

UG Research: Discovery in Science or an Oxymoron

PhySU UG Research Conference

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27 Mar 2026

Outline of my talks

1. Why do research?
2. UG research opportunities
3. How to arrange/find an UG research project
4. UG research outside the department



Should you do research as an undergraduate?

Here is one answer: NO

- Your primary task as a student, at this time, is to learn physics
- Focus on taking courses
 - Need to know theory
 - Lab courses teach about uncertainties, etc.
- You can also learn physics that is close to doing research
 - Just try to figure things out for yourself
 - Talk to friends
 - Hang out in PhySU lounge



“My cousin was a better student in mathematics than I was, but he was astounded when I showed him an alternative proof for one of the theorems. It would never have occurred to him to try to find his own proof of something we had been taught in class.”

Max Born, from “My Life”

Should you do research as an undergraduate?

Here is another answer: YES

- Your primary task as a student, at this time, is to learn physics
- Lecture and lab courses are “table stakes” for learning physics
- You also should have an immersive research experience
 - Real, challenging problems
 - Solve problems that don’t have an obvious answer
- Important for improving problem-solving skills
 - Next Job!
- Also important if you are thinking of doing advanced research degree
 1. You need to find out if you like doing research
 2. You will need letters of recommendation from someone who can attest that you are good at it.

A bit more about “to find out if you like doing research”

Doing research is not like doing courses

- You generally don't really know what you are doing
- There are people who can advise, but if they knew the answer they wouldn't need to do research
- You can work for very long times without any feedback, and without knowing if it will work

But then, magically, it all comes together

A “miracle”!

- Although learning, it is not so obvious what you are learning
- It can be very frustrating

Some people discover that they hate doing research

- Good to find out if you like it, before you start a 5-year PhD.

When (in your degree) you should do research?

First-year students typically don't have enough physics and mathematics

- Doesn't prevent one, but competing with 3rd and 4th year students

Second-year has some opportunities

- ROP299 are best example, but limited

Third year is the optimal time to start doing research

- Summer between 2nd and 3rd year
- Fall, winter or summer after 3rd year

Fourth year is most popular

- Have developed an area of focus and more familiar with research effort
- More productive in research groups

Physics has a number of resources

Department UG website is a good place to start

- Courses
- Employment as research assistants
- Fellowships
- Career programs (less research but important opportunities)

Research, Mentorship, and Career Opportunities

Supervised Courses in Physics
(PHY37x/PHY47x)

Research, Employment, Summer Opportunities

Summer Undergraduate Research Fellowship
(SURF)

Summer NSERC Undergraduate Student
Research Award (USRA)

UofT Physics Summer Student Program

Physics Directed Reading Program

Physics Career Accelerator Program

Career Opportunities in Physics

UofT Career Exploration & Education

Kinds of Research Positions

1) Paid positions (we pay you):

- Options: USRA, SURF, UTEA, Summer employment opportunities
- [Research, Mentorship, and Career Opportunities](#) has other possibilities
- Paid positions may be less structured



2) Supervised courses (you pay us):

- These need to be well structured, with a defined goal, benchmarks, final report and a final oral examination
- [Supervised Courses in Physics \(PHY37x/PHY47x\)](#)
- these are excellent opportunities to do research.



Various steps to find (or be awarded) a research project

For USRA, SURF, UTEA and other scholarships

- USRA Project descriptions are put together by potential supervisors
- Applicants are ranked – basically grades
- Offered award and students identified supervisor
- SURF is similar, though ranked on statement of interest
- Selection of projects

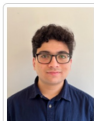
2025 Summer Undergraduate Research Fellowship (SURF)

Winners of the 2025 Summer Undergraduate Research Fellowships (SURF)

Student's Name: Kunaal Chandrashekar

Supervisor: Professor Sidhartha Goyal

Project Title: Studying variable gene expression at invertible promoters and its role in bacterial multicellularity



Student's Name: Bill Chen

11:13 AM

NSERC (USRA) Summer Student Research Job Opportunities

No.	Supervisor	Research	Student(s)
1	Arun Paramakanti	Quantum materials	Eve Lebon
2	Sergio de la Barrera	Building new quantum materials layer-by-layer	Emma Creelman (Chair's Scholar)
3	Sergio de la Barrera	Design and assembly of electronics	
4	Amar Vutha	Precision physics with ions in crystals	Nathan Wang
5	Kaley Walker	Atmospheric Remote Sensing and Spectroscopy 2026	
6	Debra Wunch	Measuring and Quantifying Toronto's Greenhouse Gas Emissions 2026	Nicolas Douville (Chair's Scholar)
7	Valentin Crépel	Numerical simulation of strongly correlated quantum many-body systems	Theodore Manev; Sam MacFadden-Quastel
8	Stephen Julian	Adiabatic Demagnetization Stage for Millikelvin Measurements	Jason Romanof
9	Ziqing Hong, Miriam Diamond, Pekka Sinervo	Dark matter 2026	Rhea Zhu (Chair's Scholar); Simon Cao; David Hussein
10	Dvira Segal	Open Quantum Systems	Alissa Guissine
11	Al-Amin Dhirani	Leveraging a recently discovered quantum phenomenon	
12	Paul Kushner, Yoni Kahn	Are heatwaves influenced by polar regions	Harry Wang
13	Young-June Kim	Magnetism and superconductivity in quantum materials	William Zheng
14	Boris Braverman	Precision measurement with atoms and light	
15	Joseph Thywissen	Ultracold Atoms 2026	Vinz Andrei Mariano (Chair's Scholar)
16	Nicolas Grisouard	Oceanic density fronts dynamics	
17	Nicolas Grisouard	Wave radiation from seamounts 2026	
18	Erica Rosenblum	Thermohaline Staircases in a Changing Arctic Ocean	Trevor Yeung
19	Morgan E O'Neill	Firenadoes!	

Supervised Courses (Reading and Research)

The most common form of immersive research experience

- Have third and fourth year versions
- Supervised reading (PHY371Y/2H and PHY471Y/2H) and Supervised research (PHY378H/9Y and PHY478H/9Y)

Need to identify a supervisor

- This is an excellent skill to develop
- Also the most challenging

Agree on project description and syllabus

- List of previous projects helpful

Submit for approval

Supervised Courses in Physics
(PHY37x/PHY47x)

Information about 3rd and 4th year undergraduate supervised research or study for course credit.

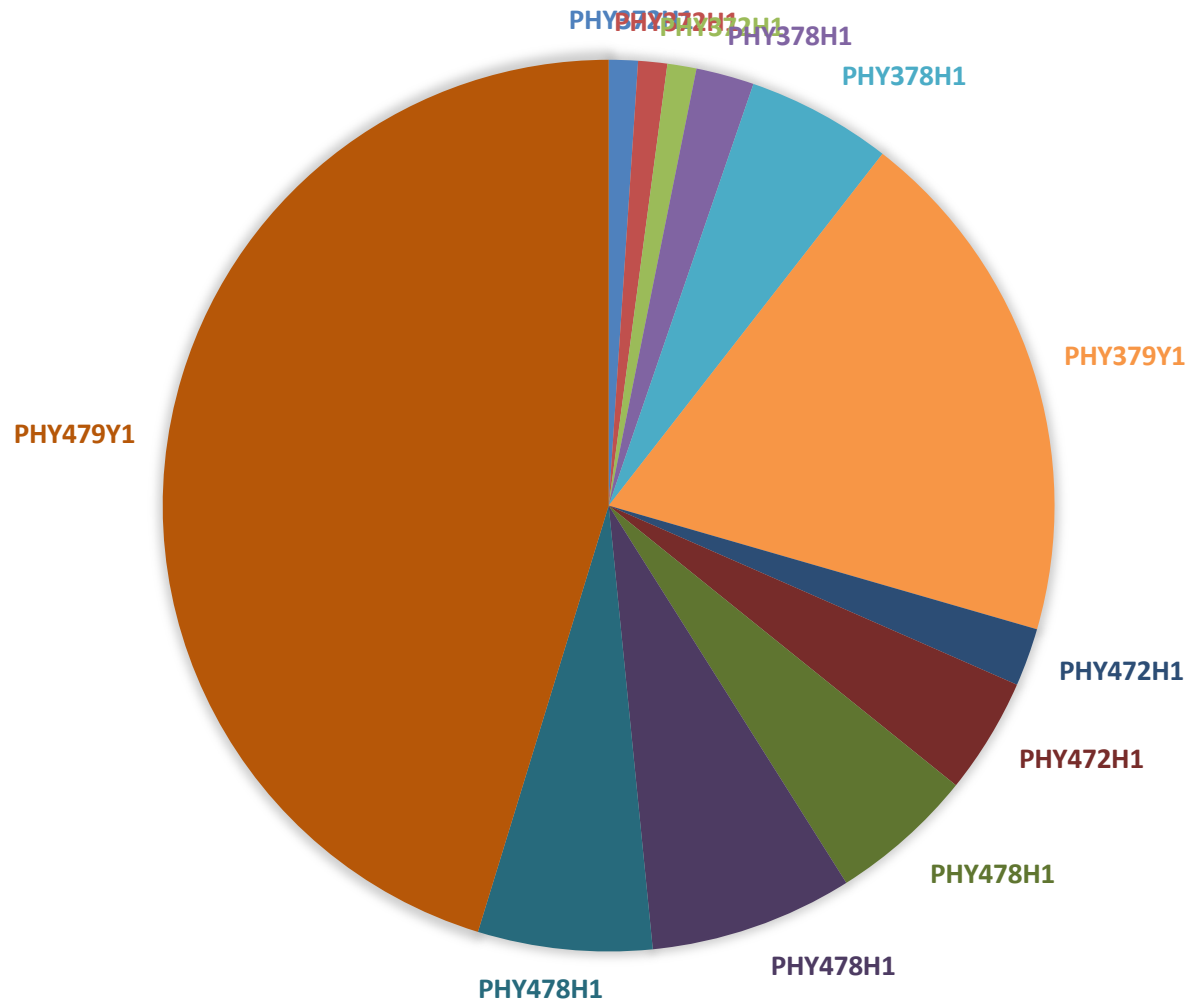
[Independent Study and Research Courses](#)

2025-2026

Date 2025-2026	Course Code	Supervisor	Project Title
2025 Summer	PHY372H	Zhang, Haibo	Geometric and Scientific Machine Learning for Critical Healthcare
2025 Summer	PHY378H	Braverman, Boris	Nonreciprocal Optical Cavities
2025 Summer	PHY378H	Hlozek, Renee	Small-Scale Connections Between Axions and Baryons
2025 Summer	PHY378H	Segal, Dvira	Open Quantum Systems: Nonperturbative Approaches
2025 Summer	PHY379Y	Hong, Ziqing	Data Quality Monitoring for the Ricochet Experiment
2025 Summer	PHY379Y	Narciso, Lucas	Assessment of a k-means Clustering Algorithm to Group Time-Activity Curves
2025 Summer	PHY379Y	Sinervo, Pekka	Study of Dilepton Production in Pb-Pb Collisions at the Large Hadron Collider
2025 Summer	PHY472H	Kee, Hae-Young	Exploring Superconductors in Strongly Correlated Electron Systems
2025 Summer	PHY478H	Kim, Young-June	Magnetic Properties of a Kagome Semiconductor
2025 Summer	PHY479Y	Hong, Ziqing	Data Quality Monitoring for the Ricochet Experiment

Supervised Courses for 2025-26

SUPERVISED COURSES 2025-26



How to approach supervised courses

First choose a research field or a few

- What you do from day to day is very different in different subdisciplines of physics
 - Data analysis, analysis software, designing instruments, building electronics or running experiments
 - if you have your heart set on something, find out what it is really like
- Chances of making a career of it and making a scientific contribution difficult to predict
 - Size of field, competitiveness, current trajectory (e.g. there are more experimentalists than theorists in the world)

Very difficult to predict, “especially the future”

- Make well-informed choices
- But follow your heart!

Look at how to find/choose a graduate supervisor:

Choose/find a supervisor at the graduate level

- I chose my PhD supervisor based more on how he thought about physics, than what he was working on.
 - (I was fortunate to survive this experience.)
- Talk to members of the group (e.g. TA's) to find out what the supervisor is like to work for
- Talk to previous students
- Have previous students published papers?
- Or just choose ... you never have enough information

What does that look like at the UG level?

• Biochemistry

- [Chakrabarty, Avi](mailto:chakrab@uhnres.utoronto.ca) (chakrab@uhnres.utoronto.ca)
- [Chan, Hue Sun](mailto:chan@arrhenius.med.utoronto.ca) (chan@arrhenius.med.utoronto.ca)
- [Forman-Kay, Julie](mailto:forman@sickkids.ca) (forman@sickkids.ca)
- [Houry, Walid](mailto:walid.houry@utoronto.ca) (walid.houry@utoronto.ca)
- [Howell, Lynne](mailto:howell@sickkids.ca) (howell@sickkids.ca)
- [Kay, Lewis](mailto:lewisekay@gmail.com) (lewisekay@gmail.com)
- [Moraes, Trevor](mailto:trevor.moraes@utoronto.ca) (trevor.moraes@utoronto.ca)
- [Privé, Gil](mailto:prive@uhnres.utoronto.ca) (prive@uhnres.utoronto.ca)
- [Prosser, Scott](mailto:scott.prosser@utoronto.ca) (scott.prosser@utoronto.ca)
- [Rini, James](mailto:james.rini@utoronto.ca) (james.rini@utoronto.ca)
- [Rubinstein, John](mailto:john.rubinstein@utoronto.ca) (john.rubinstein@utoronto.ca)
- [Sharpe, Simon](mailto:ssharpe@sickkids.ca) (ssharpe@sickkids.ca)

• Cellular/Systems Biology

- [Moses, Alan](mailto:alan.moses@utoronto.ca) (alan.moses@utoronto.ca)

• Chemistry

- [Goh, Cynthia](mailto:cynthia.goh@utoronto.ca) (cynthia.goh@utoronto.ca)
- [Izmaylov, Artur](mailto:artur.izmaylov@utoronto.ca) (artur.izmaylov@utoronto.ca); Quantum chemistry and quantum dynamics
- [McMillen, David](mailto:david.mcmillen@utoronto.ca) (david.mcmillen@utoronto.ca)
- [Schofield, Jeremy](mailto:jeremy.schofield@utoronto.ca) (jeremy.schofield@utoronto.ca)

• Ecology and Evolutionary Biology

- [Agrawal, Anil](mailto:a.agrawal@utoronto.ca) (a.agrawal@utoronto.ca)
- [Cutter, Asher](mailto:asher.cutter@utoronto.ca) (asher.cutter@utoronto.ca)
- [Jackson, Don](mailto:don.jackson@utoronto.ca) (don.jackson@utoronto.ca)
- [Mideo, Nicole](mailto:nicole.mideo@utoronto.ca) (nicole.mideo@utoronto.ca)
- [Wright, Stephen](mailto:stephen.wright@utoronto.ca) (stephen.wright@utoronto.ca)

Now look at finding an UG supervisor:

Graduate Supervisor

- I chose my PhD supervisor based ...
- Talk to members of the group
- Talk to previous students
- Have previous students published?
- Or just choose

UG Supervisor

- I chose it on who I could find/convince
- Don't know anyone – OK, maybe not
- Talk to previous students – YES
- Probably not as relevant
- Or just choose ... you never have enough information

Finding an UG research supervisor

Look at what area of research you are interested in

Find a way to talk to those in the area

If you do know them, then could ask

- “Do you ever supervise undergraduate research courses”?
- “I’m interested in doing a supervised research course, if I send you an email with a copy of my CV and transcripts would you be willing to look them over and then talk to me”?

If you don’t know them, then employ

The Dreaded Cold Call

So next slide please...



An example of a “cold call” letter...

Dear Professor X:

I am currently pursuing a specialist degree in Physics. I expect to graduate in June 2026, and I hope to do a PhD in Physics. I am currently looking for a (supervisor for a PHY37X course)/(paid summer research internship).

I am very keen on getting experience in a quantum optics/particle theory/... group. I have looked at your web site and I find your research on “X” very appealing. This led me to read your recent paper on “Y”.

I have an A+ average, and I am doing very well in my laboratory courses as you will see from my attached transcripts, and I have ... <any other relevant experience>

Do you have time this week or next to talk to me? If there are no positions in your group I would appreciate any advice you can give me on finding a supervisor in your field of research.

Best wishes, ...

Professors are used to getting email from students

- They generally like to talk about their work
- If they don’t reply, send 1 reminder, but then move on.
- It’s just that they are very busy (don’t take it personally...)

What if you don't have an A+ average?

- That's fine. You can still find a research course or internship, and you can still be successful.
- Make the most of what you are good at (programming? electronics?), and leverage your expertise in courses you have aced
- Temper your expectations. E.g., if you have B+ average, you aren't going to become a particle theorist (sorry...)

What if you aren't planning to go to grad school?

- Also, very fine. Most of you are unlikely to do that.
- Figure out what you are really interested in (transportation? green energy? financial mathematics?)
- Find a researcher whose work might get you started in this field or what you're interested in
- They don't have to be in the physics department.

Making the most of your research experience:

- Research is hard, and you are competing with other smart people who are working long hours
 - So I'm sorry, but you must work hard in order to succeed in research
- Research consists largely in keeping going, even though you don't really know what you are doing
- Don't waste too much time on the literature (reading), but you have to do enough to be familiar with other people are doing.
- Keep good records
- Ask for help when you are stuck
- Don't be afraid of looking/sounding stupid
- Talk about your work to whoever will listen
- Write about your work, even if it is only for your own use

Happy Researching!