Imagine Day 2022: Physics and Astronomy

11:00 Introductions & Welcome

11:15 General Program Information
• Honours, Majors, Minor - Mark van Raamsdonk
• Astronomy Program – Aaron Boley
• Biophysics Program – Carl Michal
• Co-op – Javed Iqbal
• Club Presentations:
  • Physsoc – Willow Benitz
  • Astronomy Club – Lucas Kuhn

11:30 Research in Physics and Astronomy
• Optical Physics – Valery Milner
• Astronomy/Astrophysics – Aaron Boley
• Condensed Matter Physics and Quantum Information – Marcel Franz
• Bio & Medical Physics – Sabrina Leslie
• Particle Physics – Colin Gay
• Gravity and Strings – Mark van Raamsdonk

1:30 Graduation and Beyond – C. Michal & J. Heyl
1:50 Student-led Q&A [no faculty]
Introduction

- Professor Colin Gay
  Head, Department of Physics and Astronomy
  Group Leader

- Shawn Salgadoe – Undergraduate Program Coordinator

- Associate Professor Carl Michal
  Undergraduate Chair

- Advisors: Profs: Mark van Raamsdonk, Aaron Boley, Vesna Sossi (regrets) and Kristin Schleich (regrets).
Shawn Salgadoe
Undergraduate Program Coordinator

Office: Hennings 329A
Office Hours: 8:30-4:30
Phone: 604-822-3026
email: ugcoord@phas.ubc.ca

- General program inquiries
- PHYS & ASTR course registration issues
- Specialization applications and specialization changes
- USRA applications and other summer research opportunity enquiries
- Liaison between department, student clubs and students: student events mailing etc.

PLEASE: always include your student number in your emails to the department (right on the subject line is best!)
Undergraduate chair: Carl Michal
1st-year advisor: Michael Hasinoff
2nd-year advisor: Mark Van Raamsdonk
3rd- and 4th-year advisor: Kristen Schleich
Astronomy advisor: Aaron Boley
Biophysics Advisor: Vesna Sossi
Combined Major in Science: any PHAS Advisor

Program coordinator: Shawn Salgadoe ugcoord@phas.ubc.ca
All of us are here to offer advice, help with any program/course issues.
In 2nd year, you entered one of our Programs:

★ Honours Physics
★ Combined Honours/Major Physics plus another Science
★ Major Physics, Major Astronomy
★ Dual Degree Program – BSc (Physics) & BEd (Secondary)
  BSc (Physics) & B Arts
  BSc (Physics) & B Music
★ You may be in another program doing a Minor in Physics

Or in 3rd year, you may enter:

Combined Major in Science & choose a Phys and Astro “package”
You are responsible for knowing your graduation requirements. Consult UBC Calendar and Faculty of Science online:
http://www.science.ubc.ca/students/degree
www.calendar.ubc.ca/vancouver
Then look under “Faculties, Colleges and Schools” then “Science” then “Physics” or “Astronomy”

Arts Electives, Science Electives, Science Breadth Requirement, Communication/English requirements are all necessary to graduate.

Use Degree Navigator in SIS to help you check that you’re meeting your program requirements. At end of 3rd year get a “Graduation Check” from Science Advising, and/or our PHAS Undergraduate Co-ordinator
BSc Graduation Requirements

Science Breadth requirement – all BSc programs entered 2020+
(older students may go by old program requirements in 2016-2019 Calendar)

Majors, Honours:  3 cr from 6 of the 7 Science Categories
Combined Majors, Combined Honours:  3 cr from 5 of the 7 Science Categories

Categories: MATH, PHYS, CHEM, CPSC, (STAT/DSCI)*, BIOL*, (EOSC/ASTR/ATSC,GEOB,ENVR)*
* some special cases/exceptions, see http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,215,410,1663

All Majors BSc:  120 credits
All Honours BSc:  132 credits
Honours

For those intending to enter career in research or continue to graduate school.

Honours degrees require a 6 credit Honours thesis.

- Honours Physics
- Honours Biophysics
- Honours Physics and Astronomy
- Honours Physics and Mathematics
- Honours Computer Science and Physics
- Honours Chemical Physics
- Honours Physics and another Science Subject

(We can help you formulate and get approval for a program which meets all Honours requirements, Faculty of Science requirements and UBC graduation requirements)

All Honours Science Degrees:

- Must take at least 30 credits Sept-April (or 15 credits/term if co-op)
- Must maintain average >68% each academic session
- Must not fail any courses.
- 2020 (due to covid): minimum 27 credits Sept-April for Honours
**Major Degrees**

- **For those intending to enter career in science/technology, education, science-related.**
- **MAJOR is NOT the recommended stream for graduate studies,** although Majors who take ALL the core senior honours physics courses + have research experience have been accepted to graduate schools.
- **Offers more flexibility than Honours (more electives)**
- **Fewer total credits (120 in Major, 132 in Honours)**
- **“Easy” to fit in a Minor** (Minor could be in Arts, Commerce, Science, + more)

- Major Physics
- Major Astronomy
- Combined Major Physics and Computer Science
- Combined Major Physics and Oceanography
- Double Major in Science and Arts
Dual Degree

For those intending to add a second specialization outside of Science.

NOT the recommended stream for graduate studies, although students who take all core senior honours physics courses may be accepted to graduate schools.

• Dual Degree Science and Arts  BSc (Physics) & BA

• Dual Degree Science and Music  BSc (Physics) & BMus

• Dual Degree Science and Education
  5 year program:
  Dual Degree Program:  BSc (Physics)  BEd (Secondary)
  Graduate with qualifications/certification to accept teaching position
Combined Major in Science

http://cms.science.ubc.ca/

★ Broad-based Science education
★ Maximum flexibility, allows for large breadth
★ Choose 3 CMS “packages” or specializations
★ NOT for those planning for graduate studies in Physics/ Astronomy

Other “Packages”:
Chemistry, Earth/Environmental Science, Life Science, Mathematical Science

Physics and Astronomy CMS Package

1. Physics Option

Prerequisites: MATH 200; PHYS 117 (or 101 or 107); PHYS 118/119 (or 102 or 108/109); PHYS 200. PHYS 219, 229 and MATH 215 recommended

Package Courses: 3 credits of PHYS numbered 300 or higher (except: PHYS 348) and 6 credits PHYS or ASTR courses numbered 300 or higher (except: PHYS 348).

Recommended Courses: PHYS 301, 304, 305, 309, 312, 314, 315, 318, 319, 330, 333, 404, 405, 420

2. Astronomy Option

Prerequisites: (MATH 200, MATH 317) or MATH 217; MATH 215; PHYS 117 (or PHYS 101 or PHYS 107); PHYS 118 (or PHYS 102 or PHYS 108); PHYS 200; PHYS 203; PHYS 216. PHYS 210, ASTR 200, and ASTR 205 recommended

Package Courses: 6 credits from ASTR 300, 333, 403, 406, 407 and 3 credits of PHYS numbered 300 or higher
Minor (outside Physics/Astronomy)

★ Pick up a second specialization
★ Relatively easy to add a Minor to a Major Physics or Major Astronomy due to more flexibility in Majors program and courses
★ With planning: add a Minor to Honours Physics
★ Not much “elective room” to add a minor to Combined Honours or Combined Majors program – but it has been done.

- Minor in another Science
- Minor in any Arts subject (Economics, Philosophy, a language, often seen in PHAS, but any Arts minor possible)
- Minor in Commerce
- Minor in Human Kinetics
- Minor in Land and Food Systems

Typically need 18 upper level (300-400-level) credits
Some Arts Minors require 30 credits, 18 of which must be upper level.
To apply for Minor: download forms from Faculty Science website.
Astronomy

- One of the oldest sciences
- The foundation for studying the universe
- Critical to space exploration
- Provides opportunities to test fundamental physical laws
- Fully integrated into society
Astronomy specializations at UBC

Astronomy Major

Career options include: technical support personnel at international observatories, astronomy educators, and outreach experts at science centres and planetaria. The diverse skills acquired in this specialization are attractive to non-academic employers.

Combined Honours Physics and Astronomy

Intended for students who want to go on to graduate studies in Astronomy and Astrophysics (or other areas of Physics, depending on upper-level electives). A Ph.D. is generally a requirement to be a scientist at a research institute or observatory, or to be a professor at a university.

Also available: Co-op, Minor, CMS
<table>
<thead>
<tr>
<th>Course #</th>
<th>Name</th>
<th>MAJ</th>
<th>HON</th>
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<tbody>
<tr>
<td>ASTR 101</td>
<td>Intro to the Solar System</td>
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<td>ASTR 102</td>
<td>Stars, galaxies, cosmology</td>
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<td>Frontiers of Astrophysics</td>
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<td>ASTR 205</td>
<td>Stars and Stellar Populations</td>
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<td>Galaxies</td>
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<td>ASTR 333</td>
<td>Exoplanets and Astrobiology</td>
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<tr>
<td>ASTR 403</td>
<td>Cosmology</td>
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<td>Rcmnd</td>
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<tr>
<td>ASTR 404</td>
<td>Astronomical &amp; Astrophysical Measurements</td>
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<td>X</td>
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<tr>
<td>ASTR 405</td>
<td>Astronomical Lab</td>
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<tr>
<td>ASTR 406</td>
<td>High-Energy Astrophysics</td>
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<td>X</td>
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<tr>
<td>ASTR 407</td>
<td>Planetary Science</td>
<td>X</td>
<td>Rcmnd</td>
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<tr>
<td>ASTR 449</td>
<td>Directed Research in Astronomy</td>
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*Useful but not required*
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**Start of specialization**

**Useful but not required**
Astronomy Opportunities at UBC

- Wide range of research topics (discussed later)
- A 0.5 metre optical telescope in Chile for student training and research
- A Small Radio Telescope on the roof of Hebb for student training
- Many opportunities to get involved with using different facilities in Canada and throughout the world!
  - LIGO
  - CHIME
  - Green Bank Telescope
  - ALMA
  - CFHT
  - Gemini
  - Hubble
  - JWST
  - Chandra
  - Eventually Square Kilometre Array and a very large optical telescope
  - Supercomputing facilities, too!
CFHT, Gemini, and CHIME: Canadian-led or large Canadian contribution observatories (experiment)
LIGO: Gravitational Wave Physics
Green Bank Telescope, ALMA, and SKA: Radio and millimetre astronomy
UBC Southern Observatory for teaching and research (in Chile)
Astronomy Career Information

- https://casca.ca/?page_id=93
- https://aas.org/learn/careers-astronomy
- https://ras.ac.uk/education-and-careers/careers

Astronomy Advising

Prof. Aaron Boley
Hennings 320A
ug-astr@phas.ubc.ca
Combined Honours Biophysics program
What is Biophysics?

An interdisciplinary science that applies theories, concepts and methods of physics to questions of biology.
Biophysics: Big Questions

• How does life work?

• The Protein Folding Problem

• (How) Has biology exploited quantum mechanics to tailor biological function?

• Neurobiology: How does the brain work? How do we learn? Neuroplasticity?
What do Biophysics Program graduates do after graduation?

Most continue their education:

• Graduate School:
  - Biophysics  - Mechanical Engineering (orthopaedics)
  - Medical Physics  - Pathology
  - Biochemistry  - Experimental Medicine
  - Neuroscience  - Epidemiology
  - Education

• Medical School
The Honours Biophysics program:

1) Defined set of courses in Physics and Mathematics, eg:
   PHYS 301 Electricity & Magnetism
   PHYS 304 Quantum Mechanics
   PHYS 305 Biophysics
   Math 300 Complex Variables
   Math 316 Partial Differential Equations

2) Flexible Life sciences component: 18 credits of life sciences that you choose. Usually structured to emphasize one of:
   - molecular and cell biology
   - macrobiology (organism level)
   - applied biology (eg medical applications)

3) Honours thesis
The Honours Biophysics program:

1) Defined set of courses in Physics and Mathematics, eg:
   PHYS 301 Electricity & Magnetism
   PHYS 304 Quantum Mechanics
   PHYS 305 Biophysics
   Math 300 Complex Variables
   Math 316 Partial Differential Equations

2) Flexible Life sciences component: 18 credits of life sciences that you choose. Usually structured to emphasize one of:
   - molecular and cell biology
   - macrobiology (organism level)
   - applied biology (eg medical applications)

3) Honours thesis

Diverse!
Physics, Math, Chemistry, Biochemistry, Biology!
Who is the Biophysics program for?

Anyone interested in how physics and physics approaches can be applied to problems in the life sciences.

Students interested in upper level courses in all of PHYS, MATH, BIOC, BIOL [and optionally: CHEM, CAPS, MICB, PCTH, MEDG]
Entrance to the Biophysics program:

For entry in second year apply through the Faculty of Science

The Biophysics program is an honours program, to **remain** in the program, UBC Science requires:

1. complete all courses attempted
2. complete a minimum of 30 credits per winter session (often more are needed).
3. maintain a minimum of 68 % average in each academic session.
Entrance to the Biophysics program:

Entrance in 3rd year is possible, at the discretion of the PHAS Biophysics and Undergraduate advisors.

Requirements:

- Average of at least 72% in second year
- Have never failed a course
- Taken a minimum of 30 credits in second year
- Course selections to date appropriate for the Biophysics program

These are minimum requirements. Applications considered on a case by case basis.
Entrance to the Biophysics program:

**Recommendations:**

Follow as closely as possible the program outlined for the Honours Biophysics program in the second year. Some missed courses can be taken in summer.

http://phas.ubc.ca/undergrad-honours-biophysics

Come and talk to the Program advisors!
Support is available:

• Biophysics is a small program, and traditionally very close-knit.
  
  Biophysics students are encouraged to join Physsoc
  
  - get to know older students who've been through it before
  
  - help with studying
  
  - social activities

• Departmental advisors and course instructors

• Science advising centre

• Science support programs:  http://science.ubc.ca/students/resources
Any other questions: please e-mail the program advisor: vesna@phas.ubc.ca (phone 822 7710)
UBC Science Co-op

Javed Iqbal       iqbal@phas.ubc.ca

www.sciencecoop.ubc.ca
## Science Co-op Programs

<table>
<thead>
<tr>
<th>Atmospheric Science</th>
<th>Biochemistry</th>
<th>Biophysics</th>
<th>Biopsychology</th>
<th>Biotechnology</th>
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</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>Cognitive Systems</td>
<td>Computer Science</td>
<td>Earth &amp; Ocean Sciences</td>
<td>Engineering Physics</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>General Sciences</td>
<td>Integrated Sciences</td>
<td>Land &amp; Food Systems</td>
<td>Mathematics</td>
</tr>
<tr>
<td>Microbiology</td>
<td>Pharmacology</td>
<td>Physics &amp; Astronomy (Undergrad &amp; Grad)</td>
<td>Statistics</td>
<td>And more…</td>
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</table>
What is Co-operative Education?

- Integration of academic studies with relevant, paid, supervised and productive work experience.
- Co-op students gain skills and experience which prepare them for the future job market, graduate studies and give them improved employment opportunities upon graduation.

Average monthly salary for Physics/Astronomy Co-op: $2800
Benefits of Co-op

• Practical work experience
• Work on real-life problems
• Focused education
• Increased job prospects after graduation
• Networking and life skills
# PHAS Co-op Schedule -1

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<th>Year</th>
<th>Term1</th>
<th>Term 2</th>
<th>Summer</th>
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<td>5</td>
<td>ST 7</td>
<td>ST 8</td>
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<tr>
<td>Year</td>
<td>Term 1</td>
<td>Term 2</td>
<td>Summer</td>
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<td>ST 5/apply</td>
<td>ST 6</td>
<td>WT 1</td>
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<td>4</td>
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<td>WT 4</td>
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<td>5</td>
<td>ST 7</td>
<td>ST 8</td>
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PHAS & BIOP Co-op Placements
(last two last years)

Physics/Astronomy
- Arista Networks
- Ballard Power Systems
- BC Cancer Research
- Canadian Space Agency
- Cellcentric
- D-Wave Systems
- Environment Canada
- Geering Up!
- Incognito Software
- INTEL of Canada
- Ledcor Corp.
- MineSense Technologies
- NRC
- SBQMI

Biophysics
- Triumf
- UBC (PHAS, CHEM, EOS)
- University of Toronto
- University of Wurzburg

- NINET
- Precision NanoSystems
- Michael Smith Labs
- NRC
- UBC (Biochemistry)
- UBC Psychology
- University of Calgary
- University of Toronto
Program Fees

• Co-op workshop fee: $ 266.75
• Co-op work term fee: $ 821.75/ WT
• Total cost of program (4 WT): $ 3,600
Application Criteria

• Must have a minimum “B” average

• Willingness to work anywhere in Canada

• Positive attitude. Keen interest in chosen field.

• Each candidate is interviewed to assess their suitability to the program.
## Application Deadlines

<table>
<thead>
<tr>
<th>Program:</th>
<th>Application Deadlines</th>
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</thead>
<tbody>
<tr>
<td>PHYS/ASTR (2\textsuperscript{nd} &amp; 3\textsuperscript{rd} Yr.)</td>
<td>October 3, 2022</td>
</tr>
<tr>
<td>BIOP (3\textsuperscript{rd} Yr.)</td>
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</table>

Apply online
www.sciencecoop.ubc.ca
WELCOME TO PHYSSOC

Willow Benitz & Matthew Smith
Co-Presidents
WHO WE ARE

• The UBC Physics Society (PHYSSOC) is a group of students who want to help support, encourage, and be friends with you!
• We host both academic and social events and help to create a sense of community within the physics and astronomy department
• You can join our club as a member, or become more involved and join our council! There are many positions ranging from photography to event planning to academic specific events
BECOME A PART OF PHYSSOC COUNCIL

Our upcoming bi-election is and a great opportunity to get involved on campus!
WHAT WE DO

Midterm review sessions
Final exam practice booklets and review sessions
BBQs
Movie/board game nights
Term-end Wine and Cheese
Trivia events
Beef and Pizza (shaping the future of our courses!)
And all sorts of other fun, for $10 per membership!
WHERE WE ARE

HENN 307! Just upstairs
○ Study/lounge rooms
○ Kitchenette
○ foosball table (and occasional tournaments)
○ loads of textbooks up for use

Take a break between classes or meet up for a study session!
HOW TO JOIN

Check out our website & socials, it's also where you will find updated information on our upcoming events

https://physsoc.phas.ubc.ca/
The UBC Astronomy Club
The most stellar club on campus since 1984
Who are we?

We are a group of students at the University of British Columbia in Vancouver who share a passion for astronomy.

Our club's goal is to educate and promote interest in astronomy through the various types of events we run.

The UBC Astronomy Club is committed to being an open and inclusive club for everyone regardless of race, ethnicity, age, gender, religion, sexual orientation, gender identity, gender expression, disability, and other diverse backgrounds.
What do we do?

**Observation**
- Flash Observations
- Off Campus Observations

**Academic**
- Lecture Series
- Astro-Coding Workshops

**Social**
- Trivia Nights
- Paint and Movie Nights
Get Involved!

- We host at least 3 events per month so drop by as many times as you want!

- How to join?
  - Standard member.
  - Exec team.

- Learn about Astronomy in an extracurricular setting.
  - Get practice using telescopes.
  - Learn how to code for research purposes.
  - Meet new friends with a shared passion for exploring the Universe!
Imagine Day Booth
Questions?

Ways to reach us

ubcastronomyclub@gmail.com
facebook.com/UBCAstronomyClub
@ubcastronomy
@ubcastronomyclub
TheUBCAstronomyClub
/u/ubcastronomyclub
Atomic, Molecular and Optical (AMO) Physics

The study and control of atoms, molecules and photons, and their quantum interactions.

- **Controlled translation**
  - Ultra-cold atoms

- **Controlled rotation**
  - Molecular super-rotors

- **Control tools**
  - Ultra-stable lasers
  - Ultra-short shaped pulses
  - Ultra-high frequencies
Control of Quantum Interactions: *Molecule – Molecule*

Imagine….

Laser Light

Useful

$T \sim 1 \times 10^{-9} \text{ K}$

$\nu \sim 1 \text{ mm/s}$

**UBC experiment:** K. Madison, T. Momose

**UBC theory:** R. Krems, F. Zhou, M. Berciu
Control of Quantum Interactions: *Molecule – Many-Body System*

*Imagine….*

**UBC experiment:** V. Milner, E. Grant, T. Momose

**UBC theory:** P. Stamp, R. Krems
Control of Quantum Interactions: *Laser Tools*

**COOLING LASERS**

**FREQUENCY COMBS**

**SHAPED PULSES**

UBC experiment: D. Jones, K. Madison, V. Milner, T. Momose
## Laser Control of Quantum Interactions: *Where To Learn?*

<table>
<thead>
<tr>
<th><strong>Fundamentals</strong></th>
<th><strong>Advanced</strong></th>
</tr>
</thead>
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<tr>
<td><strong>PHYS 408 (lectures + labs)</strong></td>
<td><strong>PHYS 532</strong></td>
</tr>
<tr>
<td>“Fundamental &amp; Modern Optics”</td>
<td>“Nonlinear Optics &amp; Quantum Electronics”</td>
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<tr>
<td>1. Wave optics</td>
<td>1. Interaction of light with <em>Solids</em></td>
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<tr>
<td>2. Fourier optics</td>
<td>2. Interaction of light with <em>Atoms</em></td>
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<td>3. Polarization optics</td>
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<td>4. Optical cavities</td>
<td><strong>PHYS 533</strong></td>
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<tr>
<td>5. Laser physics</td>
<td>“Laser Physics”</td>
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<tr>
<td></td>
<td>2. Laser types</td>
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<td></td>
<td>3. Applications of lasers</td>
</tr>
</tbody>
</table>
Astronomy research highlights at UBC

Imagine Day 2022
We cover the full range of astronomical scales, from planetary science to cosmology.

We have observers, experimentalists, modelers, theorists, and those who do some of each.

If you’re interested in any particular type of astronomy, let us know to find out about possible research opportunities.
A non-exhaustive list of research facilities and tools
(not to mention the extensive computational resources)
CFHT, Gemini, and CHIME: Canadian-led or large Canadian contribution observatories (experiment)
LIGO: Gravitational Wave Physics
Green Bank Telescope, ALMA, and SKA: Radio and millimetre astronomy
UBC Southern Observatory for teaching and research (in Chile)
What are some of the big questions UBC astronomers are addressing?
What was the formation history and evolution of the Solar System?

What can small bodies and meteorites tell us about that history?
How do planets form?
How do the building blocks of planets form?
What processes set planetary architectures?
How do planetary systems evolve?
Directly imaged planet HIP 65426 b as seen by the Webb Telescope

What can exoplanets tell us about the possibilities for life elsewhere in the Universe?

What are the connections between star and planet formation?
How was the Milky Way Galaxy assembled?

What is the record of that assembly in stellar populations?

Credit: HST/Richer et al.
What are the extreme physical conditions in compact objects and do they show a need for extensions to standard physics?

What can compact objects tell us about gravity and gravitational waves?
What are the mass ranges of blackholes?

What are the merger rates of black holes and compact objects?
How do galaxy interactions alter the gas and stars in galaxies?

How are galaxies influenced by their large-scale environment in which they reside?
Galaxy cluster SMACS 0723 as seen by the Webb Telescope

When did the first galaxies form?

What reionized the Universe - massive stars or supermassive black holes?

What was the evolution of the early Universe?

Image credit: NASA, ESA, CSA, and STScI
Cosmology – Origin and Evolution of the Universe

What are the precise values of the numbers that describe our Cosmos?

What is Dark Matter and what is Dark Energy?

Image credit: Chris Blake and Sam Moorfield
How do we avoid conflict in space?

How can space be developed such that future generations can also develop space?
The Astro Faculty Team

- **Jeremy Heyl**: White dwarfs, neutron stars, black holes, global clusters, transients
- **Paul Hickson**: Galaxies and groups, instrumentation, adaptive optics
- **Ingrid Stairs**: Pulsars, fast radio bursts (FRBs), binary evolution, tests of GR, gravitational waves
- **Harvey Richer**: Stellar populations, star clusters, space telescopes
- **Jess McIver**: Gravitational wave physics, multimessenger astronomy, machine learning, large-scale instrument characterization
- **Brett Gladman**: Dynamics of planets and asteroids, observations of solar system bodies, planetary sciences
- **Jaymie Matthews**: Stellar astrophysics, stellar pulsation, astroseismology, exoplanetary science
- **Aaron Boley**: Planet formation and evolution, astrophysical discs, meteorites, space sustainability, space security
- **Kris Sigurdson**: dark matter, particle cosmology, HI fluctuations, inflation, cosmic microwave background
- **Douglas Scott**: Early universe, structure formation, cosmic microwave background, high-redshift galaxies, astro-statistics
- **Ludo van Waerbeke**: Gravitational lensing, structure formation, galaxy formation, dark energy, dark matter
- **Gary Hinshaw**: Cosmology, cosmic microwave background, physical cosmology, star formation history
- **Mark Halpern**: Cosmic microwave background, high-redshift galaxies, baryon acoustic oscillations
- **Allison Man**: Galaxy formation and evolution, Early Universe, Star formation, Supermassive black holes, Galaxy mergers, Galaxy structure and kinematics, Stellar populations, Interstellar medium, Gravitational lensing
- **Jasper Wall**: Origin and Evolution of Galaxies, Active Galactic Nuclei, Unified Models, Statistics in Astronomy
Electron motion is crystal lattices

Understanding: “band theory of solids” 1929

Invention of transistor 1948
Transistor: The most influential invention in history?

Today it is estimated that 30 trillion transistors are produced every second!
Quantum computing: The coming revolution

By exploiting the laws of quantum mechanics directly quantum computers are in theory capable of solving classically intractable computational problems.
SBQMI Overview

Andrea Damascelli
Scientific Director

Marcel Franz
Deputy Scientific Director

Kim Kiloh
Executive Director
VISION

Quantum Materials by Design

Creating the building blocks for future technologies that will transform the world

Vision

Become the world leading institute in quantum materials & devices, and nucleate an ecosystem of companies for future technologies

Research  Training  Translation
New Faculty
2017/18

New Faculty
2018/19
CONTINUED UBC SUPPORT & COMMITMENT

Major new funding - CFREF
May 2017

• New building – expanded facilities/capabilities
• Infrastructure support
• 6 new faculty positions (for a total of 24)
• Student & PDF fellowships
• International opportunities and engagement
INTERNATIONAL ACADEMIC PARTNERSHIPS

MP-UBC-UTokyo Centre for Quantum Materials

MAX PLANCK - $2.5M – UNIVERSITY OF TOKYO - $2.5m

OBJECTIVE: To promote and further the cooperation between researchers and research groups of both parties

- Student mobility agreement with University of Stuttgart
- Joint MP-UBC-Stuttgart PhD program in Quantum Materials
Quantum materials by design

Creating the building blocks for future technologies that will transform the world
Biological and Medical Physics: the Physics of the 21st century 😊

@ UBC Physics and Astronomy

In collaboration with: Michael Smith Labs, SBME, GSAT, BIONF, Nanomedicine Center (NMIN), BC Cancer, Center for Brain Health.

2022 09 06 - UBC Imagine Day

Sabrina Leslie, Associate Professor UBC PHAS & MSL
In real life: PHAS biophysicists gather to share and energize research 😊

Leslie, Michal, Plotkin, Rottler groups, a team! Actively recruiting new students in 2022/2023.

World class single-molecule, single-cell, NMR, MRI, and other imaging facilities

QMI fabrication and high-res imaging facilities enable device innovation and characterization

Practical interdisciplinary training brings physicists’ skills, theory, imagination together with complex, fascinating challenges in biology

Solving big problems takes multiple scientific perspectives, communication, and talent
There’s Plenty of Room at the Bottom

An invitation to enter a new field of physics.

by Richard P. Feynman
“..It is very easy to answer many of these fundamental biological questions; you just look at the thing! You will see the order of bases in the chain; you will see the structure of the microsome. Unfortunately the present microscope sees at a scale which is just a bit of information..”

– Richard Feynman, 1978
Seeing is believing: Isolating and imaging DNA in nano-grooves

λ-phage DNA labeled by YOYO1 dye
Fluorescence imaging, 100x magnification

https://leslielab.msl.ubc.ca/
Biophysics core subgroup @ PHAS

Sabrina Leslie
sabrinaleslie@phas.ubc.ca

Single-molecule microscopy, biophysics of DNA, RNA interactions, mechanisms of therapeutics/vaccines, Microfluidics/optics, nano scale device engineering, etc.

Carl Michal
michal@phas.ubc.ca

NMR and MRI, brain research, spider silk, synthetic materials

Steve Plotkin
steve@phas.ubc.ca

Protein misfolding, SARS-CoV-2, Molecular genetic origins of multicellular animals

Joerg Rottler
jrottler@physics.ubc.ca

Material properties from an atomistic perspective, machine learning, polymers, biomaterials
In common: innovating instrumentation, analysis, theory

NMR and other microscopies
Can we democratize boutique technologies to accelerate science?

AI to assist data analysis

Single-molecule and single-cell microscopy
of molecules, particles, cells, tissues, ..

Seeing single molecules helps diagnostics

Biophysics skill sets through research:
Instrumentation, microscopies, optics, theory, computation, AI, machine learning, fabrication, wet sample handling, biotechnology
Towards an atomistic understanding of materials

Biopolymers, biomechanical response, AI, ..
New investigations of bio materials using NMR and MRI; further innovating these tools to democratize their use
Molecular genetic origins of multi cellular animals

Viruses and therapies

Protein aggregation
Enabling single-molecule visibility
Capturing drug/target interactions (and other molecules)
Understanding delivery dynamics in cells

Single-molecule (SM) and single-cell platform for studies of molecular interactions, applications to therapeutics discovery
Collaborations with Nanomedicine, SBME, GSAT, etc

**Example:** Leslie and Cullis inspect vaccines one particle at a time; mechanistic investigations, can we connect to clinical data?

CLiC single-imaging of vaccine nanoparticle dynamics in arrays

**Example:** Plotkin and Tokuriki take a close look at viral evolution of SARS-CoV-2

Both examples are applications of new biophysical tools in combination with theory and expertise in biochemistry to advance our understanding of medicines and hopefully improve them.
Recap: Core biophysics subgroup + interdisciplinary network

Sabrina
sabrinaleslie@phas.ubc.ca
Single-molecule microscopy, biophysics of DNA, RNA interactions, mechanisms of therapeutics/vaccines, Microfluidics/optics, nano scale device engineering, etc

Carl
michal@phas.ubc.ca
NMR and MRI, brain research, spider silk, synthetic materials

Steve
steve@phas.ubc.ca
Protein misfolding, SARS-CoV-2, Molecular genetic origins of multicellular animals

Joerg
jrottler@physics.ubc.ca
Material properties from an atomistic perspective, machine learning, polymers, biomaterials
Recap: Core medical physics group + interdisciplinary network

Medical Physics | UBC Physics & Astronomy

Vesna Sossi, PET MRA Imaging

Stefan Reisenberg, Cancer Imaging, MRI
Biological and Medical Physics: the Physics of the 21st century

@ UBC Physics and Astronomy

Join us for a coffee and gathering after the Thurs Sept 22 PHAS Colloquium by Steve Michnick on the Biophysics of Genomes

Biophysics groups are actively looking for talented students, email us!

Lots of opportunities, careers in academia & Vancouver biotech/nano industry (Abcellera, Precision Nanosystems, Acuitas, Boreal, Notch, Dwave, and many others)
Subatomic Physics at UBC

Colin Gay
Particle (Subatomic) Physics is the prototypical reductionist field, asking the questions:

What are the indivisible building blocks of matter?

What are the fundamental forces?
and tries to find the most irreducible answer

= Magnetic Force
= exchanging photons
To do this, we need to probe to the smallest distance possible

Equivalent to working at the highest energy possible

Or the hottest temperature

Or the earliest time in the universe
Particle Physics probes distance scales that are as far from the atomic scale as the atomic scale is from everyday scales.
History of the Universe
We have a mathematical framework that incorporates all the indivisible particles we know, (6 quarks and 6 leptons) and 3 of the forces (Electromagnetism, Strong, Weak, but not Gravity) and (recently) explains why (most) fundamental particles have mass.

The Standard Model

Quarks

 Forces

Leptons
The Standard Model is one of the most well-tested theories ever.

However, it has many deficiencies that are very far-reaching.
Still many Mysteries

What is Dark Matter?

Why is there any matter left to make us?
Search for Dark Matter

DM must be neutral (hence “Dark”)

Interacts extremely weakly with “normal” matter

Is cold, that is, speed is small compared to speed of light
Early Universe Dark Matter

Universe is very hot

High energy collisions of “normal” (Standard Model) particles make DM

Reaction in equilibrium: DM also collides to make SM particles equally
Early Universe Dark Matter
Current Dark Matter Search

Particle colliders let us create conditions from early universe!

Eg: Large Hadron Collider in Switzerland: $10^{-12}$ s after Big Bang

Collide protons, make Dark Matter in a lab to study
Current Dark Matter Search

Let existing DM hit huge amounts of “normal” matter, look for extremely rare interactions

Eg: SNOLab in Sudbury
Current Dark Matter Search

Might still get DM annihilation in very dense regions of space

Look for particular SM particle signatures coming from, eg, centres of galaxies
Lot’s of big questions still to address:

Can we write a Grand Unified Theory that unifies all the forces?

Are quarks and leptons indivisible?

Where did all the antimatter go?

What is Dark Matter made of?

What is the nature of Dark Energy?

How many dimensions are there?

Are there new particles/forces to be found?

...
Tools of the Trade

Accelerators

Underground labs

Massive Data sets

Quantum Field Theory

Fancy detectors/electronics

Machine Learning
Experimental Particle Faculty

Douglas Bryman
Colin Gay
Mike Hasinoff
Christopher Hearty
Alison Lister
Tom Mattison
Janis McKenna
Scott Oser
Particle physics

Cosmology

Understand via

Quantum Field Theory

Gravity

Einstein's General Relativity
Particle physics

Quantum Field Theory

Standard Model of Particle Physics

Cosmology

Standard Model of Cosmology

Understand Via

Gravity

Einstein's General Relativity
Particle physics

Cosmology

understand
 Via

Quantum

Field Theory

Standard Model
of Particle Physics

Gravity

Einstein's

General Relativity

Standard Model
of Cosmology

Extremely successful, accurately predict/explain experiments e.g.

LHC

Planck

LIGO
Still many open questions:

What is dark matter?

What is dark energy?

Is there new physics beyond the standard model?

Why is there more matter than antimatter?

What is the origin structure in the universe?
Kris Sigurdson

My theoretical research interests span cosmology and its connections to fundamental particle physics and string theory.

What physics do we need to explain Dark Matter? Dark Energy? Inflation?

Eric Zhitnitsky

I work on Quantum Chromodynamics (QCD) in the unusual environment when temperature, chemical potential, the so-called theta parameter are non-zero. Such a study is important in the area where the particle physics / nuclear physics / astrophysics / cosmology are overlapped.

David Morissey

Elementary Particle Physics

- New particles and interactions (e.g. supersymmetry, extra dimensions, strong forces)
- Interpretation and explanation of LHC data
- Candidates for dark matter
- Origin of the matter-antimatter asymmetry
- Ways to test this stuff experimentally
What is the physics of black holes?

- origin, distribution
- black hole merger physics
Jess McIver

Gravitational wave experiment with LIGO

• Large-scale instrumentation: improving the performance of the Advanced LIGO detectors
• Noise characterization and modelling
• Use GWs to explore new tests of general relativity, cosmology, and astrophysics

Part of team UBC at LIGO-Livingston

Matt Choptuik

Numerical relativity at UBC: see http://laplace.phas.ubc.ca for more info.
Theoretical aspects of gravity:
- intersections between gravity and quantum mechanics
- physics of black hole evaporation
- can exotic objects e.g. wormholes exist?
Black Hole analogy: (above) Model black hole quantum emission in fluids (water waves, BEC, optical)

Classical relativity and quantum gravity, especially the role topology plays in the classical and quantum dynamics of our universe. General relativity in higher dimensions, with a focus on problems related to M-theory and string theory.
Can we understand quantum gravity?

- String theory
- AdS/CFT correspondence

Where do time and space come from?

What is the big bang?

What's inside a black hole?

Also alternative approaches
Joanna Karczmarek
also: simple models for low D gravity
connections to quantum information

Moshe Rozali
quantum chaos & black holes
connections to condensed matter physics

Mark Van Raamsdonk

Gordon Semenoff
I work on theoretical elementary particle physics, quantum field theory and string theory:
Graduation and Beyond

Advisors:

- Mark van Raamsdonk (2nd year)  
  ug-phys2@phas.ubc.ca
- Kristin Schleich (physics and general)  
  ug-phys34@phas.ubc.ca
- Vesna Sossi (biophysics)  
  ug-biop@phas.ubc.ca
- Aaron Boley (astronomy)  
  ug-astr@phas.ubc.ca
- Program chair: Carl Michal  
  ug-chair@phas.ubc.ca

Coordinator: Shawn Salgadoe  
ug-coord@phas.ubc.ca
Graduating?

It is **your responsibility** to make sure you fulfill the departmental and Faculty of Science requirements for graduation! Check after registering, but before add/drop deadline [ie now!].

Degree Navigator, instructions here:

[https://science.ubc.ca/students/degree-navigator](https://science.ubc.ca/students/degree-navigator)

Questions about what Degree Navigator says?

- Science Advising grad check, or PHAS program advisor
Graduating?

You must follow all of the requirements from one year of the calendar [normally your 2\textsuperscript{nd} year – when you entered the program].

- Honours requirements ( >68% average, 30+ credits/year [except in final year when you should take only as many needed to graduate]).
- Arts, breadth requirements.
The Calendar

No matter what you see on phas.ubc.ca (which we try to keep up to date) or anywhere else on the web, the UBC calendar is 'the rule book' and defines what is required to get a degree from UBC.
The Calendar

Most of what you really need to be familiar with can be found under:

- Faculty of Science BSc requirements:
  http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,215,410,0

- Specialization requirements (for PHAS programs):
  Astro:
  PHYS/BIOPHYS/Other combined programs:
  http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,215,410,434

The calendar's search tool is not always the easiest way to find what you are looking for...
## BSc Graduation Requirements

### Science Breadth requirement – all BSc programs entered 2020+
(you may go by program requirements in calendar year you entered program)

<table>
<thead>
<tr>
<th></th>
<th>Major, Combined Major, or General Science</th>
<th>Major+Minor in Science</th>
<th>Major+Major (Science)</th>
<th>Honours or Combined Honours</th>
<th>Honours+Minor in Science</th>
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<tbody>
<tr>
<td>Minimum Total Credits</td>
<td>120</td>
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<td>120</td>
<td>132</td>
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<tr>
<td>of which courses 300+</td>
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<tr>
<td>Minimum Total Science Credits</td>
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<tr>
<td>of which courses 300+</td>
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<td>42</td>
<td>54</td>
<td>42</td>
<td>54</td>
</tr>
<tr>
<td>Minimum Total Arts Credits</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Maximum Credits that can be double counted</td>
<td>-</td>
<td>6</td>
<td>6</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Maximum credits not in Science or Arts</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
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</tr>
</tbody>
</table>

All Majors BSc: 120 credits  
All Honours BSc: 132 credits

Categories: MATH, PHYS, CHEM, CPSC, (STAT/DSCI)*, BIOL*, (EOSC/ASTR/ATSC,GEOB,ENVR)*  
* some special cases/exceptions, see [http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,215,410,1663](http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,215,410,1663)
Graduating?

Degree Navigator...
Graduating?

You must **APPLY** for graduation!
Deadline: February
See:

https://students.ubc.ca/enrolment/graduation/applying-graduate

and

https://science.ubc.ca/students/requirements/graduation
It won't all be smooth sailing – what to do if you have issues:

• with your course:
  – Talk to your prof.
  – If the prof can't rectify – talk to an advisor or u/g chair

• with the program
  – Administrative issues: talk to the u/g coordinator Shawn Salgadoe
  – Advising: program advisors (Profs. van Raamsdonk Schleich/Boley/Sossi)

• with life (health, finance, harassment, careers, anything...)
  – https://students.ubc.ca
  – Science Advising
  – But also – talk to the person who is most likely to be of immediate help: your profs, advisors and u/g chair.
Getting into Research I

Majors students will be exposed to research topics in PHYS 348. You’ll explore current research topics in depth, write reports and give presentations. Honours students often like to take this, too.

All Honours students take the PHYS 449 or ASTR 449 thesis course, working with a supervisor over the course of a year and conducting original research.

Anyone wanting to take PHYS 349 or ASTR 349 (Directed Studies = mini-thesis) should contact Rob Kiefl for approval (typically requires 75% accumulated average and have a research project and supervisor in mind or under discussion).
Discuss your ideas/interests with potential supervisors. Many potential supervisors: faculty members, including adjunct professors whose research is based off campus. Supervisors don’t have to be UBC PHAS affiliated at all, but you’ll need a PHAS co-supervisor if supervisor non-UBC.

Send email, knock on doors,

Self-motivated:
• You'll work with advisor & PHYS 449/PYS 349 instructor as your guides/mentors.
• You’ll learn how to conduct research, write it up & give scientific presentations.
• Your thesis project is your own work.
Getting into Research II

There are other opportunities to do research while in the department:

• Summer NSERC USRA awards (deadline in January)
• Co-op terms
• Direct hiring by professors

For these and for 449/349 projects, don’t hesitate to contact professors to help you figure out what to work on – we are used to having students ask us about projects, and can often find a project to fit students' strengths and interests.
Research – your opportunity

Examine your interests, seek opportunities

Talk to senior undergrads about their research experiences (meet them via PHYSSOC activities or in PHYSSOC lounge)

Research happens not only in academic institutions, but also government labs, high-tech industry and private companies.

Experience in computing/programming/design is a huge asset, whether seeking a job or seeking a graduate school position.

Ditto for technical experience.

I strongly recommend trying different opportunities, both inside and outside of university setting.
Paid Work/Research Opportunities for PHAS undergrads

- Co-op  [http://www.sciencecoop.ubc.ca/](http://www.sciencecoop.ubc.ca/) (4-, 8-, or 12- month co-op jobs)  
  (everything on this page except Work Learn (part-time) are valid for co-op workterms)
- NSERC USRA (Undergrad Student Research Award)  
- TRIUMF Summer student program (and 4-, 8- or 12-month co-op jobs)  
  [http://www.triumf.ca/undergraduate-student-program](http://www.triumf.ca/undergraduate-student-program)
- NRC (National Research Council Canada)  
- DAAD RISE (German Research Internships in Science & Engineering)  
  UBC is a DAAD partner
- UBC Go Global - Research Abroad  
  [https://global.ubc.ca/go-global/international-experiences/research-abroad](https://global.ubc.ca/go-global/international-experiences/research-abroad)
- More Go Global international experiences  
  [https://global.ubc.ca/go-global/international-experiences](https://global.ubc.ca/go-global/international-experiences)
- UBC SURE (Science Undergraduate Research Experience):  
  [http://science.ubc.ca/giving/projects/sure-science-undergraduate-research-experience](http://science.ubc.ca/giving/projects/sure-science-undergraduate-research-experience)
- IAESTE (International Association for the Exchange of Students for Technical Experience)  
  [http://www.iaeste.org](http://www.iaeste.org)  
  (Canadian IASTE office:  [https://iaestecanada.org/](https://iaestecanada.org/))
- UBC Work Learn Program  
  Paid, max 10 hours/week while fulltime student  
  [https://students.ubc.ca/career/ubc-experiences/work-learn-program](https://students.ubc.ca/career/ubc-experiences/work-learn-program)
After Physics and Astronomy at UBC

Jeremy Heyl

September 6, 2022
What comes next?
Do I really have to think about this now?

It is not too soon (or too late) to start thinking about the future.

<table>
<thead>
<tr>
<th>Acoustics Physicist</th>
<th>Satelite Missions Analyst</th>
<th>Hydrologist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerodynamist</td>
<td>Science Teacher</td>
<td>Lawyer</td>
</tr>
<tr>
<td>Aerospace Testing</td>
<td>Science Writer</td>
<td>Medical Physicist</td>
</tr>
<tr>
<td>Astronomer</td>
<td>Automotive Engineer</td>
<td>Medical Products Designer</td>
</tr>
<tr>
<td>Astrophysicist</td>
<td>Forensic Scientist</td>
<td>Meteorologist</td>
</tr>
<tr>
<td>Biophysicist</td>
<td>Occupational Safety</td>
<td>Seismologist</td>
</tr>
<tr>
<td>Cardiac Imaging Researcher</td>
<td>Specialist</td>
<td>Stratigrapher</td>
</tr>
<tr>
<td>Chemical Physicist</td>
<td>Quality Control Manager</td>
<td>Environmental Analyst</td>
</tr>
<tr>
<td>Computer Specialist</td>
<td>Technical Illustrator</td>
<td>Oceanographer</td>
</tr>
<tr>
<td>Computer System Engineer</td>
<td>Geodesist</td>
<td>Scientific Photographer</td>
</tr>
<tr>
<td>Satellite Data Analyst</td>
<td>Geophysicist</td>
<td>Nuclear Power Plant Mgr</td>
</tr>
</tbody>
</table>
How to get there from here?
What to do after UBC?

First steps after UBC

- Work
First steps after UBC

• Work
• Graduate School in Physics or Astronomy
First steps after UBC

- Work
- Graduate School in Physics or Astronomy
- Work then Graduate School
How to get there from here?
What to do after UBC?

First steps after UBC

- Work
- Graduate School in Physics or Astronomy
- Work then Graduate School
- Graduate School then Work
How to get there from here?

What to do after UBC?

First steps after UBC

- Work
- Graduate School in Physics or Astronomy
- Work then Graduate School
- Graduate School then Work
- Research at UBC as an Undergraduate
How to get there from here?
What to do after UBC?

First steps after UBC
- Work
- Graduate School in Physics or Astronomy
- Work then Graduate School
- Graduate School then Work
- Research at UBC as an Undergraduate
- Professional school
How to get there from here?

What to do after UBC?

First steps after UBC

- Work
- Graduate School in Physics or Astronomy
- Work then Graduate School
- Graduate School then Work
- Research at UBC as an Undergraduate
- Professional school
- Teaching qualification
How to get there from here?
What to do after UBC?

First steps after UBC

• Work
• Graduate School in Physics or Astronomy
• Work then Graduate School
• Graduate School then Work
• Research at UBC as an Undergraduate
• Professional school
• Teaching qualification
• BCS
What to do now?
How to make the most of your time at UBC?

From the point of view of a graduate admissions chair in physics and astronomy (that’s me)
What to do now?
How to make the most of your time at UBC?

From the point of view of a graduate admissions chair in physics and astronomy (that’s me) . . . but also hiring manager, admissions officer for med school, . . .

• Get good grades (obviously?)
What to do now?
How to make the most of your time at UBC?

From the point of view of a graduate admissions chair in physics and astronomy (that’s me) . . . but also hiring manager, admissions officer for med school, . . .

- Get good grades (obviously?)
- Work on a research project (get a “strong” reference)
What to do now?
How to make the most of your time at UBC?

From the point of view of a graduate admissions chair in physics and astronomy (that’s me) ... but also hiring manager, admissions officer for med school, ...

- Get good grades (obviously?)
- Work on a research project (get a “strong” reference)
- Work in a group on something that you are passionate about (build “soft skills”)
What about Graduate School?
Which kind?

Wide variety of possibilities!

- Pre-doctoral Program
What about Graduate School?
Which kind?

Wide variety of possibilities!

- Pre-doctoral Program
- Masters:
  - M.Sc. (1 year or 2 year, tuition, salary, coursework or not . . . )
  - M.Phil.
  - M.Sci.
  - M.Phys
- PhD
  - tuition, salary, how many courses?
  - one supervisor from the start, or
  - a rotation of projects to start
- What is “direct transfer”?
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Which kind?

Wide variety of possibilities!

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  - tuition, salary, how many courses?
  - one supervisor from the start, or
  - a rotation of projects to start
  - What is “direct transfer”?
What about Graduate School?

How much?

“Show me the money!”

- What is the bottom line?
What about Graduate School?

How much?

“Show me the money!”

• What is the bottom line?
• Does the department pay you?
What about Graduate School?
How much?

“Show me the money!”

• What is the bottom line?
• Does the department pay you?
  ▶ Research assistant
What about Graduate School?

How much?

“Show me the money!”

- What is the bottom line?
- Does the department pay you?
  - Research assistant
  - Teaching assistant
What about Graduate School?
How much?

“Show me the money!”

- What is the bottom line?

- Does the department pay you?
  - Research assistant
  - Teaching assistant

- Do you pay for tuition? How much?
What about Graduate School?
How much?

“Show me the money!”

- What is the bottom line?
- Does the department pay you?
  - Research assistant
  - Teaching assistant
- Do you pay for tuition? How much?
- What is the cost of living?
What about Graduate School?
How much?

“Show me the money!”

- What is the bottom line?
- Does the department pay you?
  - Research assistant
  - Teaching assistant
- Do you pay for tuition? How much?
- What is the cost of living?
- How to get additional funding?
“Show me the money!”

- What is the bottom line?
- Does the department pay you?
  - Research assistant
  - Teaching assistant
- Do you pay for tuition? How much?
- What is the cost of living?
- How to get additional funding?
- Success breeds success.
What about Graduate School?

Woo Hoo! I got in!

Now, where do I go. Important things to consider:

• Supervisors
What about Graduate School?

Woo Hoo! I got in!

Now, where do I go. Important things to consider:

- Supervisors
- Supervisors
- Supervisors
What about Graduate School?
Woo Hoo! I got in!

Now, where do I go. Important things to consider:

- Supervisors
- Supervisors
- Supervisors
- Supervisors
Now, where do I go. Important things to consider:

- Supervisors
- Supervisors
- Supervisors
- Projects
What about Graduate School?
Woo Hoo! I got in!

Now, where do I go. Important things to consider:

- Supervisors
- Supervisors
- Supervisors
- Projects
- Projects
What about Graduate School?

Woo Hoo! I got in!

Now, where do I go. Important things to consider:

- Supervisors
- Supervisors
- Supervisors
- Projects
- Projects
- Institution
What is the goal of the admission process?

Looking behind the curtain
What is the goal of the admission process?

Looking behind the curtain
What is the goal of the admission process?

Looking behind the curtain

- Over the course of your time at UBC, the department and your supervisors will invest about $150,000 in your training and living expenses.
What is the goal of the admission process?

Looking behind the curtain

• Over the course of your time at UBC, the department and your supervisors will invest about $150,000 in your training and living expenses.

• Are they that selfless?
What is the goal of the admission process?

Looking behind the curtain

- Over the course of your time at UBC, the department and your supervisors will invest about $150,000 in your training and living expenses.
- Are they that selfless?
- Graduate students do the bulk of the “work” of research. They are absolutely crucial to a successful research program.
What is the goal of the admission process?

Looking behind the curtain

• Over the course of your time at UBC, the department and your supervisors will invest about $150,000 in your training and living expenses.
• Are they that selfless?
• Graduate students do the bulk of the “work” of research. They are absolutely crucial to a successful research program.
• Researchers and universities are judged and rewarded according to the accomplishments of their students.
What is the goal of the admission process?
Finding applicants who will become good researchers

What qualities do we look for?
- Capacity to learn
What is the goal of the admission process?
Finding applicants who will become good researchers

What qualities do we look for?

- Capacity to learn
- Curiosity
What is the goal of the admission process?
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What qualities do we look for?

• Capacity to learn
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• Ingenuity
What is the goal of the admission process?
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What qualities do we look for?

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- Industriousness
- Teamwork
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What qualities do we look for?

- Capacity to learn
- Curiosity
- Ingenuity
- Perseverance
- Imagination
- Industriousness
- Teamwork
- Communication
Good Luck!!!