The background of the entire page is a black field filled with a complex, abstract pattern of glowing, multi-colored lines. These lines, in shades of purple, blue, green, yellow, orange, and red, swirl and loop together, creating a sense of dynamic movement and interconnectedness, reminiscent of particle tracks or data visualization in physics.

Physics & Astronomy at Penn: A GUIDE TO RESEARCH

by Sophie Kadan, CO'25

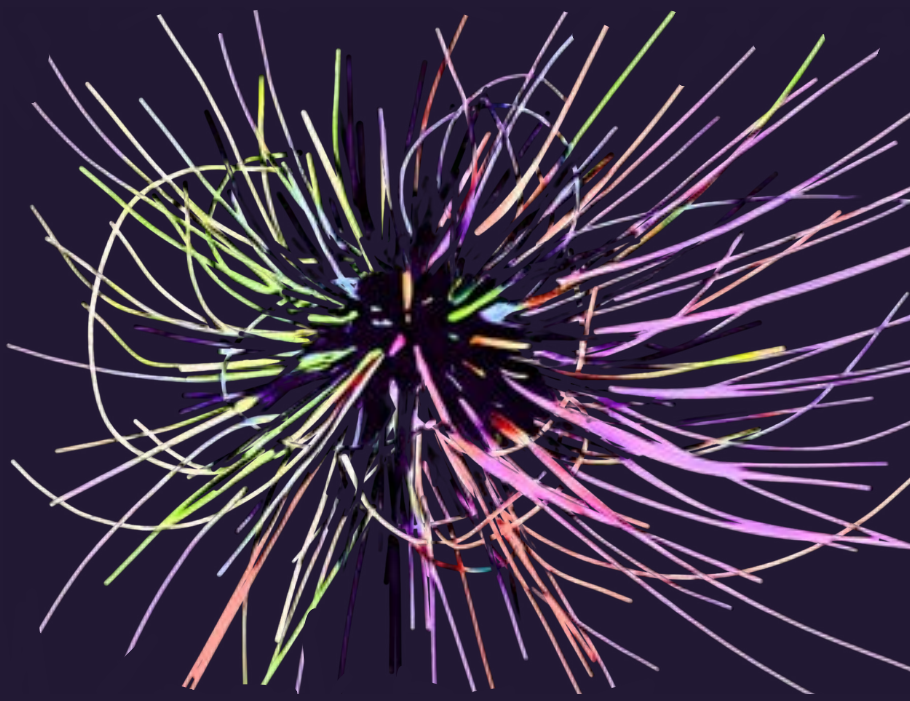
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1. OVERVIEW OF PHYSICS RESEARCH

Particle Physics

is the study of the fundamental particles and forces of the universe. Specifically, researchers collide protons with high energy accelerators, which reveals important properties of new particles and the nature of dark matter.



Condensed Matter Physics

explores the properties and behavior of solid and liquid matter, with research topics ranging from superconductors to topological insulators.

Astrophysics

studies the properties of black holes, dark energy, and exoplanets, while

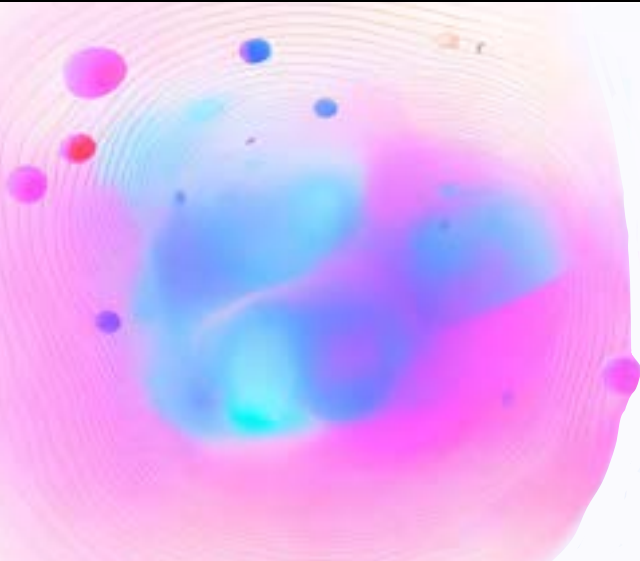
Cosmology

involves understanding the origin, evolution, and large-scale structure of the universe.



Biophysics

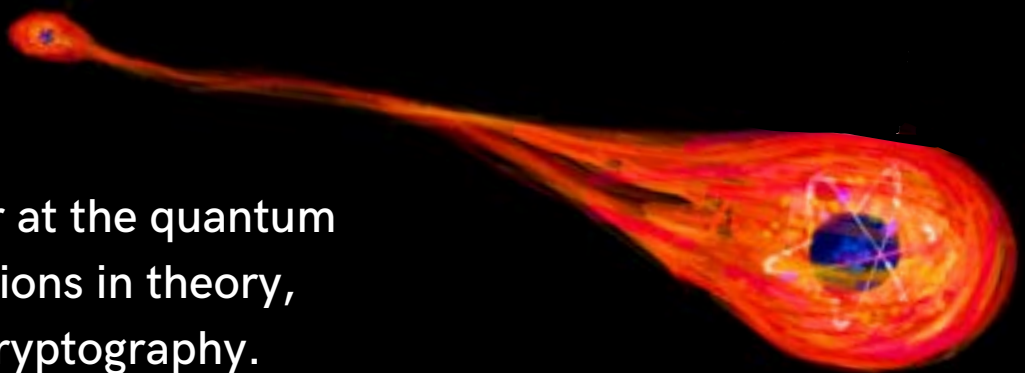
explores the physical principles underlying biological processes. This may include modeling protein folding and molecular interactions—or even complex neurological systems!



Quantum Physics

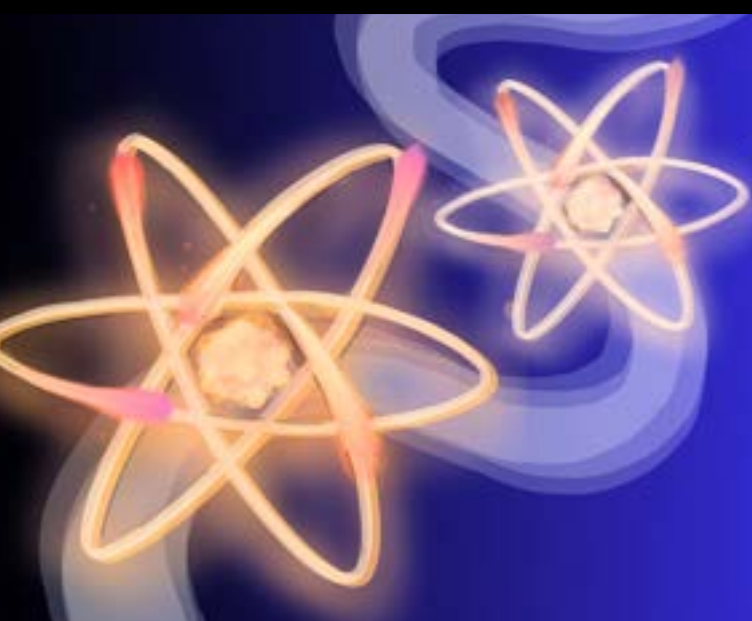
is the study of matter at the quantum scale, with applications in theory, technology, and cryptography.

Research in the field currently investigates topics such as quantum computing, entanglement, and information theory.



More Topics

Other physics research lies in many interdisciplinary applications, from medical imaging to optical materials and lasers. Theoretical work includes topics such as M-theory, which extend upon experimental findings and mathematical theorems.



2. HOW TO GET STARTED

Identifying Faculty

Identifying a Faculty Research Mentor is a critical step in your research journey, and CURF's Research Directory can help you get started. This resource provides an extensive list of faculty members that are open to discussing research opportunities with undergraduates. Students may reach out to hear more about open positions during the semester or the summer—many of which are even available to eligible students as "work-study" positions.

It should be noted before engagement with the directory that its listings are subject to change over time: the inclusion of a faculty member in the directory does not guarantee collaboration, and students should search on physics faculty websites for additional opportunities. Good luck!



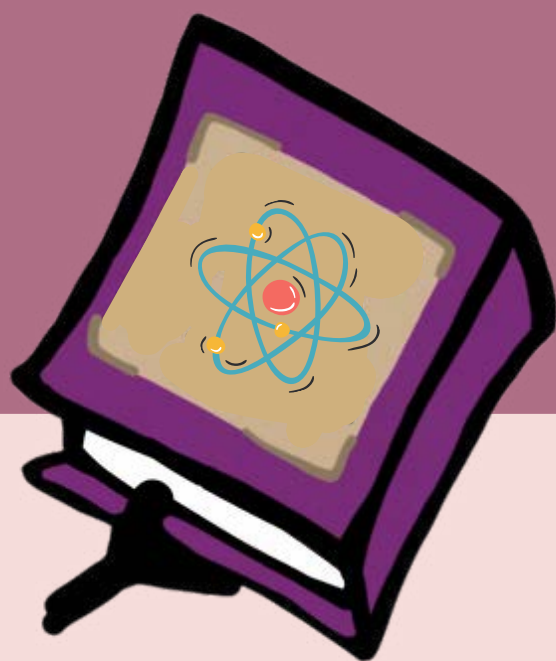
Before reaching out to potential mentors, review the tips on how to contact faculty members provided below.

Reaching out to faculty

Faculty members generally welcome undergraduates in their research, though finding the right mentor requires careful consideration. Because of this, students should avoid sending generic messages to multiple professors.

They should instead identify researchers whose work genuinely interests them, then explore faculty websites or recent publications. Before any email is sent, students should be well-versed in a professor's research areas—as well as why these topics seem interesting.

During an interview, students should ask relevant questions and show intellectual curiosity when possible! Sending a "thank you" response afterwards is strongly advised—and when it comes time for you to make a decision, potential mentors should always be kept informed.



Useful Links

[CURF Research Directory](#)

[Physics Faculty Research Site](#)

[CURF Newsletter Sign-Up](#)

[CURF Undergraduate Research Canvas Sign-Up](#)

[CURF's Tips on Contacting Faculty](#)

[Penn Career Services Resume Builder](#)

[Penn Grants and Funding Opportunities](#)

[Summer Opportunities at Penn](#)

3. COMMON QUESTIONS

1. "Am I Qualified?"

Students often question their qualifications for research, worried that professors will not be willing to mentor them. However, most faculty members are enthusiastic about nurturing young talent: they understand that students have to start somewhere.

2. "How Can I Choose a Lab?"

As a beginner, your role is to explore new topics and ask many questions! Talking to your professors, reaching out to Research Peer Advisors (RPAs), or chatting with upperclassmen can help you refine your search. These mentors can help you decide whether a topic is right for you—and if you still feel stuck, they may direct you to a few useful opportunities to try instead!

3. "How Can I Find a Mentor That is the Right Fit?"

When evaluating mentor fit, students should think critically about the mentor's style, their approach to mentorship, and what the lab environment is like. At the undergraduate level, those are more important than the specific content of the research in ensuring an enriching and meaningful research experience.

4. "How Can I Manage My Time Between Research and Coursework?"

Students often wonder about balancing research with coursework, and a key takeaway is that there is no rush to start right away. Begin when you are ready and have a good understanding of the demands on your time and are confident you won't be overwhelmed. Be sure to communicate proactively with your mentors about any time management or scheduling conflicts that may come up.

5. "Is Uncertainty Normal?"

Uncertainty is a part of research, even for experienced scientists. It's okay not to have all the answers, and it's okay if your research does not reach any definite conclusions. In fact, research often raises more questions than it answers.

6. "Do I Have to Stay at the Same Lab for All 4 Years?"

While there are many benefits to staying in a lab long-term, sometimes students may discover that the research focus or lab environment is not a good fit. If this happens to you, it is entirely okay to leave the lab.

7. "Are there Benefits to Working in Different Labs?"

Working in different labs—or switching labs altogether—can offer you the opportunity to explore new research areas, learn different techniques, and work with different mentors. It also allows you to refine your research interests and gain a broader perspective in physics for research in graduate school and beyond!

4. RESEARCH OPPORTUNITIES

1. CURF-Sponsored Opportunities

CURF provides many opportunities for Penn students to take part in research and internships over the summer and during the semester. Notably, Penn's PURM program funds first- and second-year students in mentored summer projects, regardless of previous research experience!

2. National Science Foundation (NSF) Research Experiences for Undergraduates (REU)

[NSF REU programs](#) are available in many scientific subfields. These programs provide paid summer research experiences at universities across the United States.

3. NASA Internships

NASA offers a variety of internships and co-op programs for undergraduate students in areas such as astrophysics, planetary science, and space technology.

4. Department of Energy (DOE) Science Undergraduate Laboratory Internship (SULI)

The DOE offers internships at national laboratories where students can work on cutting-edge research projects in fields like nuclear physics, materials science, and more.

5. CERN Summer Student Program

Located in Geneva, Switzerland, CERN is the European Organization for Nuclear Research. They offer a highly competitive summer program for students interested in particle physics and related topics.

6. Fermilab Internships

Fermilab is a U.S. national laboratory that specializes in high-energy physics, and it offers various internships and education programs for motivated undergraduate students.

7. American Physical Society (APS) Internships

APS offers a wide variety of internships, job postings, and networking opportunities for students, from research/education positions to policy-related initiatives.

8. Industrial Internships

Many tech companies, engineering firms, and research organizations offer internships and co-op programs where interested undergraduates can apply their skills in a practical setting.

To find and apply for these programs, check their respective websites, reach out to CURF, or speak with Penn Career Services. Consider also networking with professors and peers who may know of opportunities in your field of interest!

5. OTHER WAYS TO GET INVOLVED

1. Penn Directed Reading Program (DRP)

The DRP is a half credit P/F course that Penn undergraduates may apply to at the beginning of each semester. While the course is offered by the mathematics department, accepted students may independently study a topic of interest with their paired graduate student mentor.

2. Research-Based Courses and Seminars at Penn

Penn offers several undergraduate physics research courses and seminars that introduce students to the research process. Attend department colloquia to explore new areas of physics research.

3. Join Physics Clubs at Penn

Join clubs like the Society of Physics Students (SPS) to engage with fellow students and participate in activities that enhance your understanding of physics.

4. Exam Competitions

Participate in physics competitions such as the University Physics Competition, where students solve real-world problems. Penn also hosts local competitions for interested students.

5. American Physical Society (APS) Meetings

Attend APS meetings, which often include sessions for undergraduate research presentations and networking opportunities. Don't miss their March and April meetings!

6. Physics Summer Schools

Attend specialized summer schools like the Perimeter Institute for Theoretical Physics PSI START program to delve deeper into novel topics and research in physics.

7. Physics Teaching Assistantships

Gain teaching experience by becoming a teaching assistant for undergraduate physics courses, where you can help fellow students understand complex concepts and develop your own knowledge and communication skills.

8. Physics Outreach Programs

Get involved in outreach programs that promote physics education in local schools and communities, such as Penn's Physics Demonstration Program.

6. SHARE YOUR WORK!

When considering the following outlets, make sure to carefully read their submission guidelines, review processes, and editorial policies. It's important to ensure that your research meets their criteria and that you follow their formatting and citation guidelines. Additionally, seek guidance and approval from your research advisor or faculty mentor throughout the submission and publication process.

1. CURF Fall Expo and Spring Research Symposium

Every year, CURF hosts two presentation opportunities: the Fall Expo and the Spring Research Symposium. These sessions allow students to showcase their research to a broader audience.

2. Undergraduate Journals

Some journals are dedicated exclusively to publishing research by undergraduate students. These include The Journal of Young Investigators (JYI) or The Physics Review. Penn also runs its own undergraduate science research journal, *PennScience*. Consider submitting there, or in any other of Penn's [subject-specific journals](#)!

3. PeerJ Preprints

While not specifically an undergraduate journal, PeerJ Preprints is an open-access platform where researchers can share their preprint articles. This is helpful in making your research findings accessible before a formal peer-reviewed publication.

4. arXiv

While primarily known for hosting preprints in physics, mathematics, and related fields, arXiv allows researchers to share work in a variety of different topics with the science community.

5. American Physical Society (APS) Meeting Abstracts

Some APS meetings and conferences offer an opportunity for undergraduates to present their research and publish abstracts in the conference proceedings.

6. Local or Regional Conferences

Many universities and organizations host local or regional conferences where undergraduate researchers can present their findings. While not formal journal publications, they offer valuable exposure. Undergraduate women should consider applying to the yearly APS CUWIP conference in the Fall!

7. Special Undergraduate Sections

Some journals, especially those in the education and science communication fields, have special sections or issues dedicated to publishing undergraduate research.

7. GRADUATE SCHOOL TIPS

Graduate schools in physics typically look for a combination of academic qualifications, research experience, and personal qualities. While undergraduates are just beginning their academic journey, there are a few steps that can be taken even now to prepare for future work in physics. Below is a broad list of what many graduate schools may search for.

1. Strong Academic Record

Maintain a high GPA in your physics and related math courses, and try to take advanced courses when possible. Graduate schools often have minimum GPA requirements, and they look for students who challenge themselves with relevant coursework.

2. Research Experience

Begin working on research projects as early as you and your mentor feel that a topic is right! This can involve taking the lead in research assistantships or independent projects with faculty.

3. Letters of Recommendation

Get to know your professors! Strong relationships with professors can both guide your interests and aid in strong letters of recommendation. Your research advisors are particularly important for these letters.

4. Extracurricular Activities

Participate in physics-related clubs, conferences, or events. Show your passion for the subject beyond coursework.

5. Publications and Presentations

If possible, contribute to research publications or present your work at conferences. This can set you apart from other applicants and improve your written and verbal communication skills!

6. Diversity and Inclusion

Some programs are actively looking to diversify their student body, so highlight any relevant experiences or perspectives.

7. Funding and Scholarships

Search for funding opportunities, scholarships, and fellowships that may be available to support your graduate studies. Often, additional funding allows advisors to take on students that their lab would otherwise not have the budget for.

8. Contribute to the Community

Show that you can be a valuable member of the academic community, whether through outreach, mentoring, or other activities.