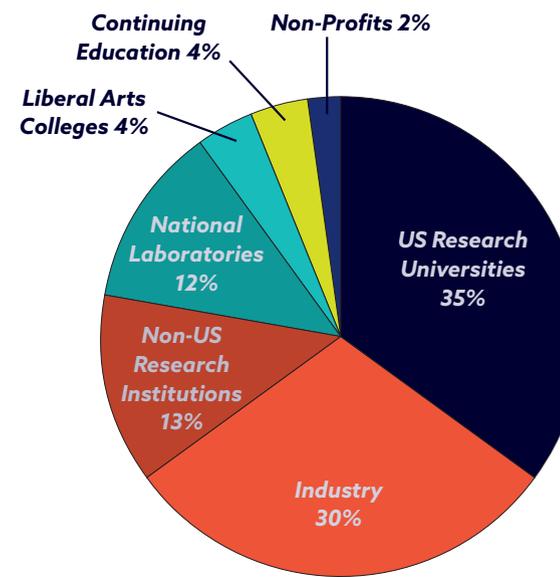
Invaluable career guidance from visiting PhD alumni is offered to our graduate students through our Physics Careers Seminar series. Speakers describe their varied career paths in industry, academia,

finance, medicine, law, and government, demonstrating the wide range of possible professions for physics PhDs.

The graduate programs office runs a Physics Grad Student Blog, where updated job, fellowship, and research information and links are posted daily. We also encourage our graduate students and our alumni to join our Illinois Physics LinkedIn network, to trade information about jobs.

We recognize the importance of building our graduate students' CVs. The department confers several graduate student awards annually to deserving students. We also regularly nominate or support the application of our graduate students to non-departmental research fellowships and distinctions.

### Initial Placement of 503 PhD Graduates (96% placement rate) 2005-2019



### Non-Departmental PhD Fellowships Conferred 2016-2019

- NSF Graduate Research Fellowship (15)
- Graduate College Fellowship (6)
- DOE Graduate Student Research Fellowship (4)
- NDSEG Fellowship (3)
- SURGE Fellowship (3)
- Dissertation Completion Fellowship (2)
- Illinois Distinguished Fellowship (1)
- Blue Waters Fellowship (1)
- CompGen Fellowship (1)
- NSERC Fellowship (1)
- Kavli Institute for Theoretical Physics Fellowship (1)

### Top Job Placements of Illinois Physics PhDs at Graduation 2005 to 2019

RANK	US ACADEMIC INSTITUTION	INDUSTRY	NATIONAL LABORATORY
1	Harvard	Intel	Los Alamos
2	Stanford	IBM	Argonne
3	U.C. Berkeley	Microsoft.	NIST
4	Princeton	Bloomberg L.P	Brookhaven
5	MIT	Google	Fermilab
6	U.W. Seattle	Goldman Sachs	Sandia
7	Northwestern	Bank of America	National Institutes of Health



Physics

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Graduate Student Blog

[PHYSICS.ILLINOIS.EDU/ACADEMICS/GRADUATES/BLOG/](https://physics.illinois.edu/academics/graduates/blog/)

Apply

[PHYSICS.ILLINOIS.EDU/ADMISSIONS/GRADUATES/APPLY.HTML](https://physics.illinois.edu/admissions/graduates/apply.html)

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