

Imagine Day 2023: Physics & Astronomy



An Introduction for Students to our Department
faculty and staff, programs and courses.



Imagine Day 2023: Physics & Astronomy

Schedule:

11:00 Introductions & Welcome

- 11:15 General Program information
- Honours, Majors, Minors – Mark van Raamsdonk
- Astronomy program = Aaron Boley
- Biophysics Program – Vesna Sossi
- Co-op – Javed Iqbal
- Club presentations:
 - PHYSSOC- Myles
 - Astronomy Club – Vlad & Gurveen

1:30 Graduation and Beyond – Carl Michal & Jeremy Heyl

- Graduation requirements
- Getting into Research
- Career options/Graduate School
- Grad School planning

1:50 – Student-led Q&A [no faculty]

12:00 Lunch

12:30 Research in Physics & Astronomy

- Optical Physics – Valery Milner
- Astronomy/Astrophysics – Aaron Boley
- Condensed Matter Physics & Quantum Information – Marcel Franz
- Particle Physics – Colin Gay
- Bio & Medical Physics – Sabrina Leslie
- Gravity & Strings – Mark van Raamsdonk





Introduction

- **Professor Colin Gay**
 - Head, Department of Physics & Astronomy
 - Group Leader
- **Carl Michal**
 - Undergraduate Chair
- **Advisors:**
 - Profs: Mark van Raamsdonk, Aaron Boley, Vesna Sossi and Kristin Schleich
- **Shawn Salgadoe**
 - Undergraduate Program Coordinator



Shawn Salgadoe

Undergraduate Program Coordinator

Office: Hennings 329A

Office Hours: 8:30-4:30

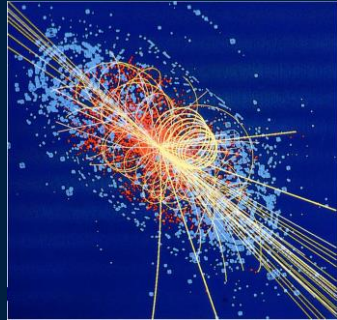
Phone: 604-822-3026

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 (in the Subject line is best!)

PHAS General Program Info



Undergraduate Program
Coordinator: Shawn Salgadoe
Email: ugcoord@phas.ubc.ca



- Undergraduate Chair – Carl Michal
- 1st year advisor: Michael Hasinoff
- 2nd year advisor: Mark van Raamsdonk
- 3rd and 4th year advisor: Kristin Schleich
- Astronomy advisor – Aaron Boley
- Biophysics advisor – Vesna Sossi
- Combined Major in Science: any PHAS advisor

*All of us are here to offer advice, help with any program/course issues.

2nd Year – Gateway to PHAS Programs

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 (and choose a Phys & Astro “package”)



Graduation Requirements

You are responsible for knowing your graduation requirements.

Consult UBC calendar www.calendar.ubc.ca/vancouver and the Faculty of Science online: <http://www.science.ubc.ca/students/degree> 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 the end of 3rd year, get a “Graduate Check” from Science Advising and/or our PHAS Undergraduate Coordinator.



BSc Graduation Requirements

Summary of Program Requirements

	Major, Combined Major, or General Science	Major+Minor in Science	Major+Major (Science)	Honours or Combined Honours	Honours+Minor in Science
Minimum Total Credits	120	120	120	132	132
of which courses 300+	48	48	60	48	60
Minimum Total Science Credits	72	72	72	72	72
of which courses 300+	30	42	54	42	54
Minimum Total Arts Credits	12	12	12	12	12
Maximum Credits that can be double counted	-	6	6	-	6
Maximum credits not in Science or Arts	24	24	24	24	24

All Majors BSc: 120 credits

All Honours BSc: 132 credits



<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science/general-degree-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>

Honours Requirements

For those intending to enter a 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**



Majors Requirements

For those intending to enter a career in science/technology, education, or something science-related

A 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.



Benefits:

- ❖ 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 Degrees

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/>

For those intending to add a second specialization outside of Science

- ❖ 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



Physics and Astronomy CMS Package

1. *Physics Option*

Prerequisites: MATH 200; PHYS 117 (or PHYS 101 or PHYS 106 or PHYS 107 or PHYS 131); PHYS 118 (or PHYS 108); PHYS 119; 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 106 or PHYS 107 or PHYS 131); PHYS 118 (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

Other “Packages”:

- Chemistry
- Earth/Environmental Science
- Life Science
- Mathematical Science

<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science/combined-major-science>

Minor (outside of Physics & Astronomy)

Minor:

- Pick up a second specialization
- Relatively easy to add a Minor to a Major Physics or Major Astronomy due to more flexibility in Majors programs 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 is possible)
 - Minor in Commerce
 - Minor in Human Kinetics
 - Minor in Land & Food systems



Typically you will need 18 upper level (300-400) credits. Some Arts Minors require 30 credits, 18 of which must be upper level. To apply for a Minor, download forms from the Faculty of 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 (See: <https://phas.ubc.ca/undergrad-degree-programs>)

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 & 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 PhD. 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

Astronomy Courses at UBC

Course #	Name	MAJ	HON
ASTR 101	Intro to the Solar System		
ASTR 102	Stars, galaxies, cosmology		
ASTR 200	Frontiers of Astrophysics	X	X
ASTR 205	Stars and Stellar Populations	X	X
ASTR 303	Galaxies	X	X
ASTR 333	Exoplanets and Astrobiology		
ASTR 403	Cosmology		Rcmnd
ASTR 404	Astronomical & Astrophysical Measurements	X	X
ASTR 405	Astronomical Lab	X	X
ASTR 406	High-Energy Astrophysics	X (or 407)	X
ASTR 407	Planetary Science	X (or 406)	Rcmnd
PHYS 449	Directed Research in Astronomy		X



Astronomy Courses at UBC

Course #	Name	MAJ	HON
ASTR 101	Intro to the Solar System		
ASTR 102	Stars, galaxies, cosmology	Useful but not required	
ASTR 200	Frontiers of Astrophysics	X	X
ASTR 205	Stars and Stellar Populations	X	X
ASTR 303	Galaxies	X	X
ASTR 333	Exoplanets and Astrobiology		
ASTR 403	Cosmology		Rcmnd
ASTR 404	Astronomical & Astrophysical Measurements	X	X
ASTR 405	Astronomical Lab	X	X
ASTR 406	High-Energy Astrophysics	X (or 407)	X
ASTR 407	Planetary Science	X (or 406)	Rcmnd
PHYS 449	Directed Research in Astronomy		X



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ASTR 205	Stars and Stellar Populations	X	X
ASTR 303	Galaxies	X	X
ASTR 333	Exoplanets and Astrobiology		
ASTR 403	Cosmology		Rcmnd
ASTR 404	Astronomical & Astrophysical Measurements	X	X
ASTR 405	Astronomical Lab	X	X
ASTR 406	High-Energy Astrophysics	X (or 407)	X
ASTR 407	Planetary Science	X (or 406)	Rcmnd
PHYS 449	Directed Research in Astronomy		X

Useful but not required

Start of specialization



Astronomy Opportunities at UBC

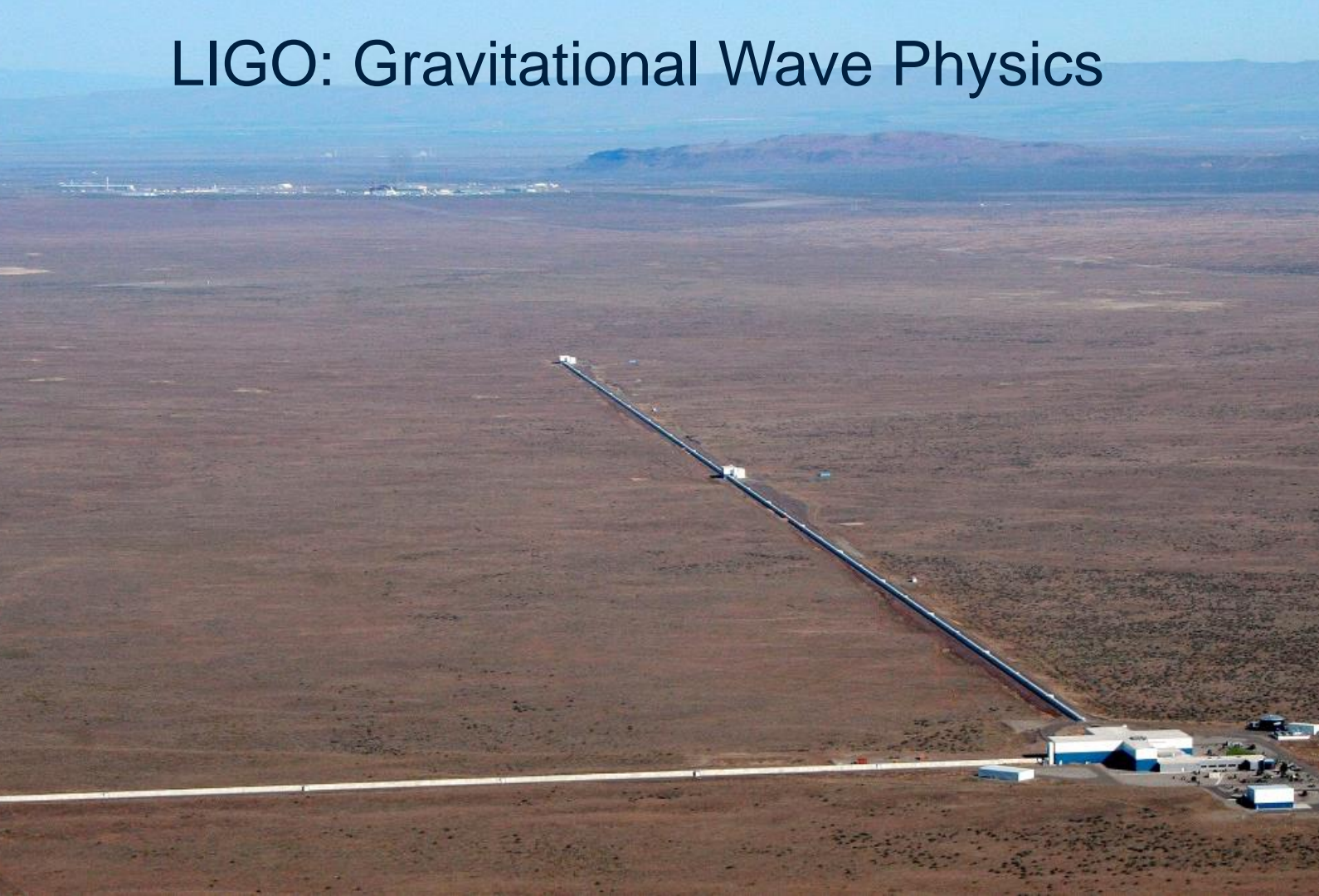
- Wide range of research topics
- A 0.5 metre optical telescope in Chile for student training and research
- A small Radio Telescope on the roof of HEBB for student training
- Many opportunities to get involved with using different facilities in Canada and throughout the world:
 - LIGO
 - CHIME
 - Green Bank Telescope
 - ALMA
 - CFHT
 - Gemini
 - Hubble
 - HWST
 - Chandra
 - Eventually Square Kilometer Array and a very large optical telescope
 - Supercomputing facilities, too!



CFHT, Gemini, and CHIME: Canadian-led, or large Canadian contribution observatories (experiment)



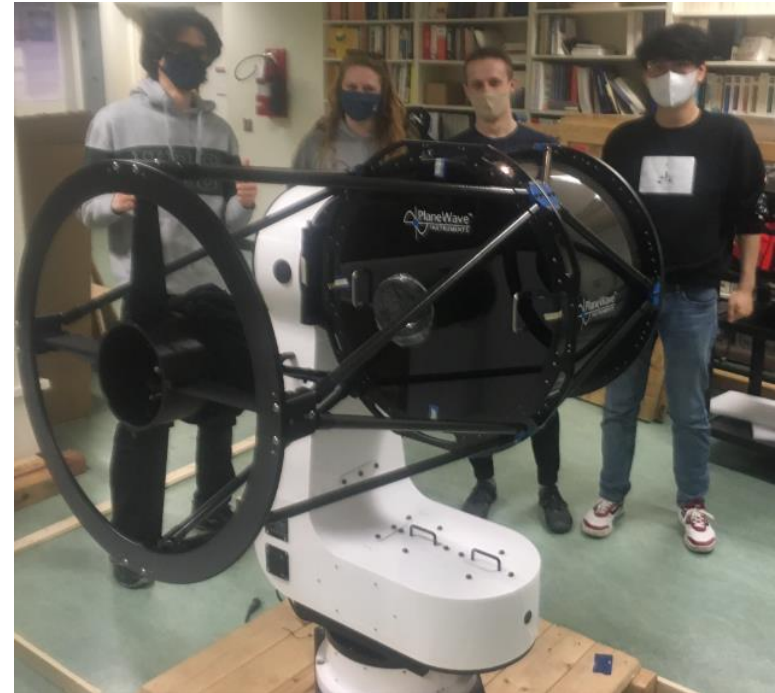
LIGO: Gravitational Wave Physics



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

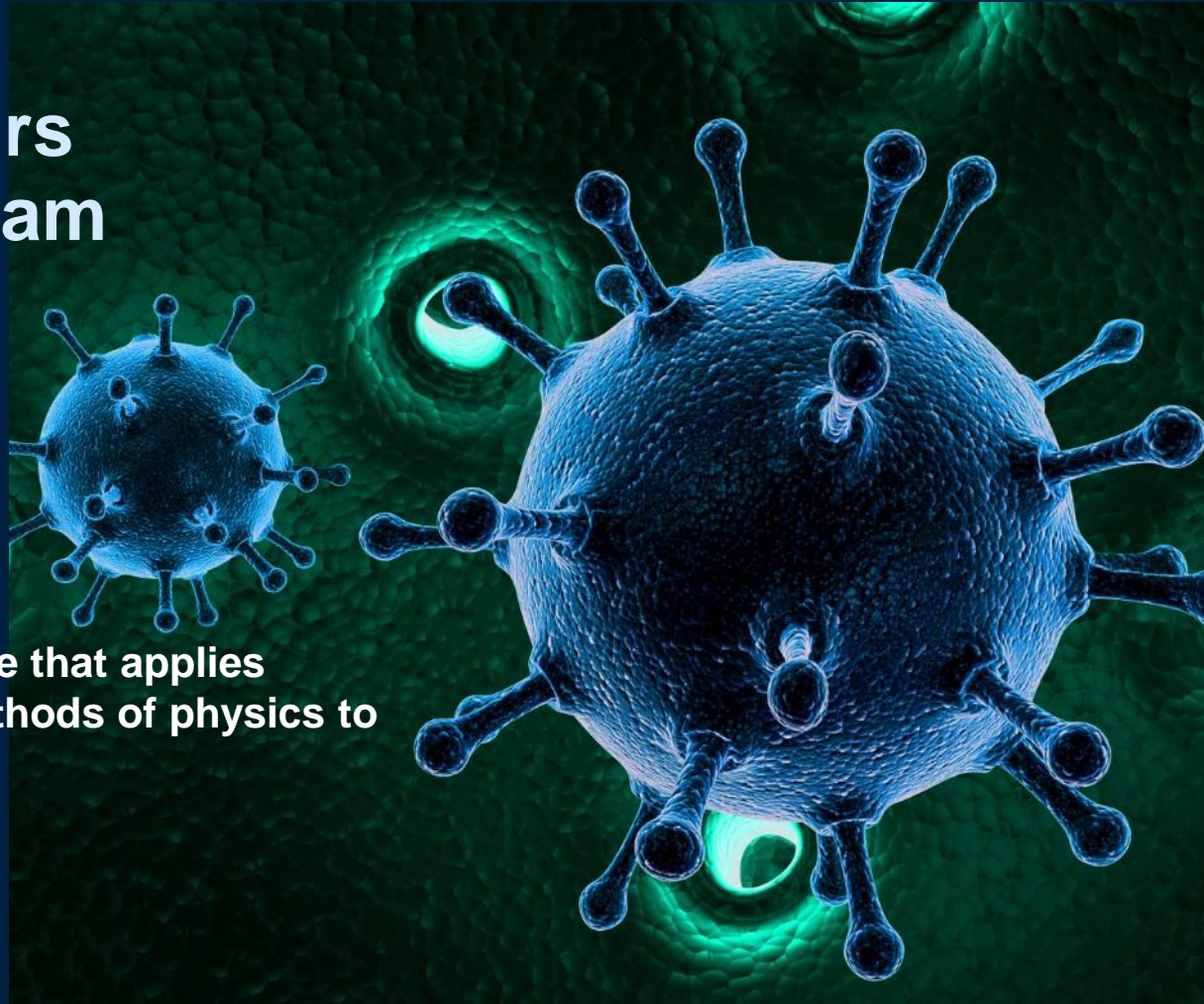
Hennings 320A

Ug-astro@phas.ubc.ca

Combined Honours Biophysics Program

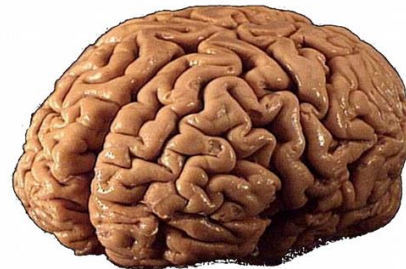
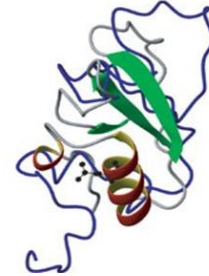
What is Biophysics?

- 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?



Biophysics: 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, for example:

- PHYS 301 Electricity & Magnetism
- PHYS 304 quantum Mechanics
- PHYS 305 Biophysics
- MATH 300 Complex Variables
- MATH 316 Partial Differential Equations

*This is a diverse program, including: Physics, Math, Chemistry, Biochemistry and Biology!



2. Flexible life Science component: 18 credits of life sciences that you choose. Usually structured to emphasize one of:

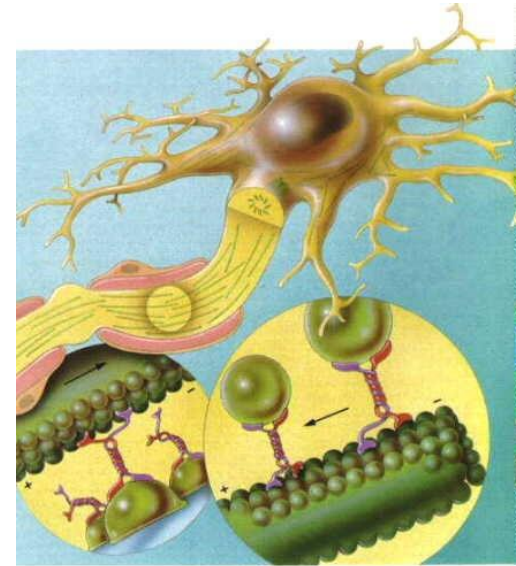
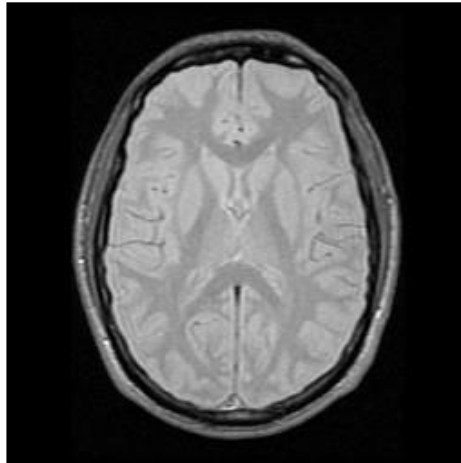
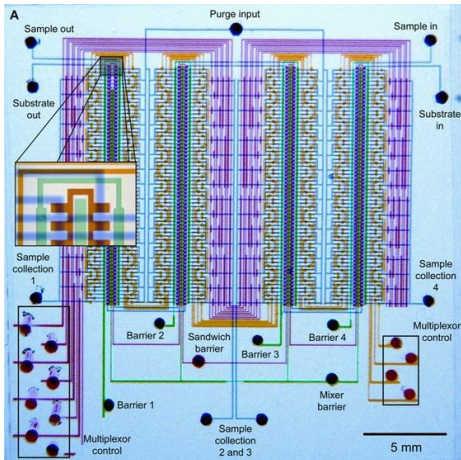
- Molecular and cell biology
- Macrobiology (organism level)
- Applied biology (e.g., medical applications)

3. Honours Thesis

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 into 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:

- Complete all courses attempted
- Complete a minimum of 30 credits per Winter session (often more are needed)
- Maintain a minimum of 68% average in each academic session.



Entrance into the Biophysics program:

Entrance in **third** 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 are considered on a case by case basis.



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>

Biophysics: 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
- Department advisors and course instructors
- Science advising centre
- Science Support programs: <http://science.ubc.ca/students/resources>



*Any other questions:
please email the program
advisor, [Vesna Sossi](mailto:Vesna.Sossi) at:
vesna@phas.ubc.ca /
phone: 604-822-7710

Physics & Biophysics Co-operative Education Program



Javed Iqbal, September 2023

- iqbal@phas.ubc.ca
- 604-822-2465

What is Co-op?



- **Integration of academic studies with relevant, supervised, full-time and paid** work experiences within student's field of studies
- **16 months** to obtain a Co-op designation (4, 8, 12 or 16-month placements)
- **Multiple placements** with different employers

*Average monthly salary
for PHAS & BIOP
Co-op: \$2800

Benefits of Co-op

- Practical work experiences
- Opportunity to work on real-life problems
- Focused education
- Increased job prospects after graduation
- Informed decisions about graduate studies
- Networking
- Life skills



Program Fees

- Co-op Administration & Workshop fee: \$266.75
- Co-op work term fee: \$838/WT
- Total cost of program (4 WT): **\$3,600**

Application Deadlines

- Year 2 & 3 students: **October 3, 2023**
- Year 1 & 2 students: **March 6, 2024**

Schedule I (1st year PHAS)

Year	Term1	Term 2	Summer
1	ST 1	ST 2/apply	
2	ST 3	WT1	WT2
3	ST 4	ST5	WT 3
4	WT4	ST 7	WT 5
5	ST 7	ST 8	



Schedule II (3rd Year PHAS & BIOP)

Year	Term1	Term 2	Summer
1	ST 1	ST 2	
2	ST 3	ST 4	
3	ST 5/apply	ST 6	WT 1
4	WT 2	WT 3	WT 4
5	ST 7	ST 8	

PHAS & BIOP Co-op Placements (Fall 2022-Summer 2023)

Physics/Astronomy

- Amazon
- Apex Geoscience Ltd.
- Boreal Genomics
- C.J. Greig & Associates
- Canadian Space Agency
- Corvus Energy
- Chartered Professional Accountants BC
- D-Wave Systems
- Environment & Climate Change Canada
- INTEL of Canada
- Laser Zentrum (Germany)
- Max Planck Institute for Chemical Physics of Solids (Dresden)
- Meta Materials
- MineSense Technologies
- Moment Energy
- Nanotech Security
- Netgear
- Nokia
- NRC Labs
- Nyoka Designs
- Regenerative Waste Labs
- Robert Bosch (Germany)
- SBQMI
- SFU
- Tesla Motors
- TRIUMF
- UBC (PHAS, CHEM, EOS)
- University of Toronto
- University of Wurzburg (Germany)
- Visier Inc.
- VGH

Biophysics

- KAUST (Saudi Arabia)
- Michael Smith Labs
- UBC Physics & Astronomy
- Vitacore Industries



New Course!

★ NEW COURSE

BE AHEAD OF THE CURVE

TRY PHYS 310: MACHINE LEARNING FOR PHYSICS & ASTRONOMY DATA ANALYSIS

- ALGORITHMS FOR DATA STRUCTURING
- DIMENSIONALITY REDUCTION
- LINEAR REGRESSION & CLASSIFICATION
- ARTIFICIAL NEURAL NETS
- CONVOLUTIONAL NEURAL NETS
- UNSUPERVISED LEARNING



Questions:

- Prof. Joerg Rottler
- jrotter@physics.ubc.ca

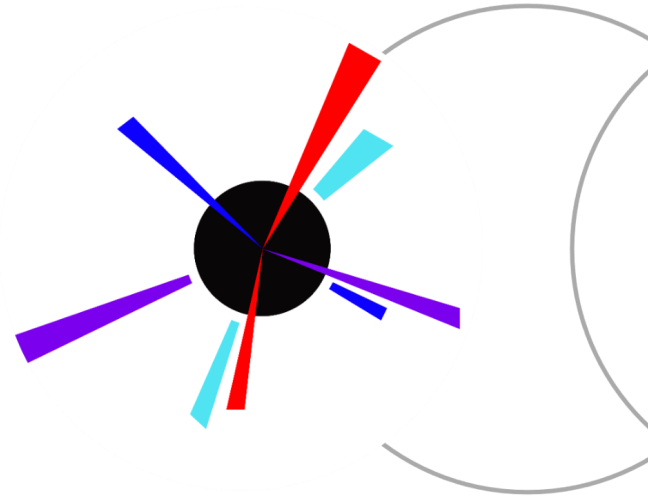
PHAS STUDENT CLUBS

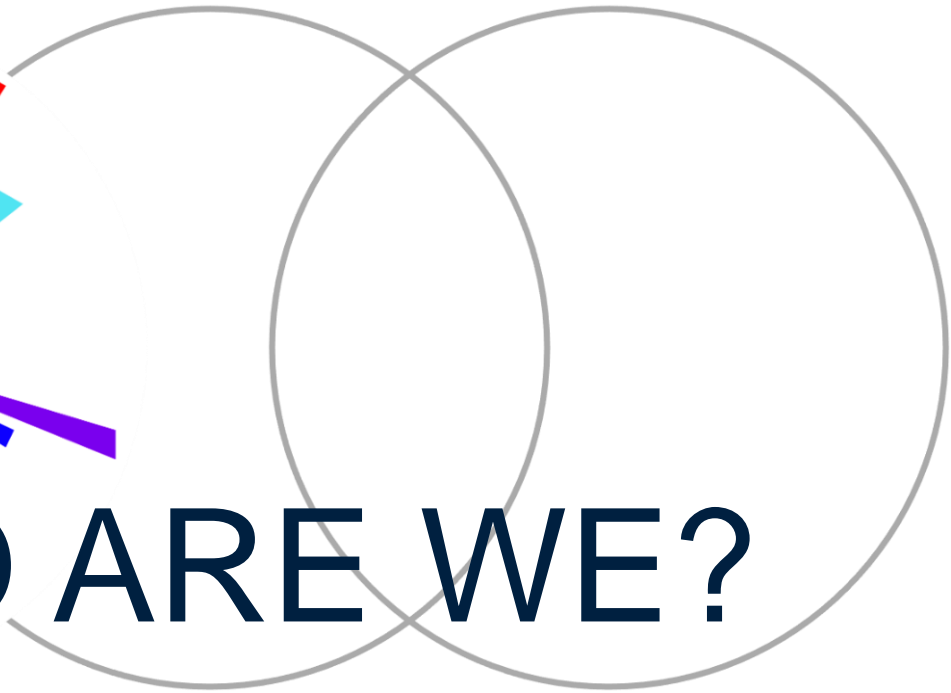
PHYSICS Society
(PHYSSOC) &
ASTRONOMY
CLUB



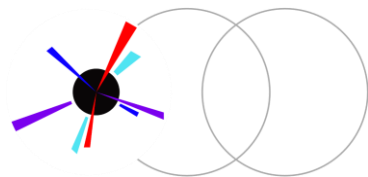
UBC PHYSICS SOCIETY

\presenters [Co-Presidents] {Myles
Osenton, Jason Li}

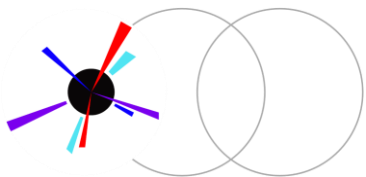




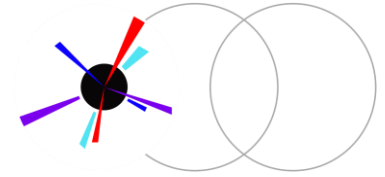
WHO ARE WE?



YOUR DEPARTMENTAL STUDENT SOCIETY



1930



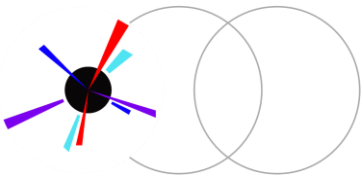
Founding Year

16 Council members

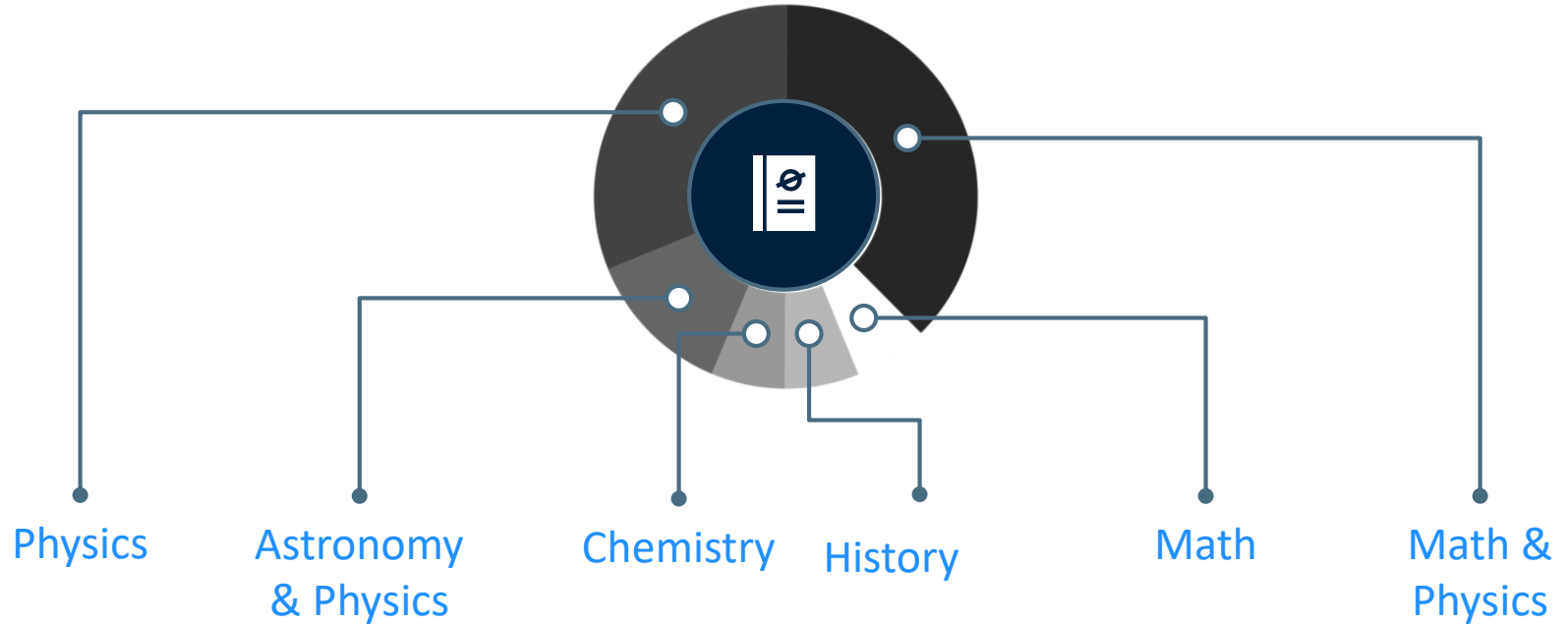
Largest Council in our History

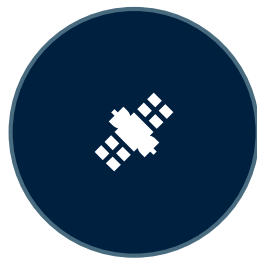
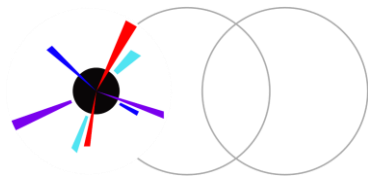
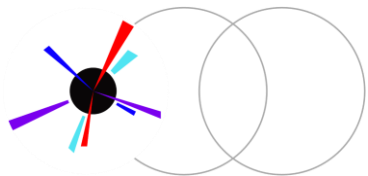
\$10

Membership Fee



STATS ABOUT US





WHAT DO WE
ACTUALLY DO?

SEPTEMBER EVENTS

Sun	Mon	Tue	Wed	Thur	Fri	Sat
3	4	Imagine Day Booth	6	Welcome Back Social	Welcome Back BBQ + Pub Trivia	9
10	11	12	13	14	Welcome Back BBQ + Pub Trivia	16
17	18	Math Methods Workshop 1	20	21	Pub Trivia	23
24	25	26	27	Python Workshop 1	Pub Trivia	30

FUTURE EVENTS



BEEF & PIZZA



CO-OP PANEL



WINE & CHEESE



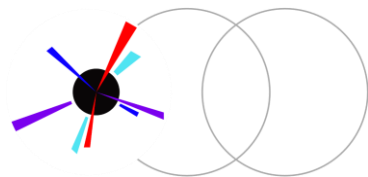
LATEX
WORKSHOPS



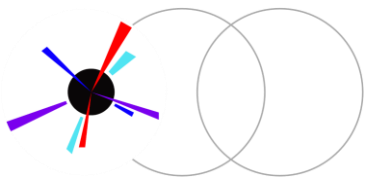
EXAM REVIEW
SESSIONS

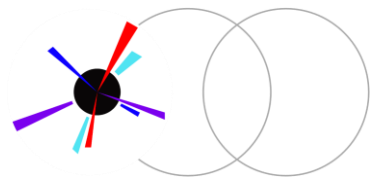


INTER-CLUB
SOCIALS

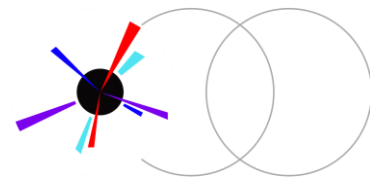


24/7 CARD ACCESS

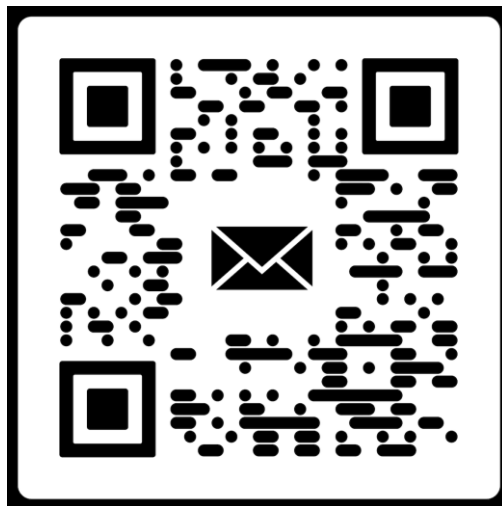




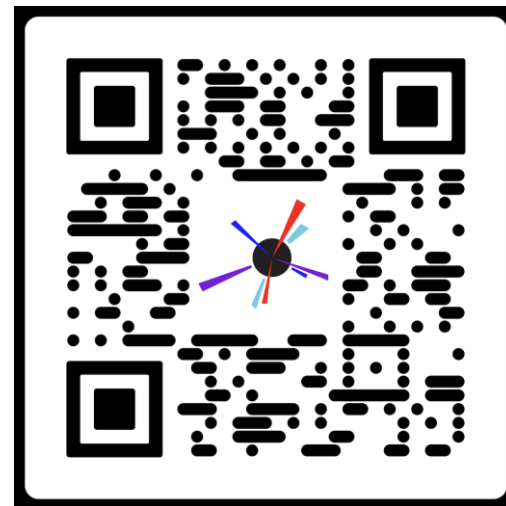
THANKS!



Discord



Email
List

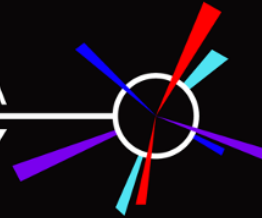


Website

CONTACT

Lounge & Office: HENN 307
Email: physsoc@phas.ubc.ca
Website: physsoc.phas.ubc.ca
Instagram: [ubcphysicsociety](https://www.instagram.com/ubcphysicsociety)
Facebook: [The UBC Physics Society](https://www.facebook.com/TheUBCPhysicsSociety)

UNIVERSITY OF BRITISH COLUMBIA
PHYSICS SOCIETY



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UBC
ASTRONOMY
CLUB

The UBC Astronomy Club

Looking up 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?

Social

Observational

Academic

Outreach



Paint-tea



Flash Observations



Lecture Series



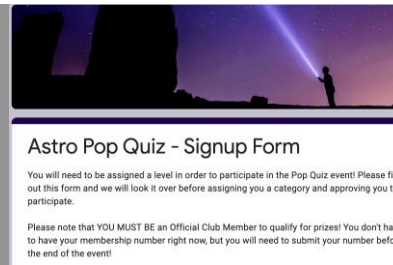
Movie Nights



Trivia Nights



How-to
Workshops



Online Quizzes



School Visits

Join us!

- We host several events each month - drop by as many times as you want!
- Come visit us at Lee Square (outside the bookstore area)!
- How to join:
 - Standard Member
 - Exec Team
- Learn more about Astronomy outside of your courses
 - Get practice using telescopes
 - Hear from experts in the field about cutting-edge research
 - Meet new friends with a shared passion for exploring the Universe!



Questions?

Ways to reach us



ubcastronomyclub@gmail.com



@ubcastronomy



facebook.com/UBCAstronomyClub



TheUBCAstronomyClub



@ubcastronomyclub



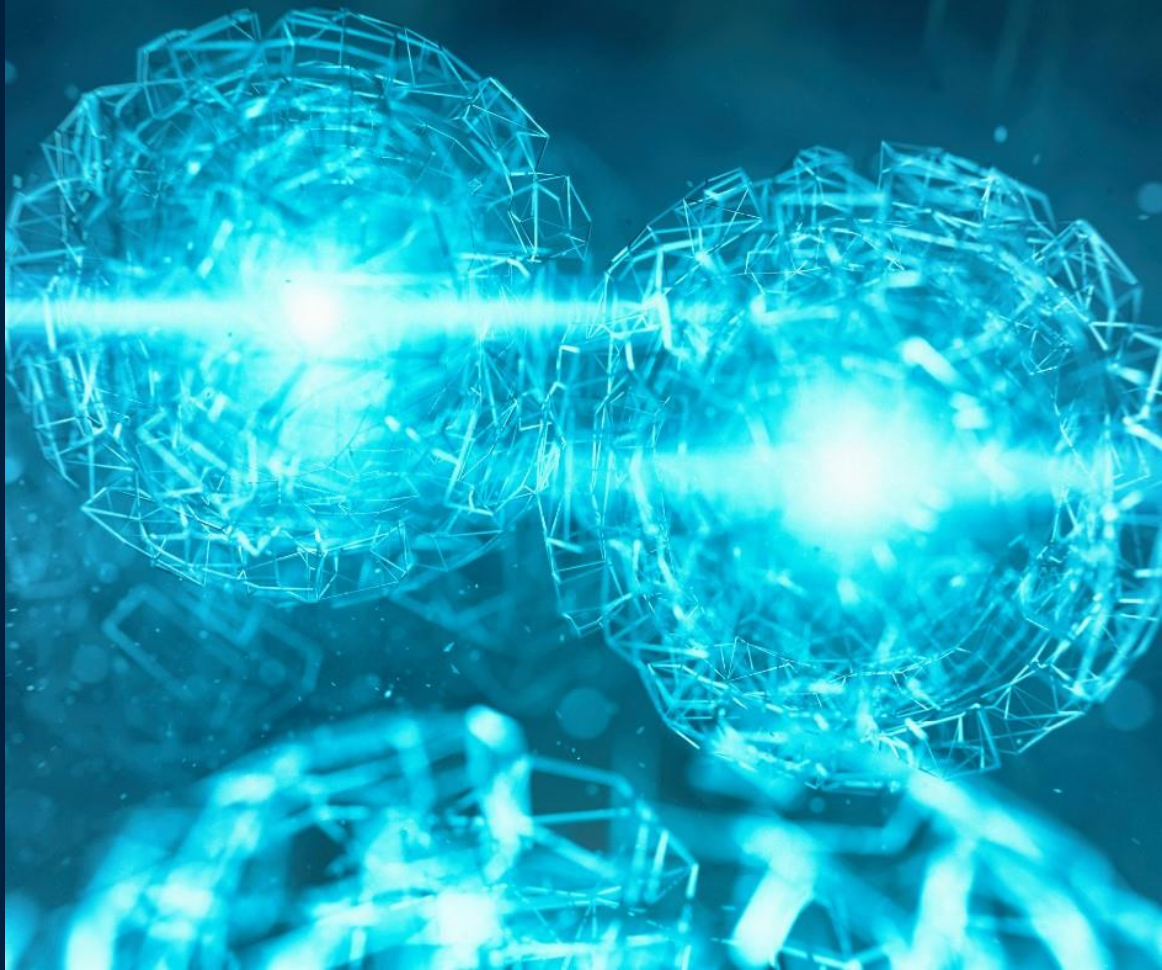
/u/ubcastronomyclub



ubcastronomyclub.com



Atomic Molecular & Optical (AMO) Physics



Atomic, Molecular and Optical (AMO) Physics

Laser control of Atoms, Molecules and their Quantum Interactions

Ultra-cold atoms
Atoms in superfluid helium
Anti-atoms

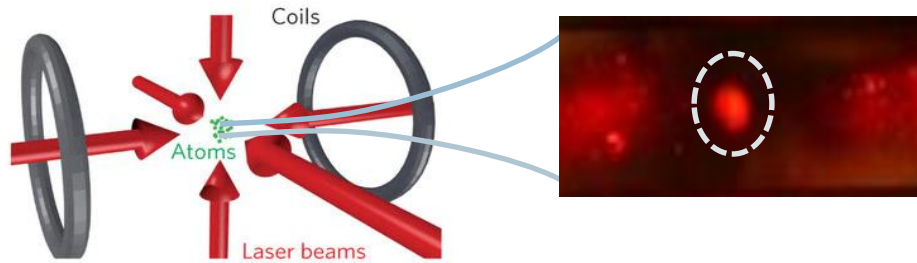
Ultra-cold molecules
Molecular super-rotors
Cold molecular plasmas

Frequency combs
Extreme frequencies
Optical centrifuge

What is Atomic Physics?

QUANTUM GASES

[Madison]



QUANTUM LIQUIDS

[Milner]



Roton "smoke rings"

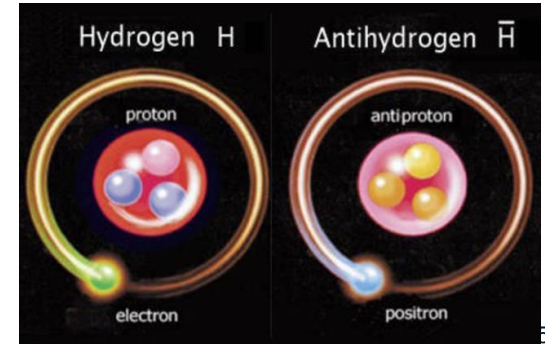
Ultra-short laser pulse



ANTIMATTER

[Momose]

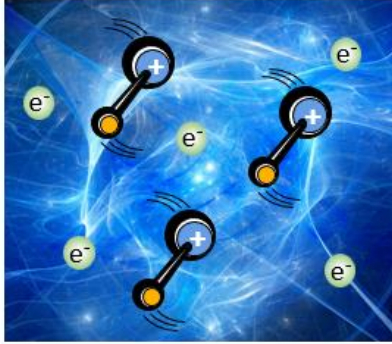
Antihydrogen



What is Molecular Physics?

COLD MOLECULAR PLASMAS

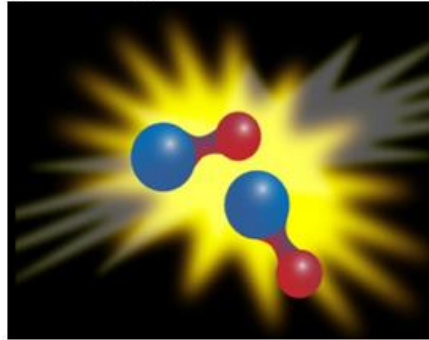
[Grant]



NO

ULTRACOLD MOLECULES

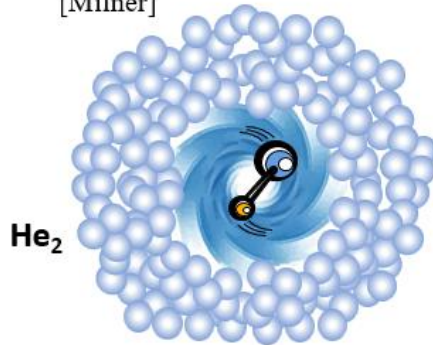
[Madison]



LiRb

MOLECULAR SUPER-ROTORS

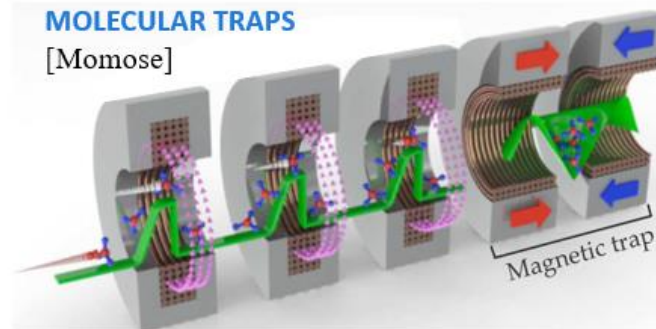
[Milner]



He₂

MOLECULAR TRAPS

[Momose]

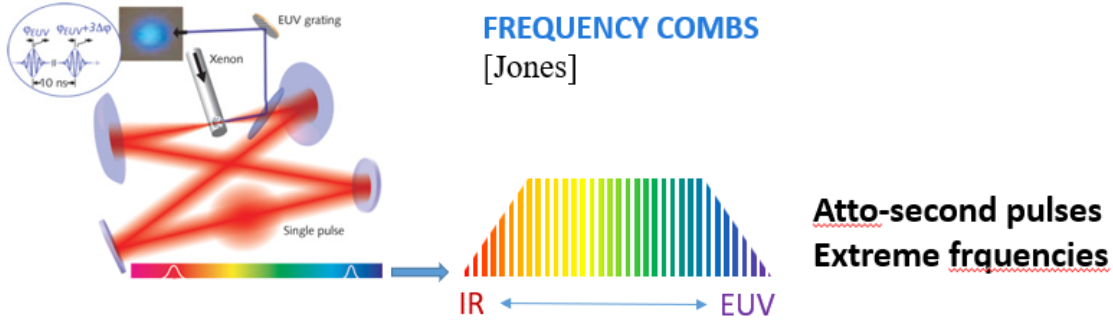


CH₃

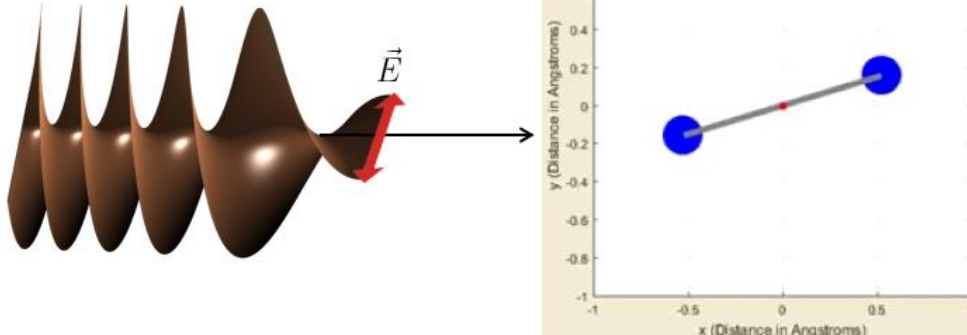
Magnetic trap



What is Optical Physics?



OPTICAL CENTRIFUGE [Milner]



Advanced AMO Physics: How to Learn?

PHYS 408 (*lectures + labs*) - “Fundamental & Modern Optics”

PHYS 532 - “Nonlinear Optics & Quantum Electronics”

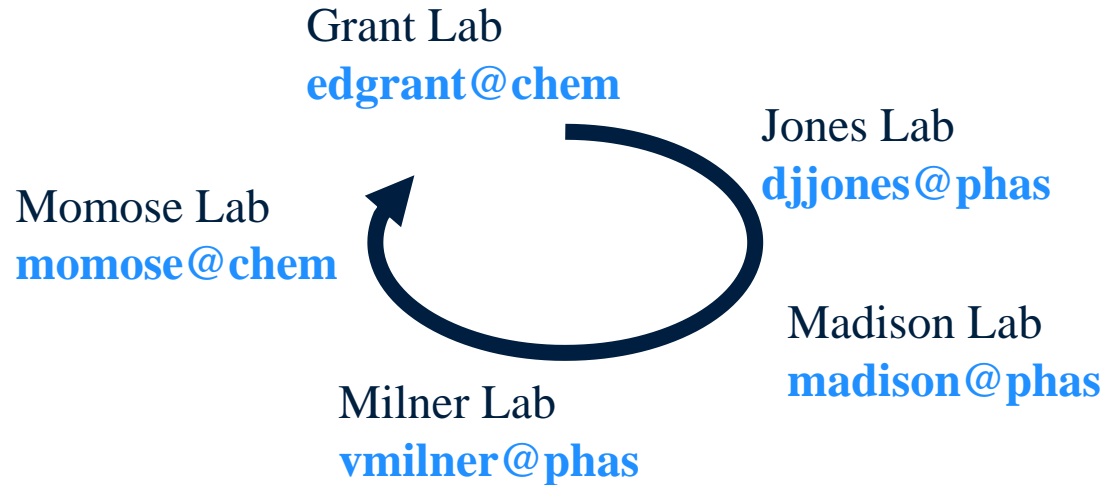
PHYS 533 - “Laser Physics”



AMO “Rotation Program”

- Pick 2-4 labs
- 3-6 weeks/lab

***Interested? Email us today!**

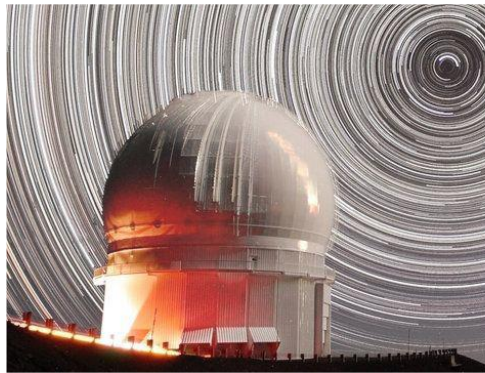
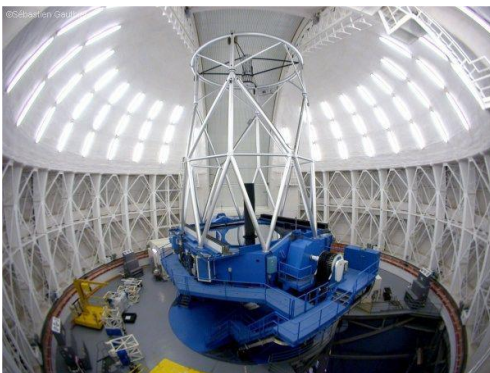


Astronomy Research Highlights at UBC



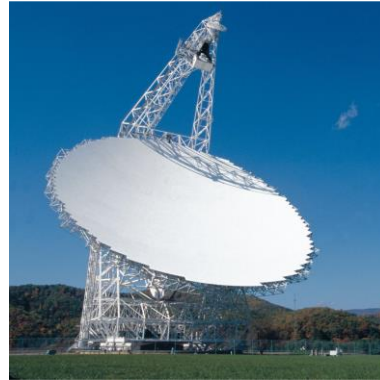
Astronomy

- We cover the full range of astronomical scales, from planetary science to cosmology
- We have observers, experimentalists, modellers, 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

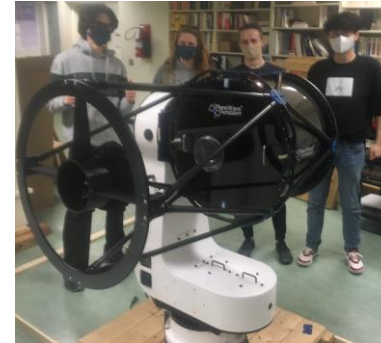


CFHT, Gemini, and CHIME: Canadian-led, or large Canadian contribution observatories (experiment).

Astronomy

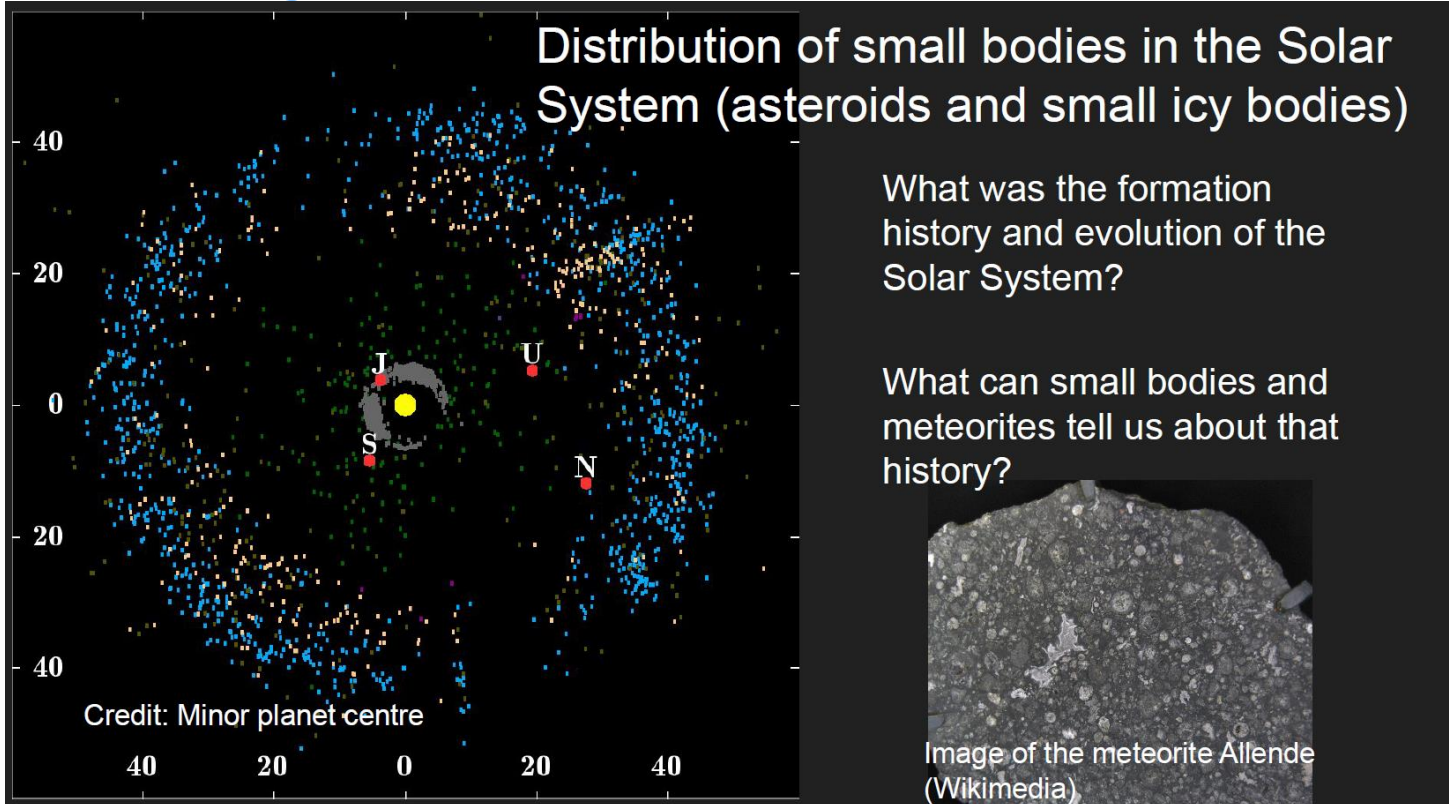


LIGO: Gravitational Wave Physics; Green Bank Telescope and ALMA



SKA: Radio and millimetre astronomy, and UBC Southern Observatory for teaching and research (in Chile)

What are some of the big questions UBC astronomers are addressing?



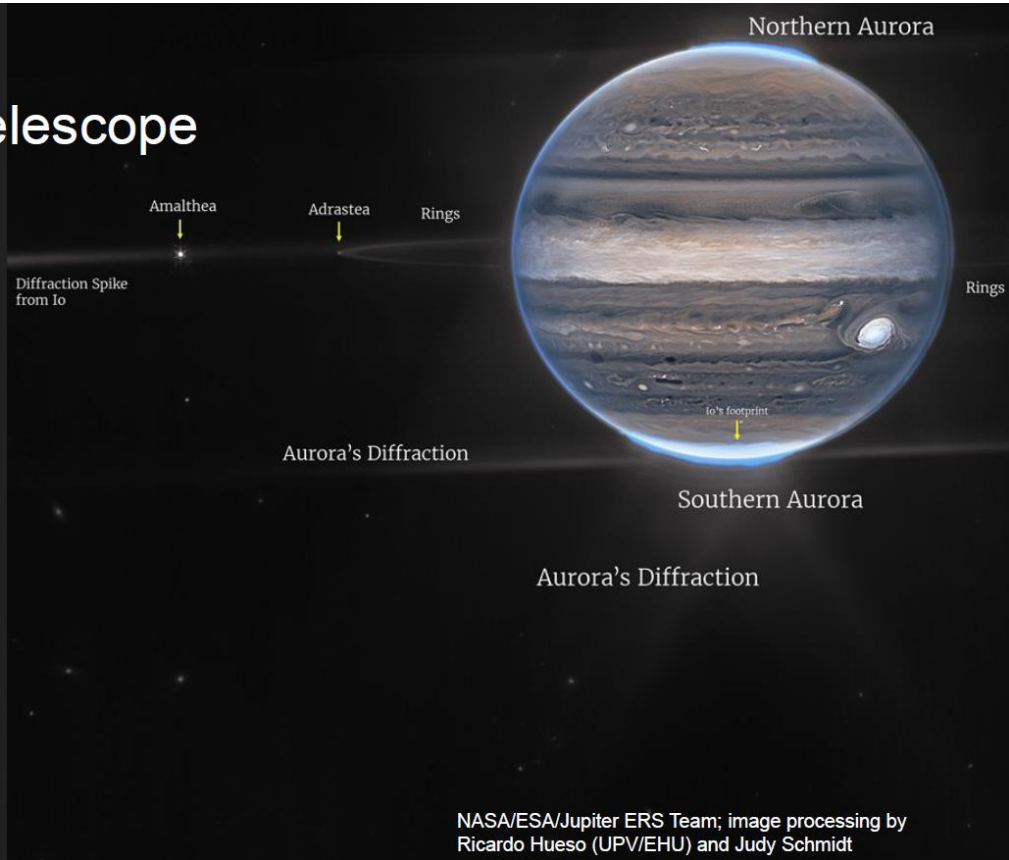
Jupiter as seen by the Webb Telescope

How do planets form?

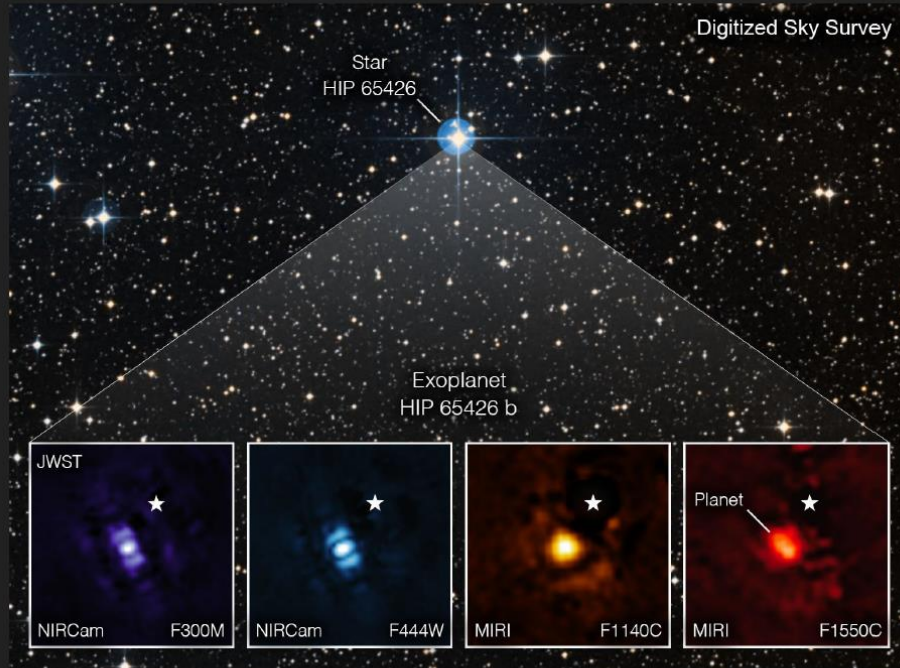
How do the building blocks
of planets form?

What processes set
planetary architectures?

How do planetary systems
evolve?



Directly imaged planet HIP 65426 b as see by the Webb Telescope



Credit: NASA/ESA/CSA, A Carter (UCSC), the ERS 1386 team,
and A. Pagan (STScI).

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

What are the connections
between star and planet
formation?





47 Tuc as seen by the Hubble Space Telescope



How was the Milky Way
Galaxy assembled?

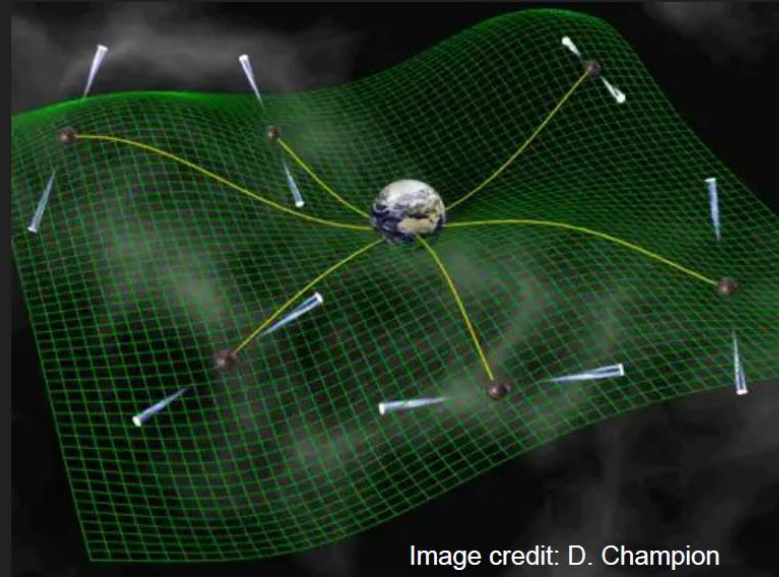
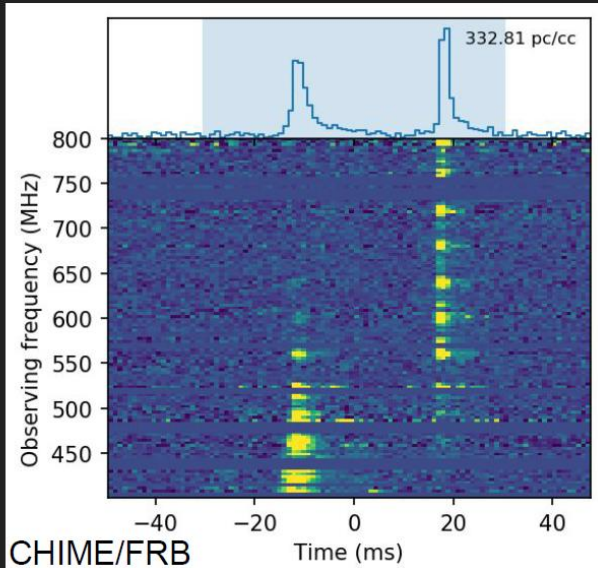
What is the record of that
assembly in stellar
populations?

Credit: HST/Richer et al.

CHIME/FRB and Pulsar Timing Arrays

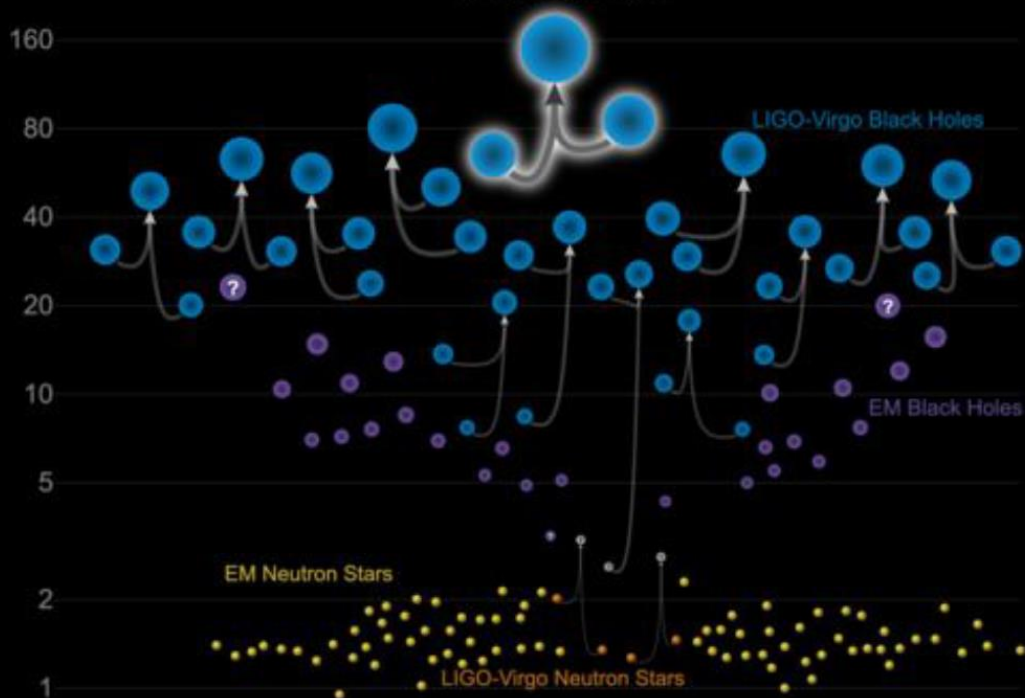
What are the extreme physical conditions in compact objects and do they show a need for extensions to standard physics?

What can compact objects tell us about gravity and gravitational waves?



Masses in the Stellar Graveyard

in Solar Masses



Updated 2020-09-02
LIGO-Virgo | Frank Elavsky, Aaron Geller | Northwestern

What are the mass ranges of black holes?

What are the merger rates of black holes and compact objects?





“Stephan’s Quintet” as seen by the Webb Telescope

How do galaxy interactions alter the
gas and stars in galaxies?

How are galaxies influenced by their
large-scale environment in which
they reside?



Image credit: NASA, ESA, CSA, and STScI

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?

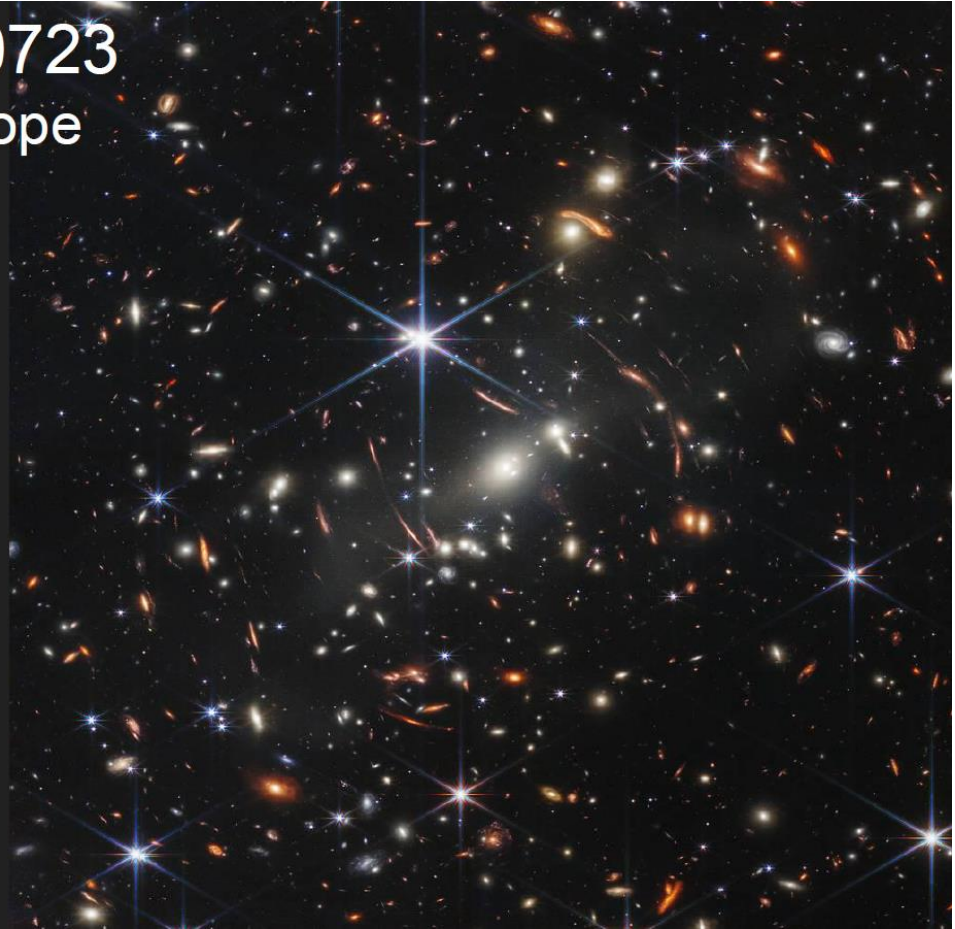


Image credit: NASA, ESA, CSA, and STScI

Cosmology – Origin and Evolution of the Universe

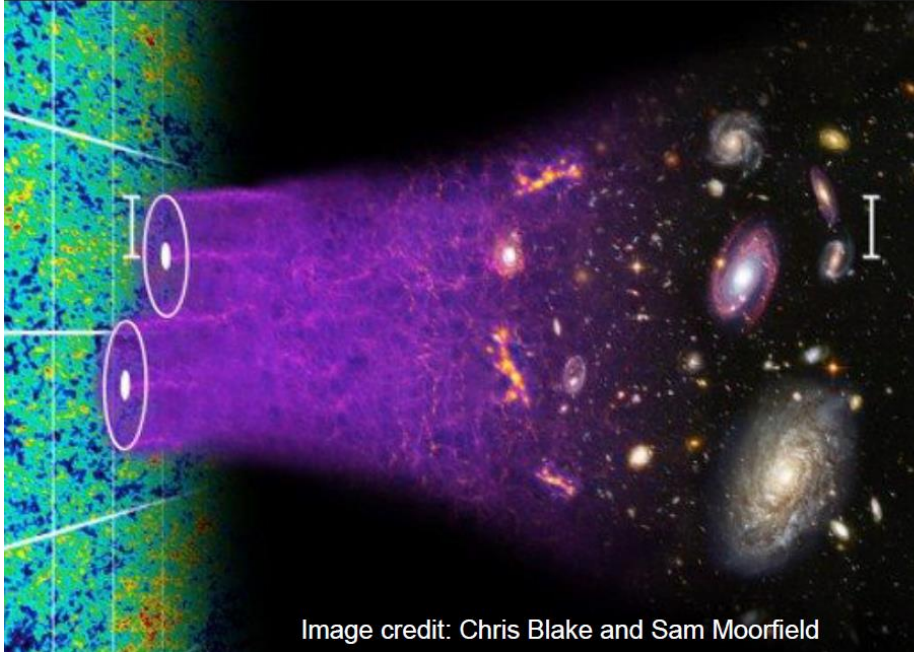


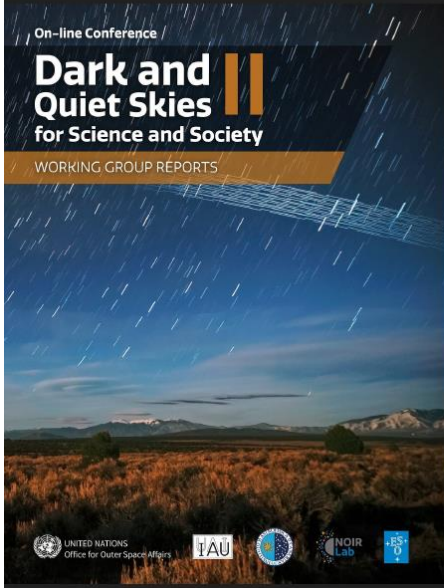
Image credit: Chris Blake and Sam Moorfield

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

What is Dark Matter and what is Dark Energy?

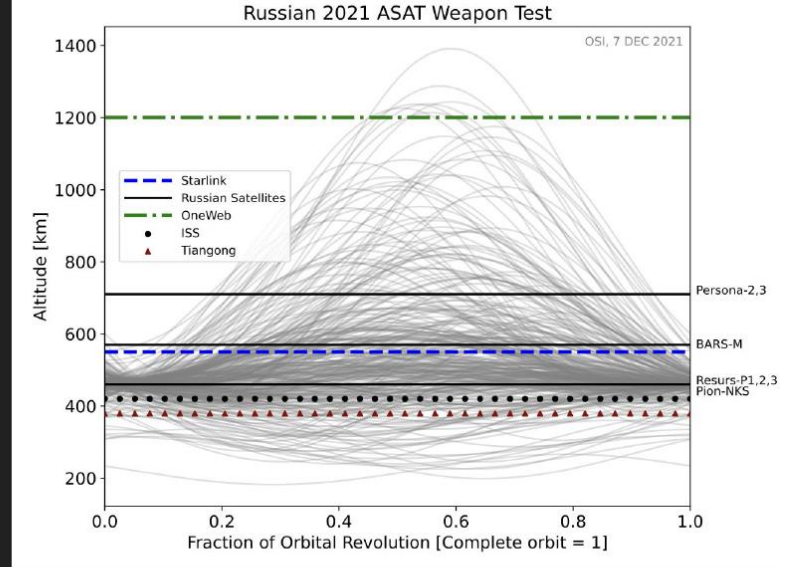


Space Sustainability and Science-Policy



How do we develop space while protecting access to dark and quiet skies?

How can space be developed such that future generations can also develop space?



How do we avoid conflict in space?

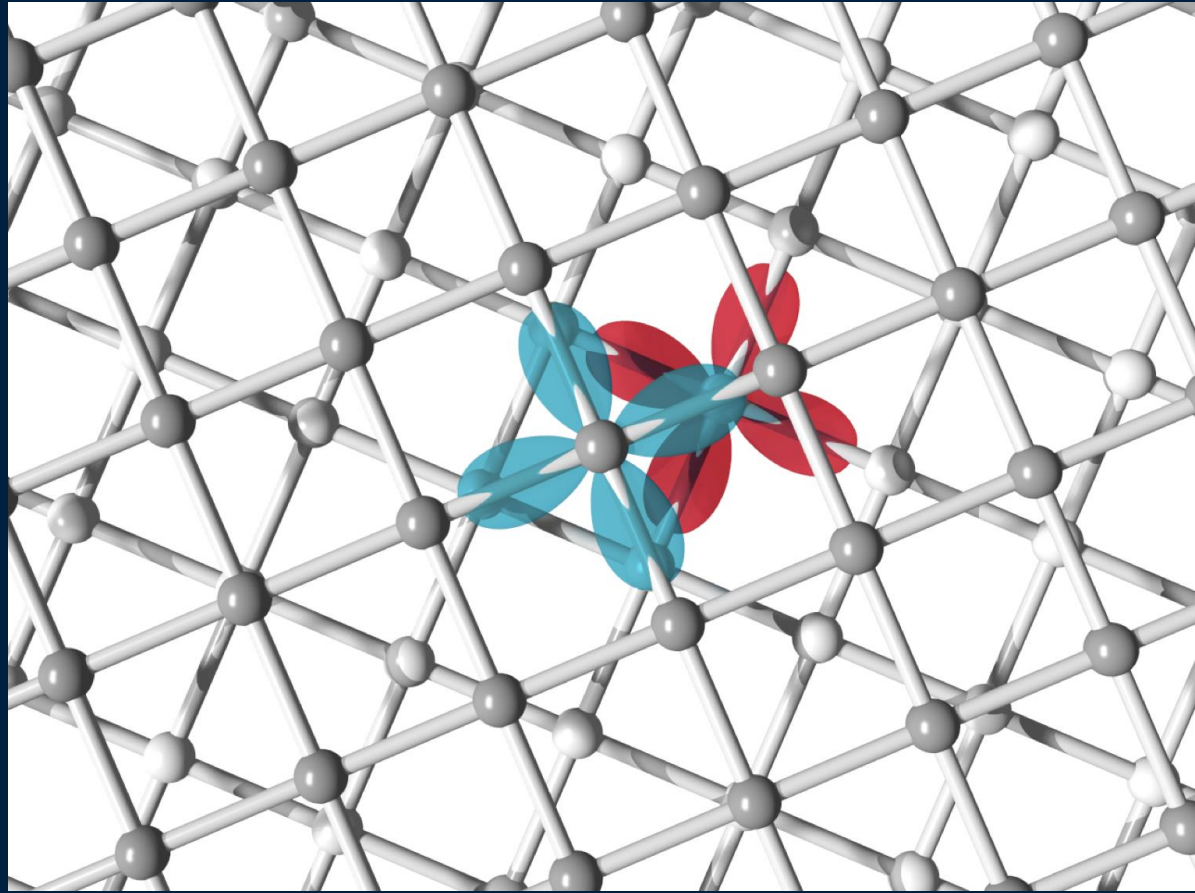
The Astronomy Faculty Team

- ❖ **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
- ❖ **NEW! Michelle Kunimoto:** Exoplanet demographics, exoplanet transits, statistical modelling, observational astronomy
- ❖ **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, multi-messenger 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

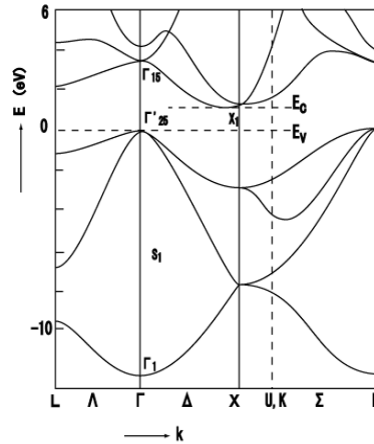
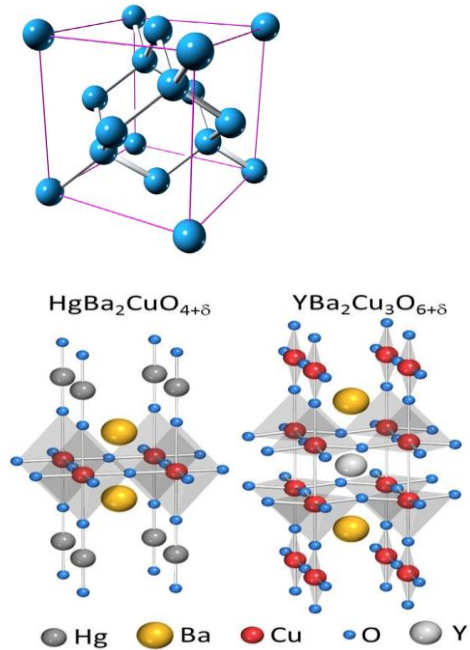


Condensed Matter Physics

(at UBC and more
generally)



Electron Motion is Crystal Lattices



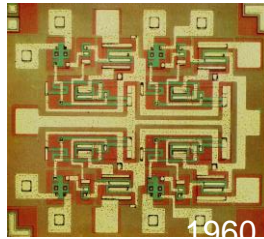
Understanding:
"band theory of solids"
1929



Invention of transistor 1948



Transistor: The most influential invention in history?



Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World in Data

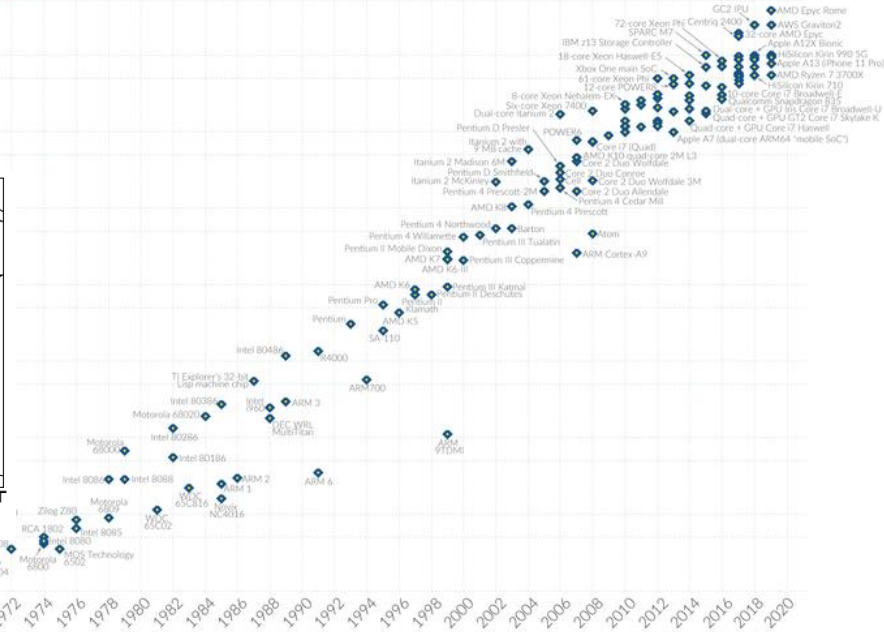
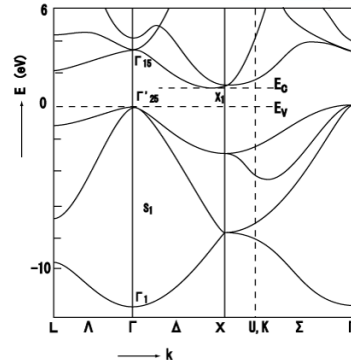
Transistor count
50,000,000,000

10,000,000,000

5,000,000,000

1,000,000,000

500,000,000



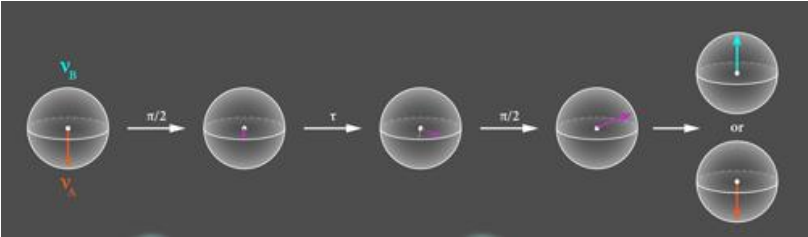
Today it is estimated that **30 trillion** transistors are produced every second!

Data source: Wikipedia (wikipedia.org/wiki/Transistor_count) Year in which the microchip was first introduced

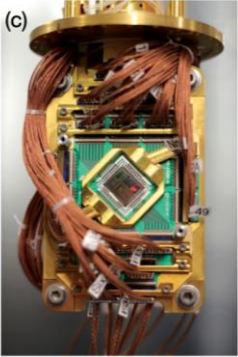
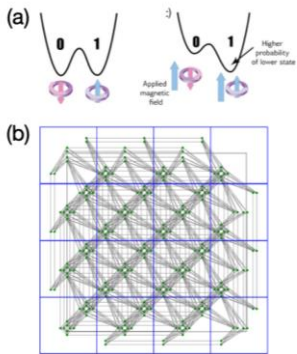
OurWorldInData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

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.



Stewart Blusson Quantum Matter Institute (SBQMI)



Stewart Blusson
Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

VISION

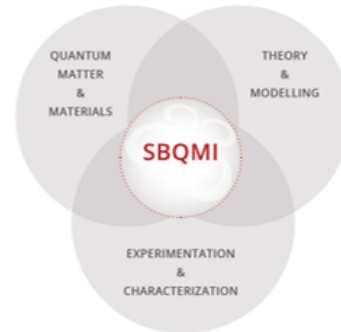
Quantum Materials by Design

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

• Physics • Chemistry • Electrical Engineering •



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

ELECTRONIC PROPERTIES OF STRONGLY CORRELATED MATERIALS

and their link to physical properties

DECEMBER 4 - 6, 2017
VANCOUVER UBC



LECTURERS

P. Abhayavatsana
T. Afilliac
W. Allen
G. Di Biase
J. van den Brink
A. Damascelli
T. De Groot
H. Eschke
C. Fong
J. Frell
A. Fujimori
D.G. Hawthorne
B. Horne

INVITED SPEAKERS

D. Khomahli
G. van der Laan
B. Li
L. Li
D. Luo
D. Mandrus
A.N. Moroz
T.H. O'Leary
G.N. Scaletzky
C.D. Scott
K.M. Shoen
Z. Song
L.V. Spruiell
J. Zaanen

Quantum Matter Institute

ORGANIZERS

H. Renard
L.H. Frong
D. van der Marel

ULTRAFAST QUANTUM CONTROL OF MATTER

THE PATH TO SOLIDS

SCHOOL 11-12 Dec 2017
Vancouver UBC

**WORKSHOP 13-15 Dec 2017
Vancouver UBC**

LECTURERS

Prof. Richard University of Toronto, Canada
Prof. Aronov University of Toronto, Canada
Prof. M. M. Wolfson University of Toronto, Canada
Prof. J. K. Freericks University of Toronto, Canada
Prof. D. S. Citrin University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
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Prof. S. Ghosh University of Toronto, Canada

Stewart Blusson Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

30 Years of AKLT

Interacting systems in low dimensions

April 26-28, 2018
Vancouver, UBC



SPEAKERS

Ben Alfrink
Mohammad Amin
Colin Beufort
John Caley
Jon Robinson
Claudio Chamon
Sébastien Couteau
Tom Giamberini
Dimitris Goulinas
Masayuki Hatakeyama
Hans-Hartmut Hofer
Bertrand Huopaniemi

ORGANIZERS

Renald Franco
Moussa Oudine
akb2018@qm.i.ubc.ca

Stewart Blusson Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

NANOSCALE THERMAL TRANSPORT & HEAT LOCALIZATION

SCHOOL August 29, 2018
UBC, Vancouver, Canada

**WORKSHOP August 30 and 31, 2018
UBC, Vancouver, Canada**

LECTURERS

Prof. Thomas University of Illinois, Urbana, USA
Prof. J. K. Freericks University of Toronto, Canada
Prof. M. M. Wolfson University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada

INVITED SPEAKERS

David Gold, University of Illinois at Urbana-Champaign, USA
David Gold, University of Illinois at Urbana-Champaign, USA
David Gold, University of Illinois at Urbana-Champaign, USA
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ORGANIZERS

Prof. Thomas University of Illinois, Urbana, USA
Prof. J. K. Freericks University of Toronto, Canada
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Prof. S. Ghosh University of Toronto, Canada
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Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada
Prof. S. Ghosh University of Toronto, Canada

REGISTRATION

Please register at www.nanoscale-thermal-transport.org

Stewart Blusson Quantum Matter Institute
WALL

Stewart Blusson Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

SBQMI WORKSHOP ON SYNTHETIC TOPOLOGICAL MATTER

FEBRUARY 18-20, 2019
UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, CANADA

INVITED PARTICIPANTS:

Jason Alicea (Caltech)
Thomas Christianen (MIT)
Ashley Cook (Berkeley)
Chang-Dawg Choi (Caltech)
Eugene Demler (Harvard)
Shunhuai Fan (Stanford)
Gregory Feiguin (USC)
Roman Flory (EPFL)
Michel Fruchart-Combet (Villars)
Victor Galitski (McGill)
Muhammad Hafeez (UCI)
Naveen Kumar (MIT)
Hao Martin Lee (Alamo)
Julia Meyer (Grenoble)

INVITED PARTICIPANTS:

Joel Moore (Berkeley)
Francis Maier (MIT)
Yuxue Ouyang (Weizmann)
Sofia Hermans (Oxford)
Tara Pereg-Barnea (MIT)
Michael Reiser (Penn State)
Mark Rudner (Cornell)
David Schuster (Chicago)
Eran Sela (Tel Aviv)
Justin Song (Stanford)
Jeffrey Tao (Virginia)
Naveen Kumar (MIT)
North Tuck (Berkeley)
Tao Tu (Cornell)

ORGANIZERS:

Gil Refael (Caltech)
Moussa Franco (UBC)

qm.ubc.ca/top2019

Stewart Blusson Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

SBQMI Brainstorming session and summer school on INTERACTING MAJORANA FERMIONS

MAY 1-3, 2019, VANCOUVER BC
School, May 1, Brainstorming, May 2 and 3

Invited participants:

David Assan (QTP)
Chang-Min Chiu (QTP)
Paul Fendley (Oxford)
Sergey Frolov (Pittsburgh)
Guillaume Gervais (QTP)
Timothy Healey (Pittsburgh)
Jun-Feng Liu (Shanghai)
Charles Kane (Princeton)
Dimitris Goulinas (Oxford)
Dimitry Malin (Stanford)
Amos Auerbach (Princeton)
Constantin Schwab (MIT)
Jeffrey Tao (Virginia)

ORGANIZERS:

Ben Alfrink (UBC)
Moussa Franco (UBC)
qm2019@qm.i.ubc.ca



NEW FRONTIERS IN QUANTUM MATERIALS RESEARCH

October 3 - 4, 2019
QMI, UBC, VANCOUVER

RICE SPEAKERS

Fahri Alpar
Pengcheng Dai
David Gold
Nancy Rubin
Mark Sadowski
Andy Youngblut
Baris Yildirim

UBC SPEAKERS

Melissa Amundson
Dong Bann
David Gold
Julia Koh
Alexei Korolev
Alexei Korolev
Zhang Ye
Kai Zhou

ORGANIZERS

QMI, UBC, VANCOUVER
GORDON AND BETSY MOORE FOUNDATION
UBC



QUANTUM PATHWAYS

Stewart Blusson Quantum Matter Institute

The Stewart Blusson Quantum Matter Institute at the University of British Columbia is offering unique summer research opportunities to students from groups that are under-represented in the physical sciences and engineering. The Quantum Pathways program provides up to 6 years of research experience to undergraduate students interested in the field of quantum materials and includes:

- SCHOLARSHIPS TO SUPPORT A QUANTUM OF UP TO 10,000 US DOLLARS (SUMMER RESEARCH OPPORTUNITIES)
- POSITIONS AVAILABLE TO FIRST-YEAR AND SECOND-YEAR UNDERGRADUATE STUDENTS
- ONE-ON-ONE MENTORING IN RESEARCH, WRITING, AND PUBLIC PRESENTATIONS
- WORKSHOPS AND COURSES TO DEVELOP RESEARCH AND PROFESSIONAL SKILLS
- OPPORTUNITIES TO WORK WITH OUR PARTNER INSTITUTIONS
- TRAVEL ALLOWANCE TO COVER UBC AND RESEARCH-RELATED TRIP AND MEAL CONSIDERATIONS

ENQUIRIES | APPLICATIONS | REFERENCE LETTERS
QUANTUM PATHWAYS @ SBQMI, UBC, CA



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



MAX-PLANCK-GESellschaft



Universität
Stuttgart

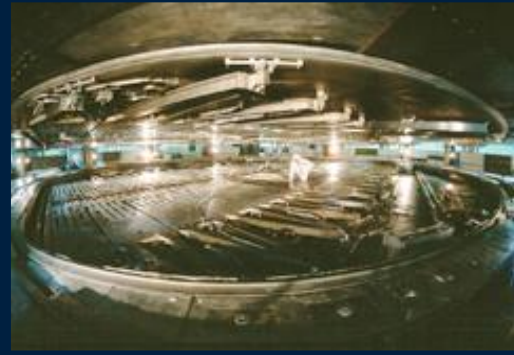
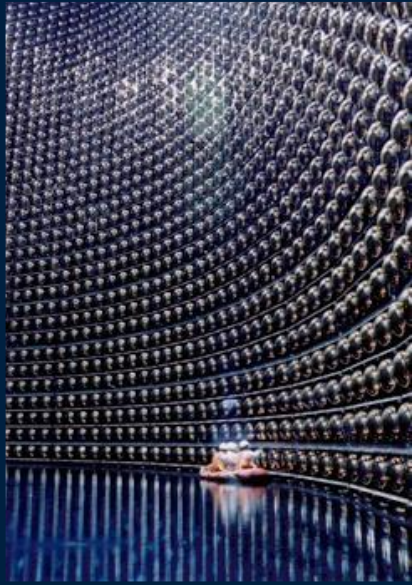
Quantum materials by design

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



Stewart Blusson
Quantum Matter Institute
THE UNIVERSITY OF BRITISH COLUMBIA

Subatomic Physics at UBC



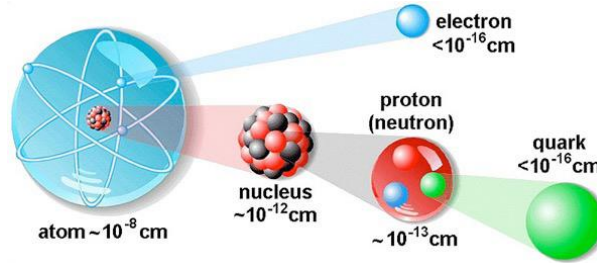
Particle (Subatomic) Physics

Particle 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

Forces

Strong		Electromagnetic	
Gluons (8) Quarks Mesons Baryons		Photon Atoms Light Chemistry Electronics	
Gravitational		Weak	
Graviton ? Solar system Galaxies Black holes		Bosons (W,Z) Neutron decay Beta radioactivity Neutrino interactions Burning of the sun	

The particle drawings are simple artistic representations

Particle (Subatomic) Physics

To do this, we need to probe to the smallest distance possible,

Equivalent to working at the highest energy possible,

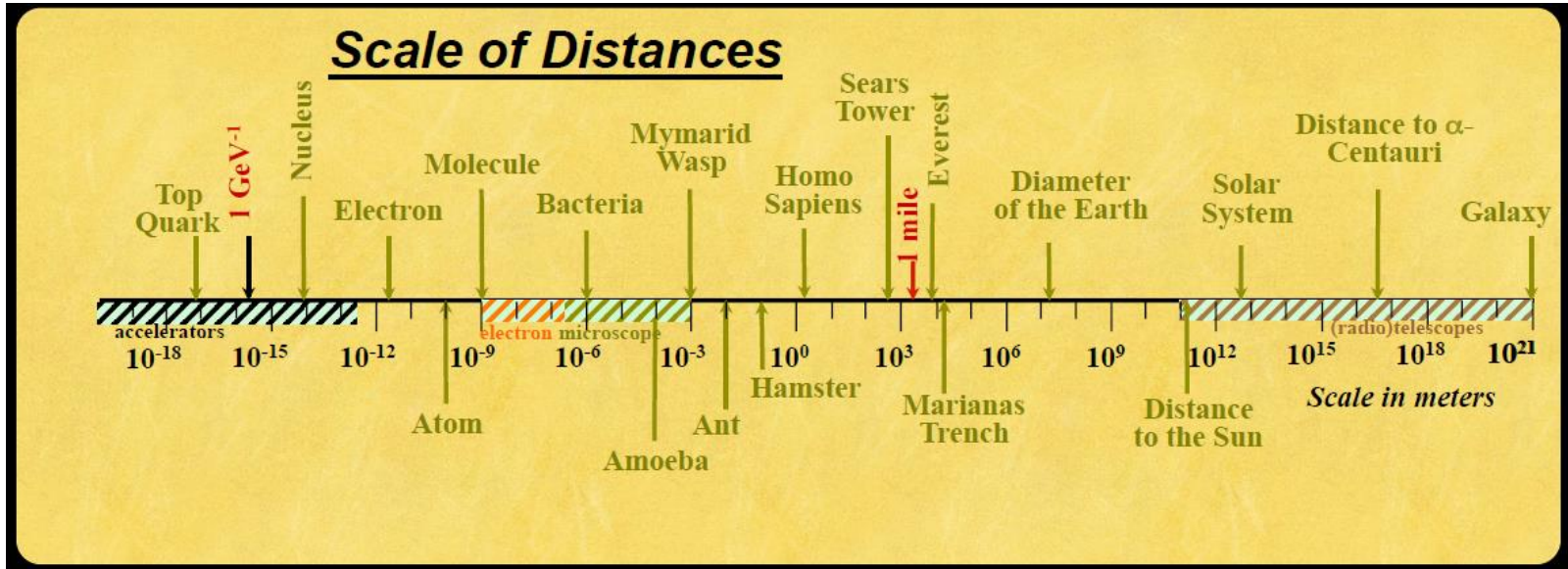
Or the hottest temperature,

Or the earliest time in the universe,...

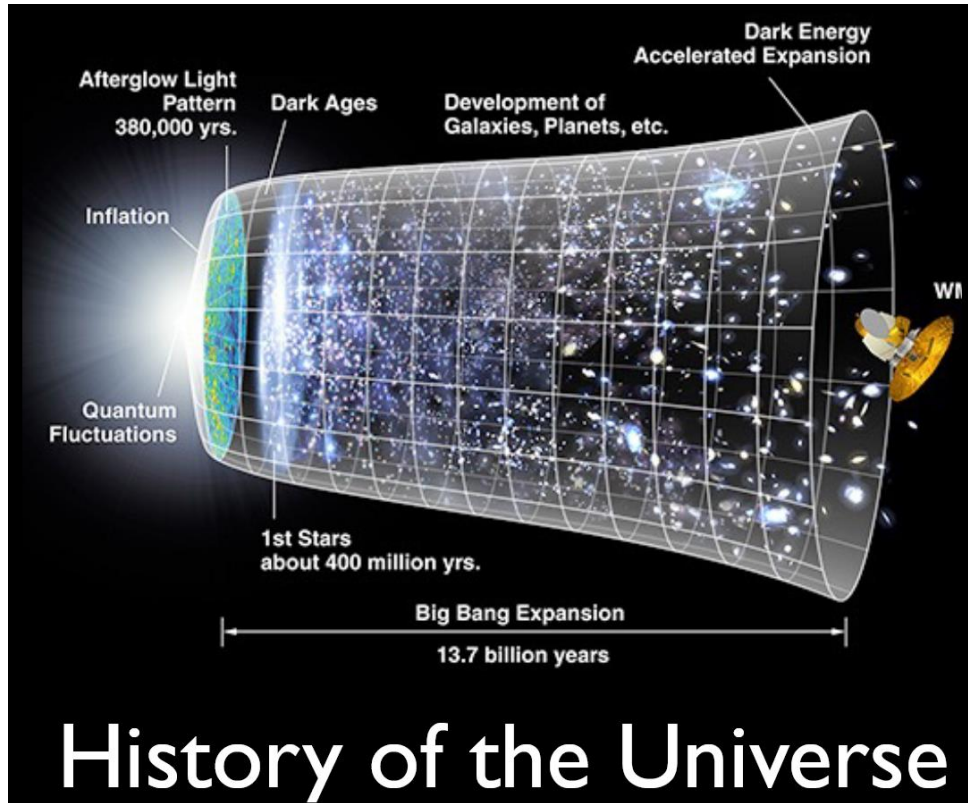


Particle (Subatomic) Physics

Particle Physics probes distance scales that are as far from the atomic scale as the atomic scale is from everyday scales.

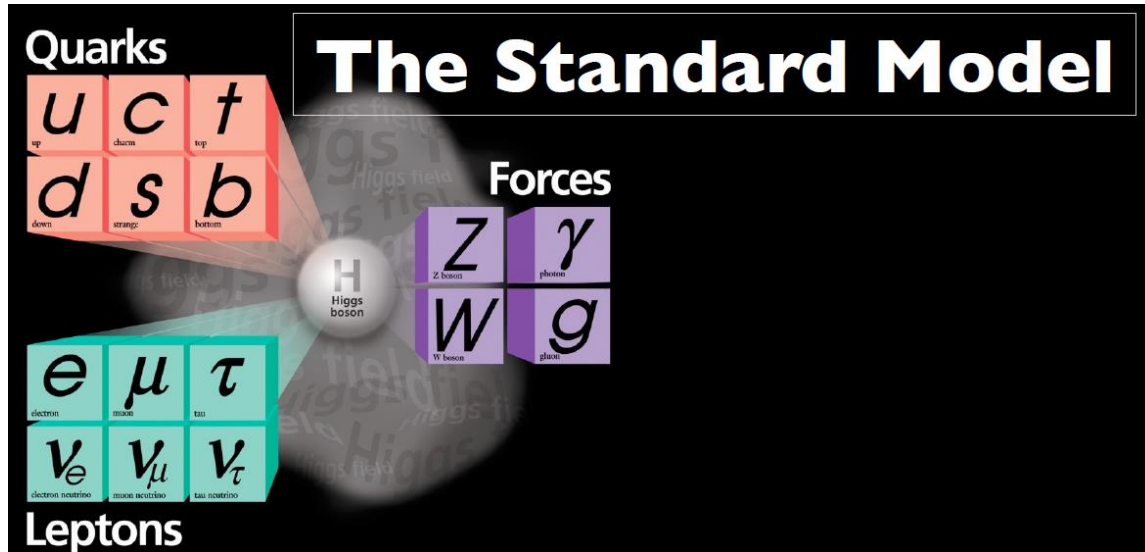


Particle (Subatomic) Physics



Particle (Subatomic) Physics

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.



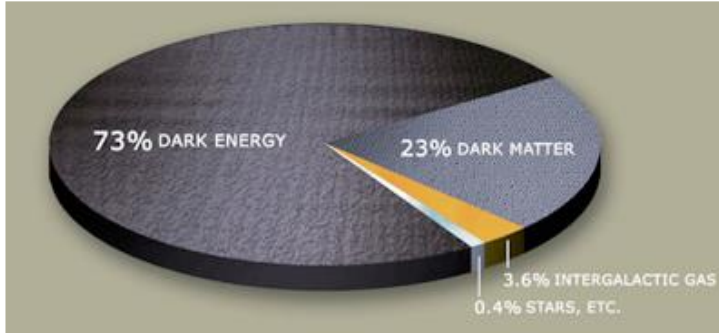
The Standard Model is one of the most well-tested theories ever.

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

Particle (Subatomic) Physics

Still many mysteries:

- What is Dark Matter?



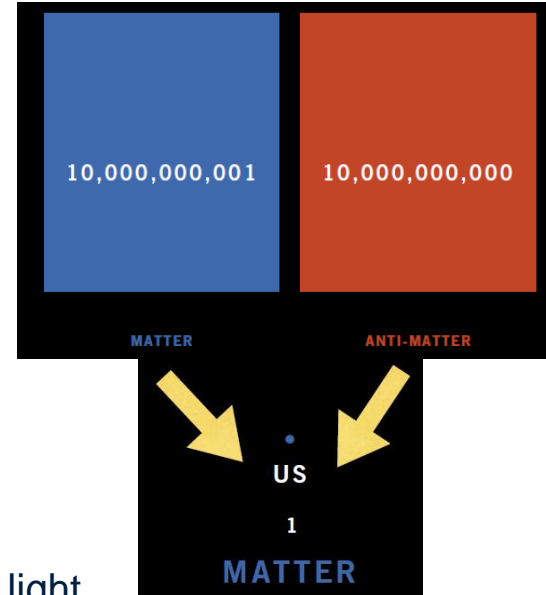
Search for Dark Matter

DM must be neutral (hence “Dark”)

Interacts extremely weakly with “normal” matter

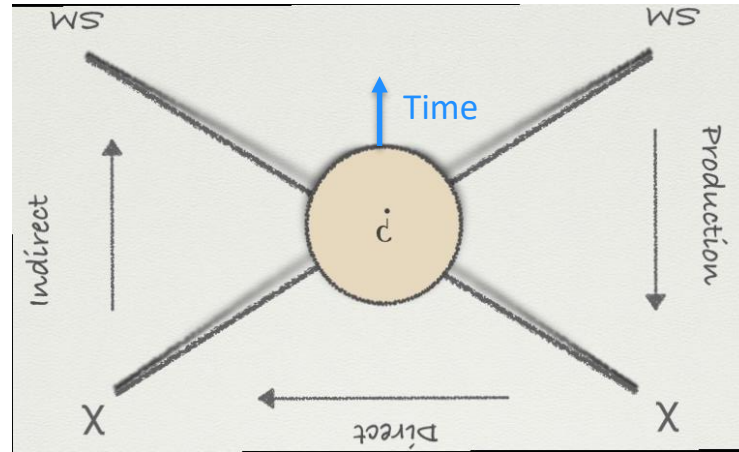
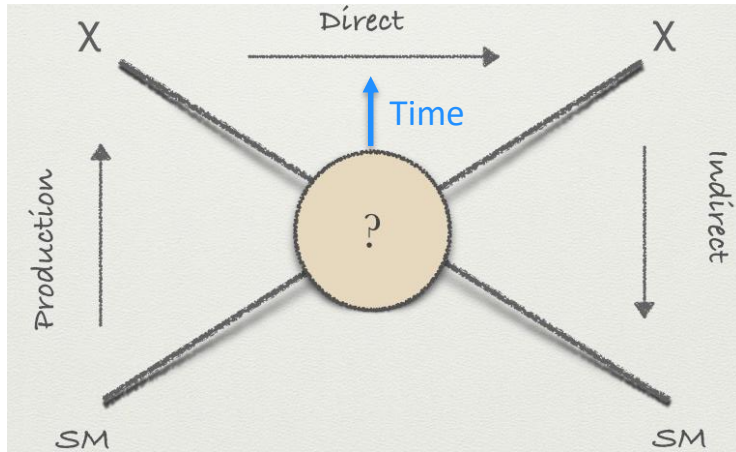
Is cold, that is, speed is small compared to the speed of light

- Why is there any matter left to make us?



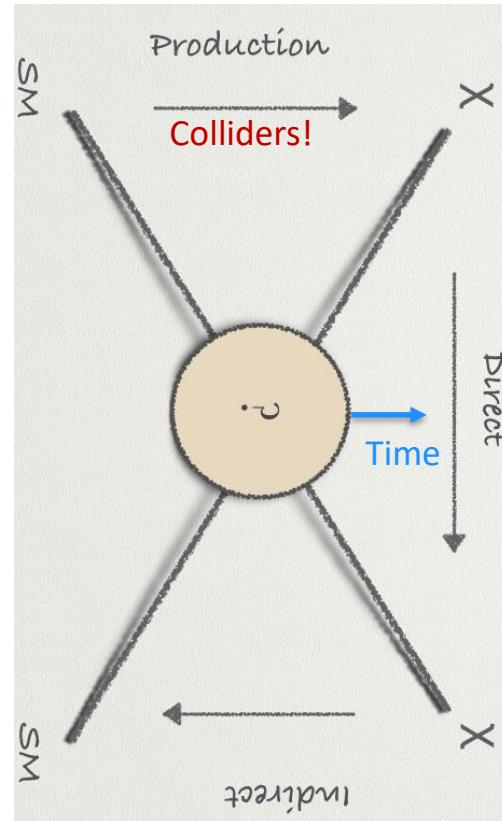
Early Universe Dark Matter

- The 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



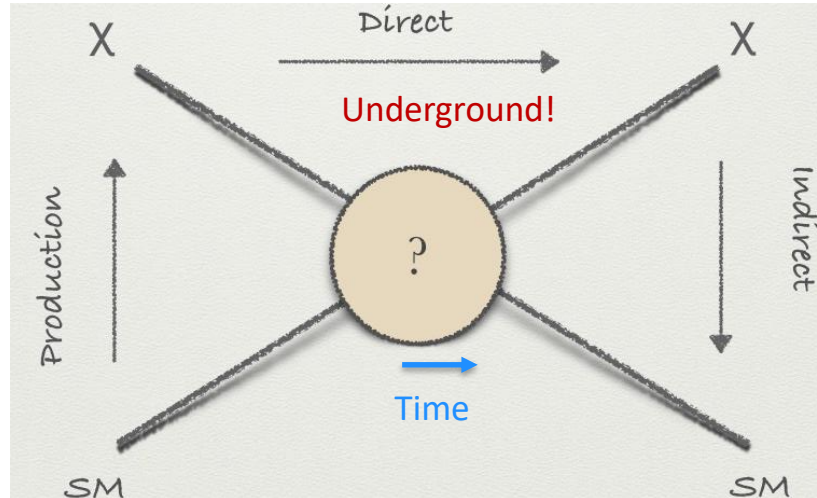
Current Dark Matter Search

- Particle colliders let us create conditions from the early universe!
- Eg: Large Hadron Collider in Switzerland: 10^{-12} s after Big Bang
- Collide protons, make Dark Matter in a lab to study



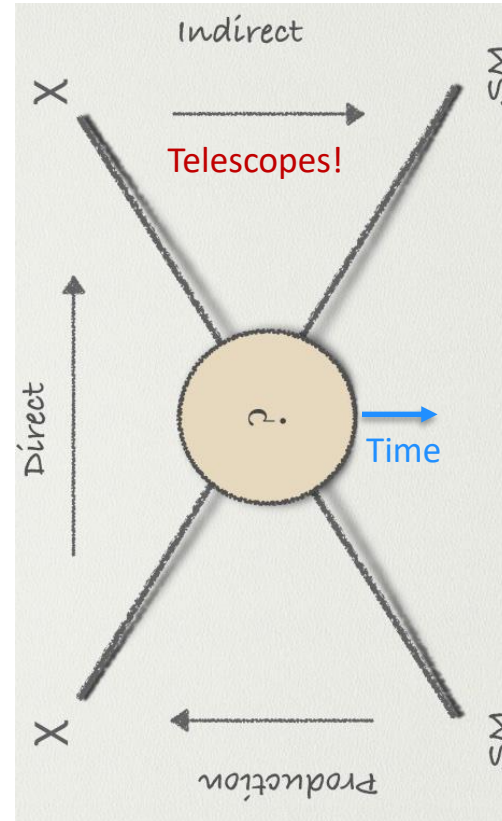
Current Dark Matter Search

- Let existing MD hit huge amounts of “normal” matter, look for extremely rare interactions
Eg: SNOLab in Sudbury, Ontario



Current Dark Matter Search

- Might still get MD annihilation in very dense regions of space
- Look for particular SM particle signatures coming from, eg, centres of galaxies

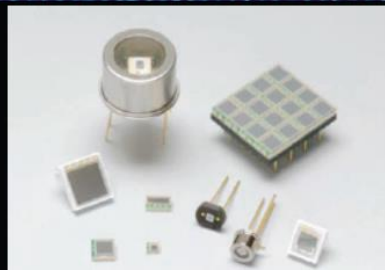
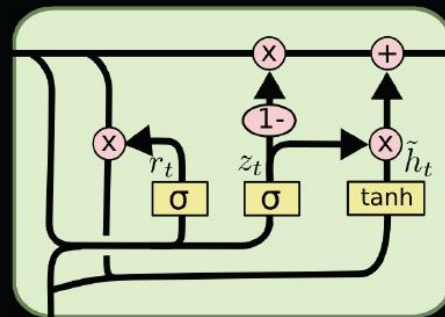
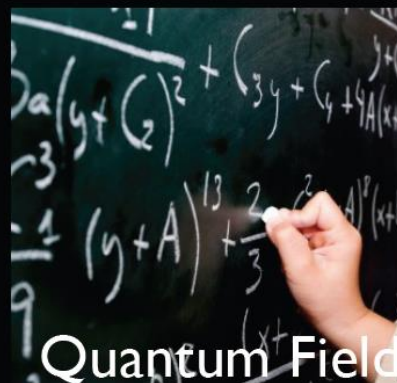


Lots of big questions still to address:

- 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



Experimental Particle Faculty at PHAS:

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



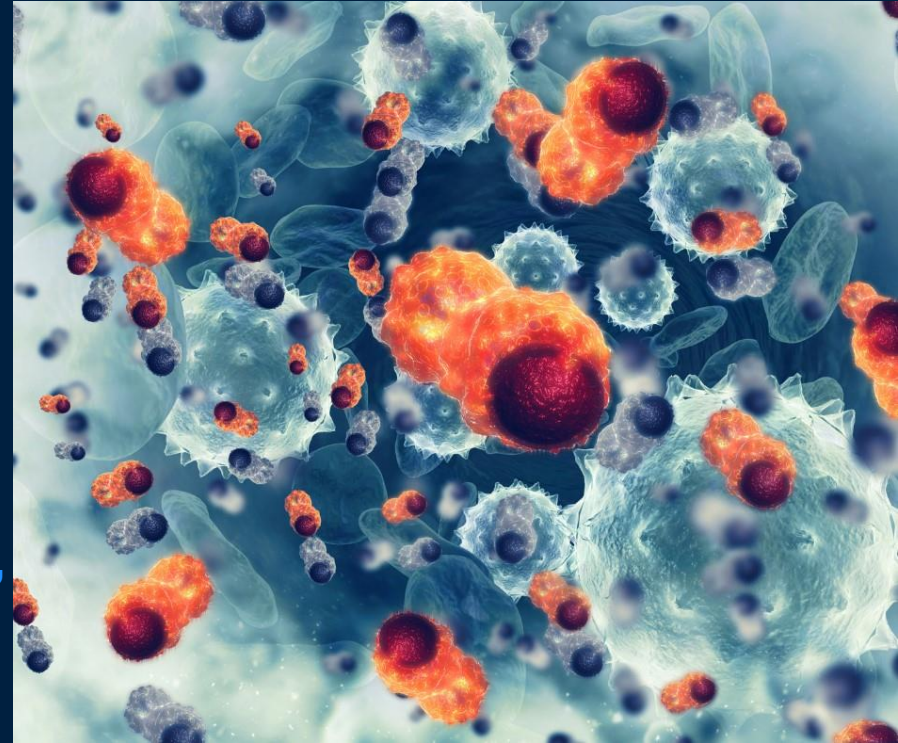
Biological and Medical Physics: the Physics of the 21st century 😊

In Collaboration with:

Michael Smith Labs, SBME, GSAT, BIONF,
Nanomedicine Center (NMIN), BC Cancer,
Center for Brain Health

By Sabrina Leslie,

Associate Professor UBC PHAS & MSL



Interdisciplinary Research: Team Effort 😊

Biophysics Day 2022



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

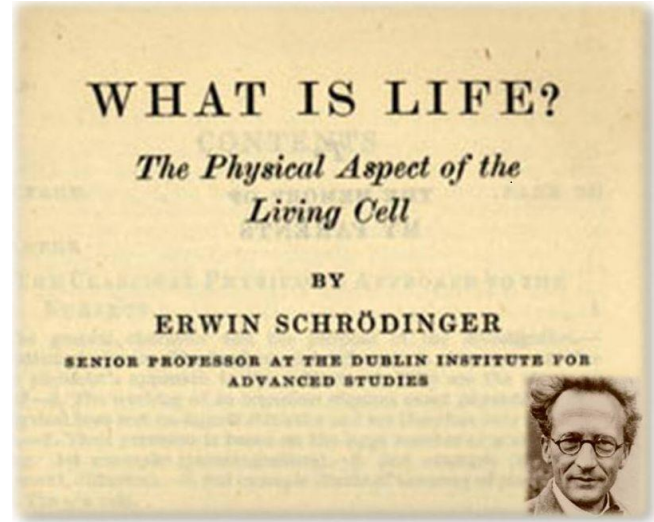
Working at the Interface of Physics, Biology, and Medicine

There's Plenty of Room at the Bottom

An invitation to enter a new field of physics.

by Richard P. Feynman

1978



1944

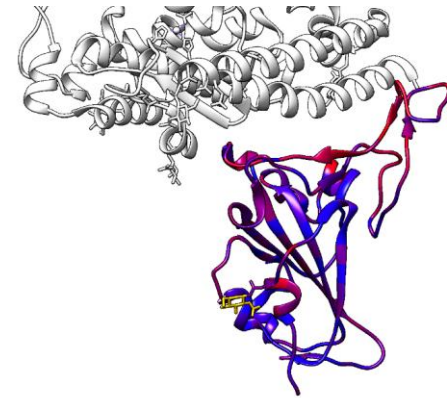
New biophysical tools enable new discoveries

“..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



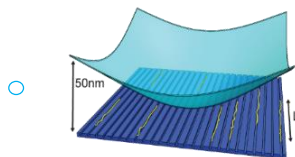
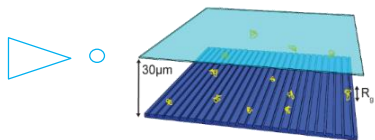
DNA



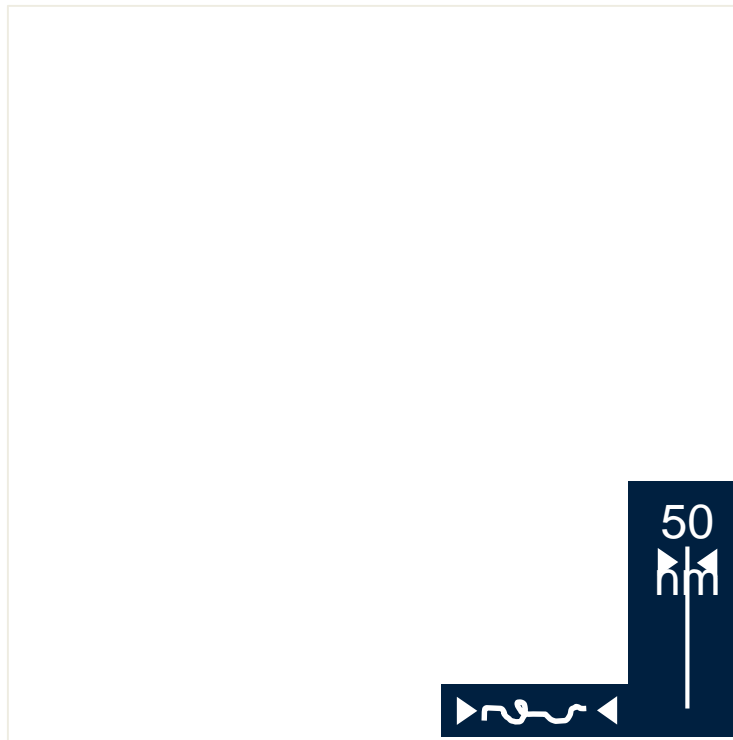
Spike protein on SARS-COV-2

2020

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 multi
cellular animals



Joerg Rottler
jrottler@physics.ubc.ca

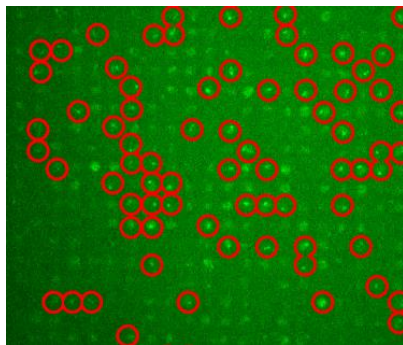
Material properties from an
atomistic perspective, machine
learning, polymers, biomaterials



In common: innovating instrumentation, analysis, theory

NMR and other microscopies **AI** to assist data analysis

Can we democratize boutique technologies to accelerate science?



Seeing single molecules helps diagnostics

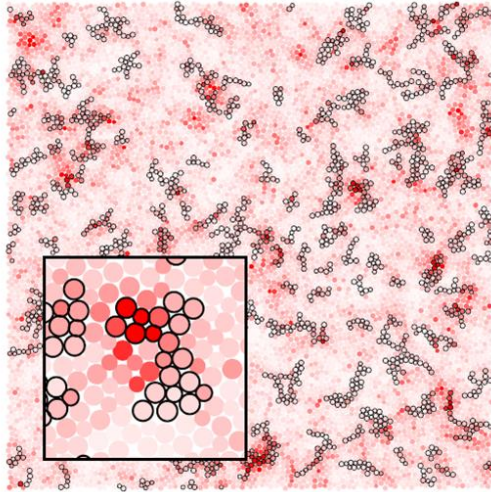
Single-molecule and single-cell microscopy of molecules, particles, cells, tissues, ..



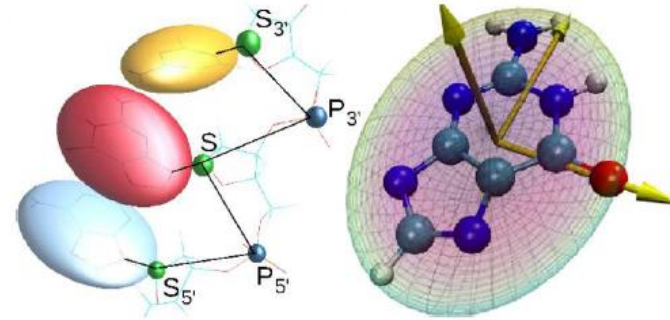
Biophysics skill sets through research:

Instrumentation, microscopies, optics, theory, computation, AI, machine learning, fabrication, wet sample handling, biotechnology

Rottler Lab



Towards an atomistic understanding of materials

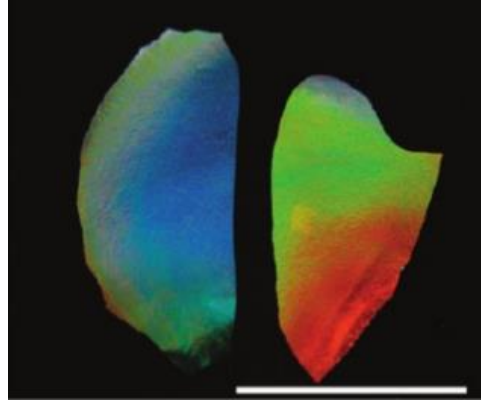


Biopolymers, biomechanical response, AI, ..

Michal Lab



Brain
research



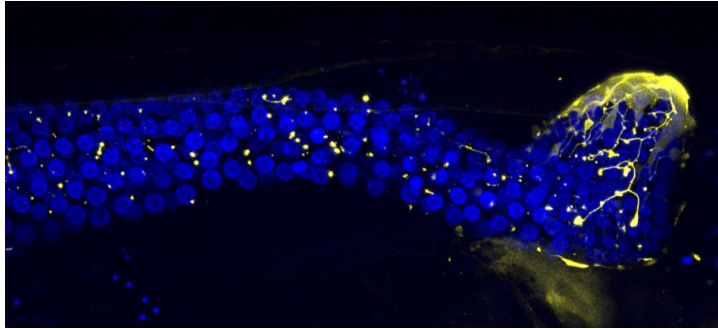
Spider silk and synthetic materials



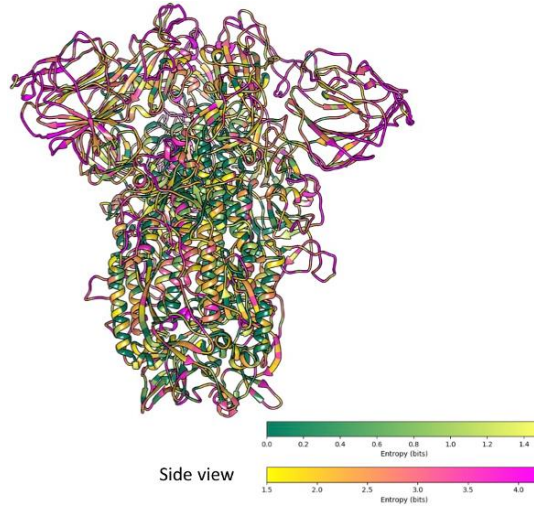
NMR

New investigations of bio materials using NMR and MRI; further innovating these tools to democratize their use

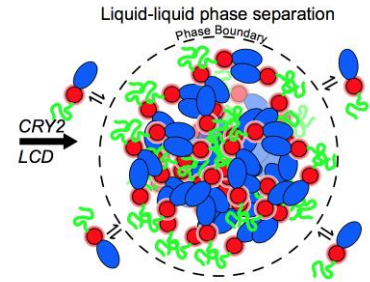
Plotkin Lab



Molecular genetic origins of multi cellular animals

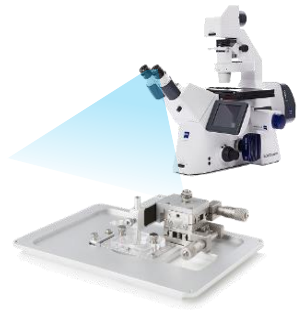


Viruses and therapies

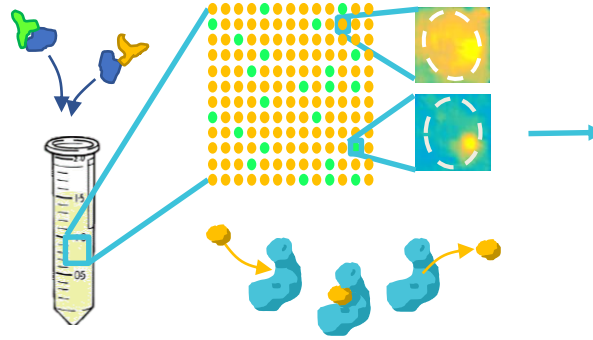


Protein aggregation

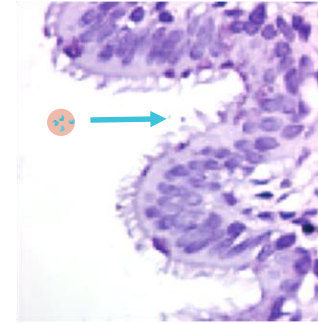
Leslie Lab



Enabling single-molecule visibility



Capturing drug/target interactions
(and other molecules)

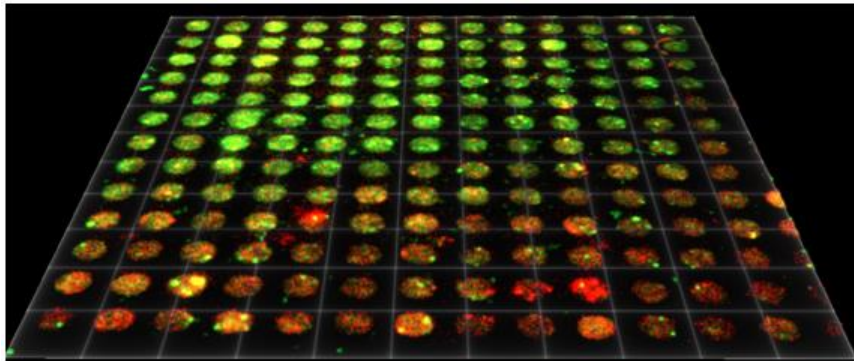


Understanding delivery
dynamics in cells

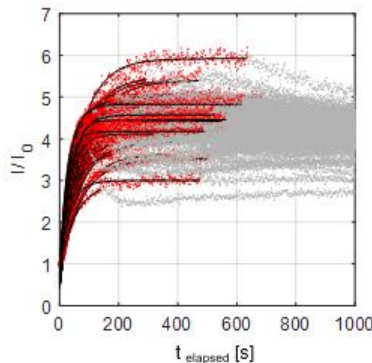
Single-molecule (SM) and single-cell platform for studies of molecular interactions, applications to therapeutics discovery

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?

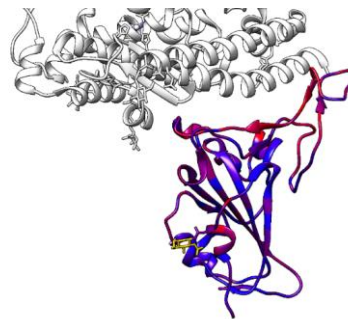


CLiC single-imaging of vaccine nanoparticle dynamics in arrays



Pieter,
2022
Order of
Canada
@ LSI

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



Nobu,
2022
Full Prof
@ MSL

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 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

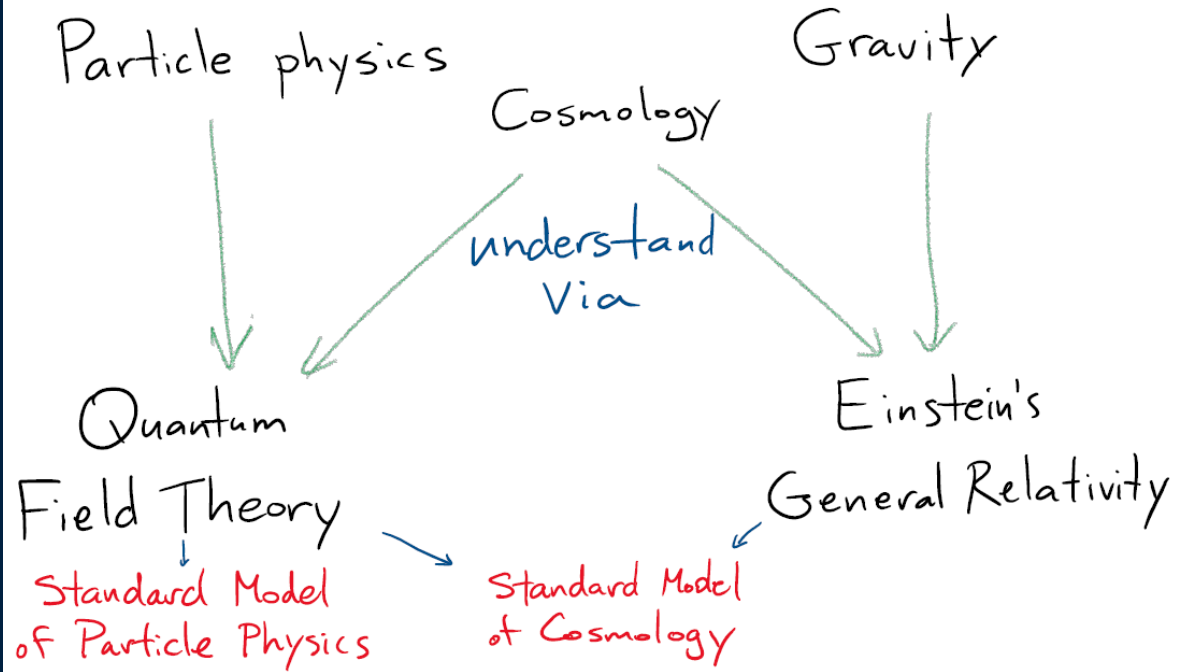
@ UBC Physics and Astronomy

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

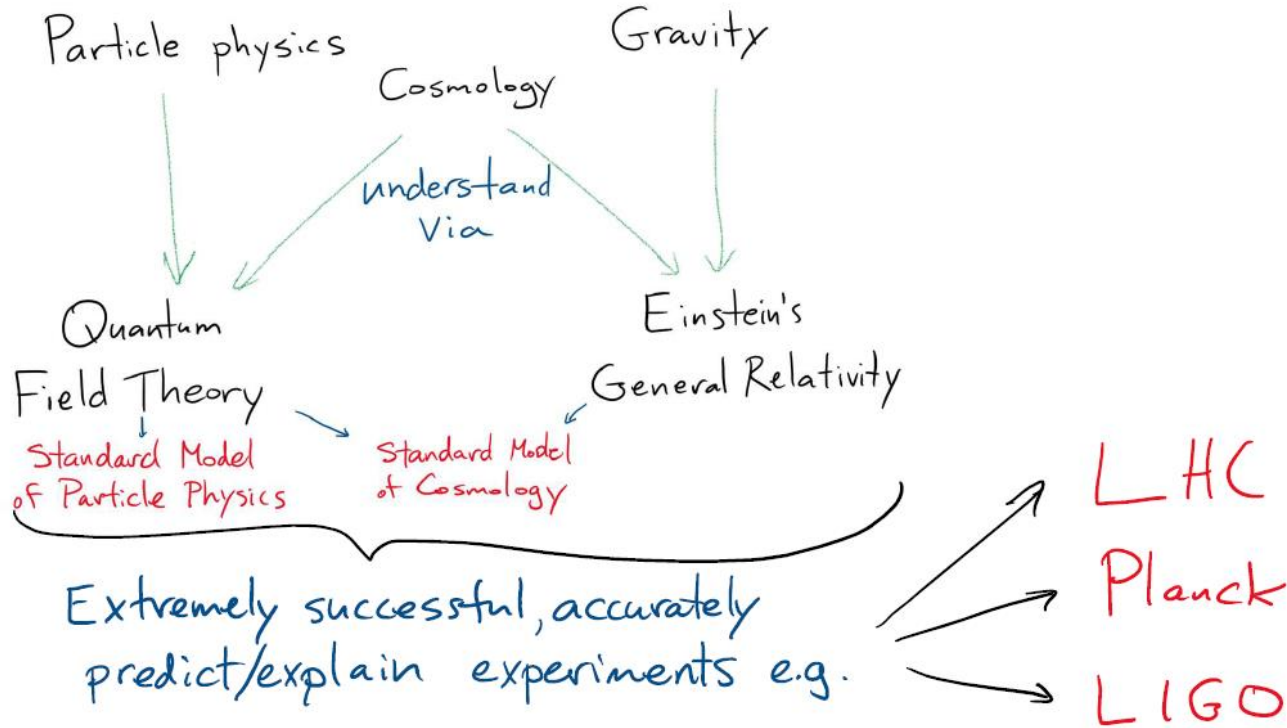
Biophysics groups are actively looking for talented students, email us!

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

Particle Theory & Cosmology



Particle Physics Theory & Cosmology | How to Test?



Particle Theory & Cosmology

Still many 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?



Particle Physics Theory & Cosmology | Faculty

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?

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**

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.



Nick Rodd

My research focusses on the search for **dark matter** in astrophysical datasets, an approach known as indirect detection. I also work on **effective field theory, axions, statistics, and collider physics.**



Particle Physics Theory & Cosmology | Questions

Theoretical aspects of gravity to quantum field theory:

- What is the physics of black holes? – origin, distribution, mergers
- What is the physics of black hole evaporation?
- Can exotic objects (e.g. wormholes) exist?
- What are the possible quantum field theories?



Can we understand quantum gravity?



String Theory

AdS/CFT correspondence

- also alternative approaches

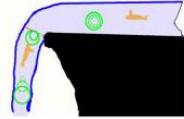
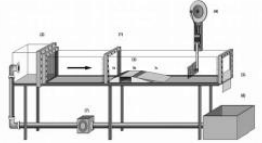
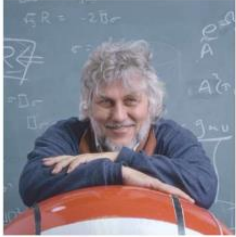
Where do time and space come from?

What is the big bang?

What's inside a black hole?

Particle Physics Theory & Cosmology | Faculty

Bill Unruh



Black Hole analogy: (above) Model black hole quantum emission in fluids (water waves, BEC, optical)



Kristin Schleich

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**.



Matt Choptuik

Numerical relativity at UBC:
see <http://laplace.phas.ubc.ca> for more info



Julio Parra-Martinez

Theoretical aspects of quantum field theory and gravity, scattering

Quantum Cosmology



Foundations of Quantum Mechanics:



**PHILIP
STAMP**

Decoherence
in
quantum
gravity
Alternatives
to
standard
quantum
mechanics &
gravity

Particle Physics Theory & Cosmology | Faculty

Joanna Karczmarek



also:
simple models
for low D
gravity

Moshe Rozali



quantum
chaos
& black holes



Mark Van Raamsdonk

connections
to quantum
information



Can quantum gravity
models teach us
about dark energy,
cosmology?

connections to
condensed matter
physics

Gordon Semenoff

I work on **theoretical elementary particle physics, quantum field theory and string theory:**



Graduation & 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



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>



Year 2-3 Students | **Year 4 Students** | Year 1 Students | Integrated, General & Forensic Science Students

Year 4 Students

For students with Year 4 standing, use the "Audit - UBC Report" in Degree Navigator to review your graduation requirements (both faculty and specialization). Once you have registered in your final year, you might see some courses listed as "unused" near the bottom of your report - these courses are still included in your credit summary for Science Credit, Upper Level Credit, and Upper Level Science Credit; it is important to review those numbers before you drop any courses so that you continue to meet those requirements.

When you meet the requirements, you will need to apply for graduation through the [Student Service Centre](#).

Degree Navigator is not applicable to Integrated Science, Biotechnology, Forensic Science, General Science and Bachelor of Computer Science (BCS) students.

Please Note

Although the Degree Navigator checks for specific faculty and program requirements (i.e. required courses), your report is subject to a final approval by the department. Consult [Science Advising](#) or your department advisor.

Questions about what Degree Navigator says?

-> [Science Advising grad check](#), or [PHAS program advisor](#)

How Do I Use Degree Navigator?

Resources and Help

- [Accessing Degree Navigator](#)
- [Reading Your Report](#)
- [Need Help? Contact Science Advising](#)

Instructions

1. Access your Degree Navigator through your [Student Service Centre](#) and take a look at your Degree Navigator report.
2. You will see X's next to the requirements that you haven't completed.
3. Register for some courses.
4. Go back to your Degree Navigator report and see how those courses that you are now registered in change your report. Aim to have more checkmarks in your report. You may need to refresh the report by hitting apply or refreshing the page.
5. Hopefully you will get as many completed requirements as you want and you can see which credits you're

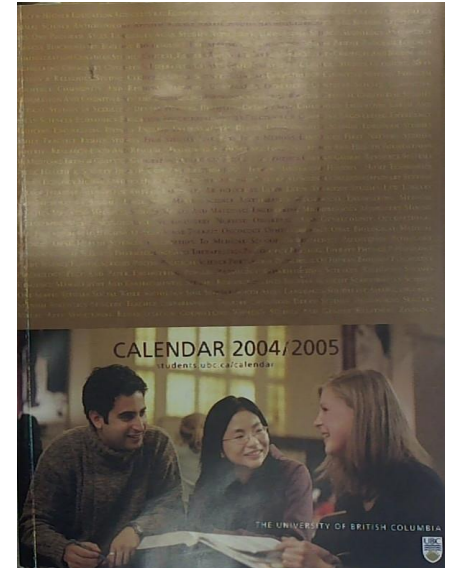
Graduating?

You must follow all of the requirements from one year of the calendar (normally your 2nd year – when you entered the program)

Honours requirements (>68% average, 27+ credits/year (except in final year when you should take only as many credits as needed to graduate))

Arts/Breadth requirements

*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:

<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science>

.Specialization requirements (for PHAS programs):

.Astro:

<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science/astronomy>

.PHYS/BIOPHYS/Other combined programs:

<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science/physics>

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



BSc Graduation Requirements

Summary of Program Requirements Science

	Major, Combined Major, or General Science	Major+Minor in Science	Major+Major (Science)	Honours or Combined Honours	Honours+Minor in Science
Minimum Total Credits	120	120	120	132	132
of which courses 300+	48	48	60	48	60
Minimum Total Science Credits	72	72	72	72	72
of which courses 300+	30	42	54	42	54
Minimum Total Arts Credits	12	12	12	12	12
<u>Maximum Credits that can be double counted</u>	-	6	6	-	6
Maximum credits not in Science or Arts	24	24	24	24	24

All Majors BSc: 120 credits

All Honours BSc: 132 credits



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

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

<https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-science/bachelor-science/science-breadth-requirement>

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>



What happens if you run into issues?

With a 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).

449 Thesis, 349 Mini-Thesis

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/PHYS 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 I

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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** (4-, 8-, or 12- month co-op jobs)
 - <http://www.sciencecoop.ubc.ca/>(everything on this page except Work Learn (part-time) are valid for co-op workterms)
- **NSERC USRA** (Undergrad Student Research Award)
 - https://www.nserc-crsng.gc.ca/students-etudiants/ug-pc/usra-brpc_eng.asp
- **TRIUMF** Summer student program (and 4-, 8- or 12-month co-op jobs)
 - <http://www.triumf.ca/undergraduate-student-program>
- **NRC** (National Research Council Canada)
 - <https://nrc.canada.ca/en/corporate/careers/post-secondary-students>
- **DAAD RISE** (German Research Internships in Science & Engineering)
 - <https://www.daad.de/rise/en/rise-germany/> *UBC is a DAAD partner
- **UBC Go Global - 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>
- **UBC 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> (Canadian IAESTE office: <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>



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.

Actuary

Aerodynamist

Aerospace Testing

Astronomer

Astrophysicist

Biophysicist

Cardiac Imaging Researcher

Chemical Physicist

Computer Specialist

Computer System Engineer

Satellite Data Analyst

Satellite Missions Analyst

Science Teacher

Science Writer

Automotive Engineer

Forensic Scientist

Occupational Safety

Specialist

Quality Control Manager

Technical Illustrator

Geodesist

Geophysicist

Hydrologist

Lawyer

Medical Physicist

Medical Products Designer

Meteorologist

Seismologist

Stratigrapher

Environmental Analyst

Oceanographer

Scientific Photographer

Nuclear Power Plant Mgr

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

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 is the goal of the Graduate Admission process?

Finding applicants who will become good researchers

What are the qualities we look for?

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





THE UNIVERSITY OF BRITISH COLUMBIA

Questions? Need help?

Contact PHAS faculty advisors, or the
undergraduate Coordinator for assistance!

[Contacts & Advising | UBC Physics & Astronomy](#)