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Phase ^{iq} Shift



Volume 3, Issue 3, May 15th 2026

Phase^{iφ} Shift

Volume 3 Issue 3

May 15th, 2026



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We acknowledge and respect the Lək'wəḡən (Songhees and X'wsepəm/Esquimalt) Peoples on whose territory the university stands, and the Lək'wəḡən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

Hello all!

We would like to start by thanking everyone who made this issue possible. A tremendous amount of work goes into creative content like this, from designing logos and the cover, to writing, fact-checking, logistics, and support. A special thanks to Phasers President Ash Samra for her continuous encouragement. And, of course, to our new Design Lead MJ Anderson for all her hard work on the design side of things and for her constant support in helping bring this issue together. We're also grateful to the entire Phasers community and everyone on the fourth floor for your excellent ideas, pitches, and input—we could not have done this without you.

We would also like to thank the professors and experts who lent us their time. Your willingness to share your knowledge not only strengthened the science in these pages, but also shows our readers how vibrant and generous the community can be. And, of course, to the authors and artists who contributed their input and shared their enthusiasm, this issue is yours as much as it is ours.

This issue includes a report on a conference held this past term for women and gender minorities in physics. It's an inspiring look at the growing movement to make physics more inclusive. Alongside this feature article, we are proud to present an exploration of the too-often-overlooked field of Indigenous astronomy. We also shine a spotlight on groundbreaking student research, showcasing a co-op project at TRIUMF where theoretical nuclear physics meets astrophysics.

For those planning their academic journey, we're offering a curated guide to course recommendations and perspectives you won't find in the standard planning sheets. We invite you to challenge your understanding with a deep dive into the classic thought experiment of Maxwell's Demon, explore an engaging explanation of NMR spectroscopy, and experience a gallery of astrophotography to spark your sense of wonder.

Stay curious, stay inspired, and we hope you enjoy the read!

The 2025-2026 Phase Shift Publishing Team

Calendar

UVic Observatory Open House (Bob Wright Centre, free to attend): Wednesdays 8:30-10:30 pm, until August 26th

Dominion Astrophysical Observatory Star Parties (Free to attend, ticket required): Saturdays 7:30-11:00 pm, dates listed below.

May 2nd, 16th, 30th

June 13th, 27th

July 4th, 11th, 18th, 25th

August 1st, 8th, 15th, 22nd, 29th

September 5th

Peak of Delta Aquariid & Alpha Capricornid Meteor Showers: July 30-31

Peak of Perseid Meteor Shower: August 12-13

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Cover Photo

This image shows Large Hadron Collider (LHC) entry site Point 5 in Cessy, France. From this entrance, the Compact Muon Solenoid (CMS) detector was lowered into the experimental cavern 100 metres underground. It was taken in August 2025 during my visit to the CMS experiment as a CERN summer student.

The challenges at Point 5 began long before CMS arrived. Unique difficulties arose from the geological structure of this site. The first challenge came from water tables 10-20 metres below the surface impeding shaft-mining. The ground had to be frozen, and liquid nitrogen, at temperatures below -195 degrees Celsius, proved the only sufficient coolant. As digging commenced, geologists soon realized the cavern ground materials were so soft that without intervention, it would collapse. Engineers designed an inventive supportive structure requiring 7-metre-thick reinforced support structure—more than any other LHC cavern. Rather than using traditional explosives for excavation, they dug out small sections at a time and sprayed with “shotcrete”, a special concrete that sets as soon as it hits the walls. Waterproofing was the final step: installing drainage systems, painting the cavern, and constructing a 4-metre-thick permanent concrete wall.

Ash Samra

While these underground feats were happening directly below Point 5, above ground, further teams of physicists and engineers were completing the construction of the CMS detector. Weighing in at 14,000 tonnes—nearly 1.5 times the mass of the Eiffel Tower—CMS is shaped like a cylindrical onion, with concentric layers of various tracking and calorimetric detectors built around a huge solenoid magnet made of superconducting cable. A to-scale cross-section of the detector is printed on the wall behind the entry shaft at Point 5. Unlike its sister experiments which were assembled in situ, CMS was constructed in 15 sections at ground level, then slowly lowered through the entry shaft and reassembled in the cavern below. The heaviest piece weighed 2,000 tonnes and took 12 hours to be completely lowered!

CMS is most famous for its discovery, in parallel with ATLAS, of the Higgs boson in 2012. None of the incredible physics done at the LHC, however, would be possible without the engineers, physicists, builders, and many other labourers whose ingenuity, creativity, and hard work wrought a marvel of modern human engineering.

-Ph/As- TO/DAY

Ian Maass

The NMRticle

Those who have ever had the pleasure of perusing the third floor of the Elliott building may have happened upon room 346. From the outside, this room seems rather unremarkable. However, even a passing glance inside will reveal the room's pièce de résistance: the chemistry department's 300 MHz NMR spectrometer. What is this hulking, stainless steel contraption? And why would the department add it to their hardware collection despite its hefty price tag?

NMR, which is an initialism for Nuclear Magnetic Resonance, is a spectroscopic technique that exploits the magnetic properties of atomic nuclei to identify molecules present in a sample. NMR functions by subjecting nuclei to a strong magnetic field (7.05 tesla in this 300 MHz spectrometer) and then irradiating the sample with photons in the radio range of the electromagnetic spectrum.

As these photons interact with a nucleus aligned with the magnetic field, they push the angular momentum vector generated by the spin of the nucleus out of alignment, causing it to precess around the magnetic field vector. This precession and eventual realignment releases energy in the radio band, which can be detected and plotted to form a spectrum. The exact frequency of radio waves that cause this precession for a given nucleus depends on the chemical environment of the nucleus, that is, the distribution of electrons around a nucleus. Circulating electrons generate their own small magnetic fields around the nucleus which oppose the applied field from the NMR spectrometer. These shield the nucleus and change the photon frequency that enables it to precess in the applied field. Ideally, this leads to a unique peak being generated for every unique nucleus in a molecule, which allows molecules in a sample to be identified based on known peaks of common chemical environments such as well-studied functional groups.

First observed by physicists in the 1930s, the phenomenon that gives rise to NMR was originally used to support the development of quantum theory. The underlying principle being exploited is the fact that subatomic particles have spin, which is a key aspect of quantum mechanics. The potential application of NMR as a spectroscopic technique in chemistry was quickly realized and the technology was further refined throughout the rest of the 20th century. Today, NMR can be carried out on a number of different types of nuclei, with some commonly-interrogated nuclei being hydrogen-1, carbon-13, phosphorus-31, fluorine-19, silicon-29, tin-119, and nitrogen-15. Additionally, the



The chemistry department's 500 MHz NMR spectrometer, surrounded by a barrier indicating the safe distance from the spectrometer's magnetic field.

development of two- and three-dimensional NMR techniques allows for the connectivity of nuclei to be determined.

The ability to identify molecules in a sample is invaluable to researchers, and is the primary application of NMR for students and faculty here at UVic. There are a plethora of other uses for the technique, possibly the most familiar being in diagnostic medicine. Anyone who has ever had an MRI scan has firsthand experience with NMR. Magnetic Resonance Imaging (MRI) uses the same principles as the chemistry department's NMR spectrometers, subjecting nuclei to strong magnetic fields and then irradiating them with radio waves, but with the caveat that the nuclei are inside of organs rather than test tubes. MRI also examines a wider area, allowing whole tissues to be imaged as opposed to a 30 mg sample. A picture of the imaged organ can be generated with visible differences between the various tissues present. Other uses of NMR in chemistry include monitoring reactions, identifying components of mixtures, and characterizing proteins and

polymers. NMR techniques were also used in the first experimental two-qubit quantum computer in 1998, which used nuclear spin states as qubits. (Qubits are the quantum computing analogue of binary bits.) NMR is still used today in quantum algorithms, particularly in experiments due to its relative simplicity and ease of use.

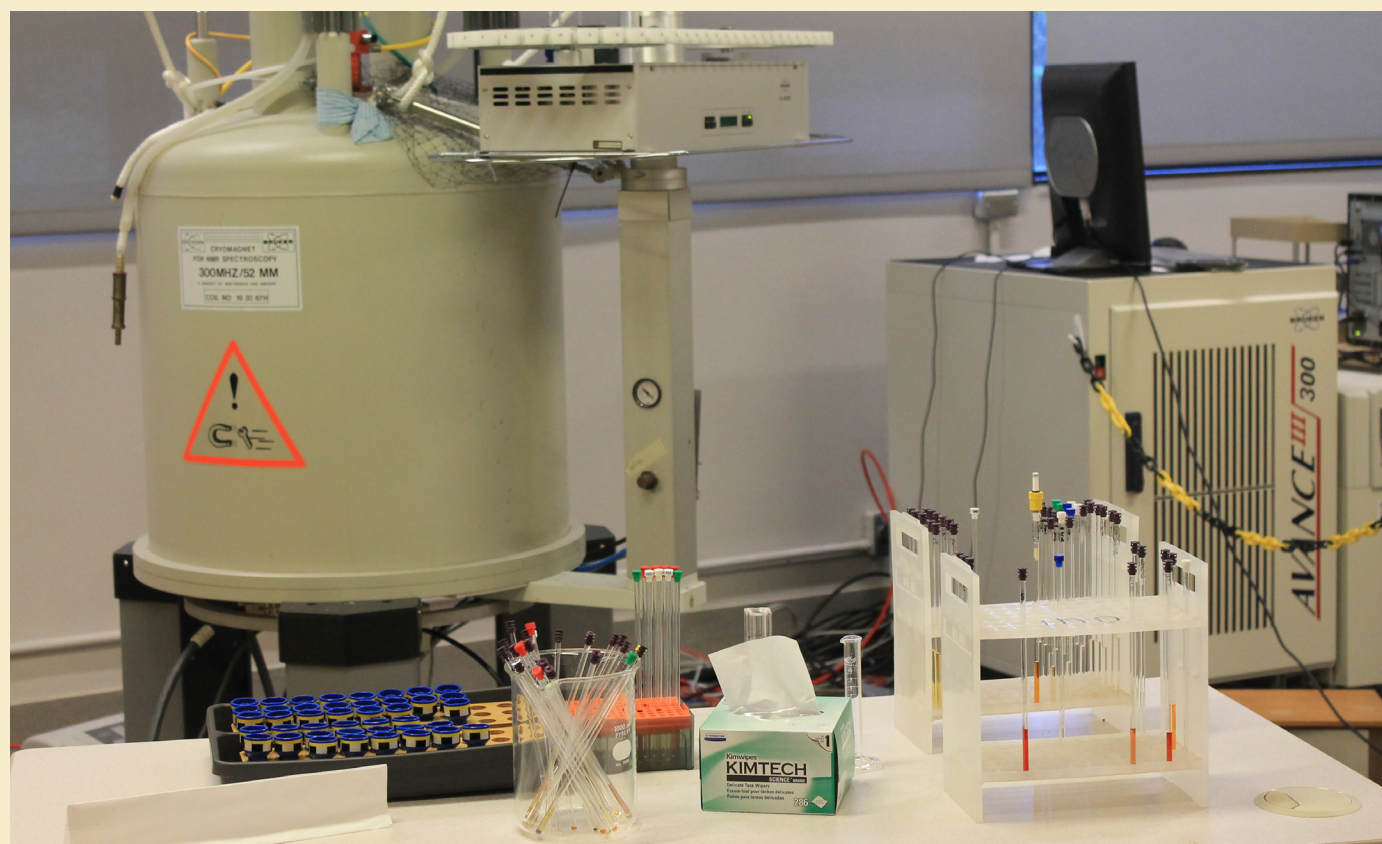
All of these useful applications make NMR spectrometers an essential part of any materials research lab, which is why UVic's chemistry department currently owns four of them. These spectrometers range in resolution from two 300 MHz spectrometers, such as the one in Elliott 346, to 400 and 500 MHz spectrometers housed in the basement of the Petch building. The department's newest addition, the 400 MHz spectrometer, was just recently installed in July 2025 and came with a \$600,000 price tag. This new spectrometer replaced the department's 360 MHz, which was retired due to having out-of-date electronic parts. The higher-resolution NMR spectrometers attempt to correct a rather fundamental shortcoming of NMR as a technique: its inherently weak sensitivity. The

signal detected by an NMR spectrometer comes from nuclei being knocked out of alignment with the applied magnetic field in the spectrometer, however, when samples are subjected to such a field it is possible to align nuclei opposite the applied field. Each aligned-opposed pair of nuclei contributes no net signal, and as such cannot be detected by the spectrometer. Fortunately, the ratio of aligned to opposed nuclei is not one-to-one, resulting in more nuclei generating a signal than cancelling out a signal. Unfortunately, the difference in energy between the two states is small so there are very few nuclei actually able to generate a signal (about one in a million nuclei for hydrogen-1 NMR). When the strength of the applied magnetic field is increased, the result is a greater energy difference between the aligned and opposed states. Because of this, fewer nuclei will cancel out the signal, and a better resolution can be achieved in the produced spectrum. The drawback of higher-resolution spectrometers is that stronger magnetic fields are harder to generate, so they cost more than their less sensitive counterparts.

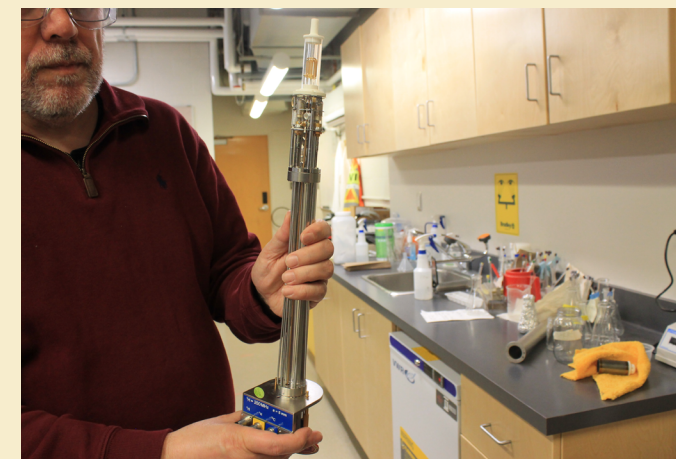
near a frigid 4 kelvin or -269 degrees Celsius. These conditions are so cold that the helium layer is surrounded by a layer of liquid nitrogen, a much cheaper cryogen, to prevent the helium from heating up and reducing the conductivity of the magnet. Even with this extra layer, the liquid helium is topped-off to ensure the spectrometer functions properly. Between the department's four spectrometers, one dewar of helium is consumed on refills every ten weeks, generating around \$3,000 in operating costs. The burden of these operating costs is shouldered jointly by the various research groups that use the spectrometers, with the share paid by each group based on how much time their experiments take to run.

From medicine to chemistry to physics, NMR spectroscopy plays no small part in many cutting-edge fields of science. It is thanks to NMR that countless discoveries have been made and countless papers have been published. And so, next time you stroll past room 346, take a moment to appreciate the 300 MHz NMR spectrometer and all it contributes to research and education here at UVic.

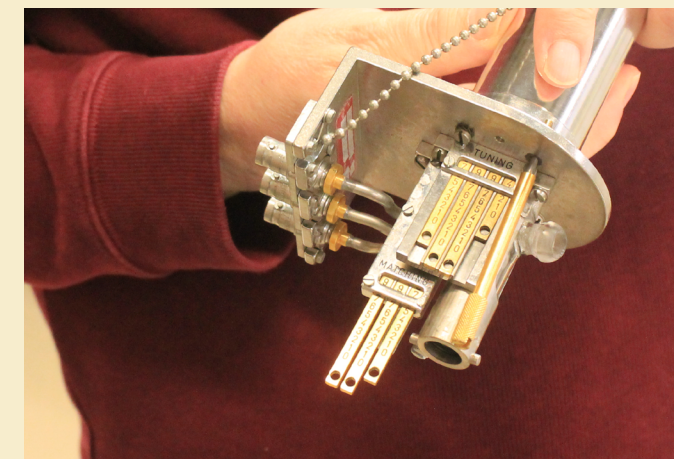
Due to the high costs associated with purchasing NMR spectrometers (\$100,000 used for the 300 MHz in Elliott 346), great care is taken to maintain them for as long as possible. Part of this upkeep is establishing the conditions necessary to sustain the spectrometer's superconducting magnet. In practice, this means surrounding the magnet with a layer of liquid helium, keeping the temperature



The chemistry department's Avance 300 MHz NMR machine and the NMR facility's sample prep station. Samples must be placed in turbines (pictured bottom left) so that they can be spun to ensure a uniform distribution of molecules before spectra are obtained.



A disassembled sample probe containing radio frequency coils used to generate and receive radio waves which are used to produce NMR spectra.



A probe's tuning knobs, used to manually adjust the frequency at which the probe receives signals. This allows users to select which nucleus is being analyzed.

STUDENT SPOTLIGHT

Roan Stafford

TRIUMF in Theory

A highlight of Canadian physics research can be found in Vancouver at TRIUMF, or as it is also known, the Tri-University Meson Facility. TRIUMF was founded in 1968 by the University of British Columbia (UBC), Simon Fraser University (SFU) and the University of Victoria (UVic). It now has 21 member universities as well as many international and private sector partners. The lab hosts over 500 staff and students, as well as many impressive facilities such as its trademark 520 MeV cyclotron, the largest in the world.

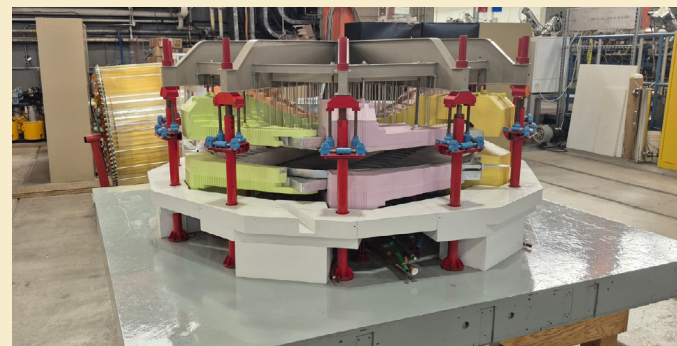
From January through August of 2025, I had the incredible opportunity to be on a co-op at TRIUMF as a Theoretical Nuclear Physics Student Research Assistant. The focus of my co-op was looking at the $^{14}\text{N}(p,\gamma)^{15}\text{O}$ reaction in stars using an ab initio framework called the no-core shell model with Continuum (NCSMC).

The motivation to look at such a reaction lies in understanding the mechanisms by which stars undergo nuclear fusion of hydrogen into helium.

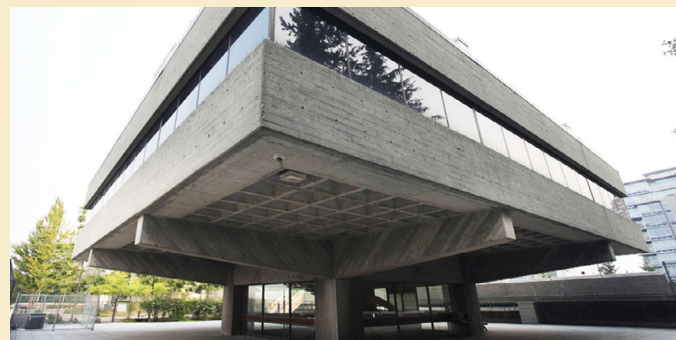
The two primary ways this happens are the proton-proton chain and the carbon-nitrogen-oxygen (CNO) cycle. At 1.3 solar masses, the CNO cycle becomes the dominant mechanism. The slowest (and therefore rate-determining) reaction in this cycle is the nitrogen-14 proton reaction. Understanding this reaction can allow us to ascertain the reaction rate of the CNO cycle, and use this to calculate the lifetimes of massive stars, among other applications.

To perform the computations necessary to analyze this reaction, we used a supercomputer located at SFU called Cedar. Until August 2025 (when it was replaced with the upgraded Fir computing cluster), Cedar was the largest academic supercomputer in Canada and had over 3.6 petaFLOPS of computing power. I had the opportunity to go to SFU in June for a summer school in high-performance computing where we received a tour of Cedar.

The no-core shell model allows us to describe the interactions between nucleons (protons and



A 1:20 colour-correct scale model of the TRIUMF cyclotron, located on top of the real one. TRIUMF is the world's most colourful cyclotron!



The SFU Water Tower Building data centre, where Cedar is located, alongside a Tier 1 data centre for the ATLAS experiment at CERN.



A few witty safety posters at TRIUMF on the cyclotron floor.

neutrons), and therefore the nuclear structure of, in this case, oxygen-15, while still being able to describe the longer-range electromagnetic interaction between nuclei. The process of using this model to perform calculations of the $^{14}\text{N}(p,\gamma)^{15}\text{O}$ system has two main steps.

First, we want to find the wavefunction that best describes the reaction and the resulting structure of oxygen-15. This means we need to find the wavefunction that represents the correct position of seven bound states and nine resonance states, which each play a role in the reaction at low energies common in astrophysical environments. To do this, we run our NCSMC code and look at the output files to determine the position of these states. However, the model, while good, is not perfect, so the results must undergo a process called phenomenological shifting to change the NCSMC eigenvalues (which represent each state in the nucleus) before running the code again to see where the new positions of the states are. This process of changing eigenvalues and running the code is done repeatedly until the eigenvalues correctly give the positions of the bound and resonance states which agree with experimental data. Now, this can be a long and tedious process, so during my co-op I worked to develop a Python script that automates this process, which I can now say finally works!

Once we find the correct NCSMC wavefunction, we can use it as input in the second code. This calculates the cross section of capture and the subsequent gamma decay to each of the different bound states of oxygen-15.



The floor of the ISAC 1 building at TRIUMF. Here, we can see the GRIFFIN experiment, which investigates nuclei with gamma rays, the TITAN experiment, which measures the mass of short-lived isotopes, and off to the right is the β -NMR facility, which detects an NMR spin precession signal through beta decay of a radioactive isotope.

This is the overall process that I have undergone during my co-op. We have done this using two different models for the interaction between nucleons in order to get a more complete picture of what the reaction looks like.

I highly recommend trying to get a co-op at TRIUMF. It is a fantastic environment with amazing people and opportunities to do cutting-edge research on a variety of different topics in physics. I will be forever grateful for the time I got to spend here and I am excited for what TRIUMF will continue to do in the future. Ahead is the addition of the Advanced Rare Isotope Laboratory (ARIEL), which focuses on creating more rare isotopes by adding two new production targets, along with a new superconducting electron linear accelerator, among other developments. The new Institute for Advanced Medical Isotopes (IAMI) is also currently under construction and when online, it will push the frontier of life-saving medical isotopes and radiopharmaceuticals forward.

Next page: An illustrated poster by TRIUMF advertising their five-year strategic plan, which centred around ARIEL. Illustrated by Danielle Adams with inspiration from classic NASA imagery.

ARIEL



Presley Bohlmann

CCUW*iP: Gender Representation in STEM

Hi everyone! I am a second-year student in Physics and Astronomy and I had the absolute pleasure of attending the Canadian Conference for Women and Gender Minorities in Physics (CCUW*iP) this January. This annual conference took place at the University of British Columbia (UBC) in Vancouver this time, but moves between different Canadian universities each year. From Friday to Sunday, we spent nearly every waking moment listening to keynote speakers, touring different facilities, attending panels and workshops, and watching presentations of undergraduate research.

Only a few hours after arriving on Friday, I was getting on a bus to see the largest particle accelerator in all of Canada: TRIUMF. Walking through this lab and hearing about all the various experiments being conducted there sparked an interest in particle physics that I never knew I had. This was further felt later on in the weekend during my tour of UBC's ATLAS, CHIME, and LIGO labs where researchers study physics from fundamental particles to gravity waves. I also learned about several topics in physics from the eight different keynote speakers, with my favourite covering how astronomers use telescopes to study the formation of massive galaxies like our own Milky Way.

By far the most impactful part of the conference for me was hearing about the research being conducted by fellow undergraduates, and gaining insight into the academic journeys that led people from their undergraduate studies to careers as researchers, doctors, and professors. These experiences gave me a significantly deeper understanding of what it means to exist as someone in academia, especially as a woman in

physics, and left me with a strong realization that I too could make a living out of trying to understand the seemingly endless mysteries of our universe.

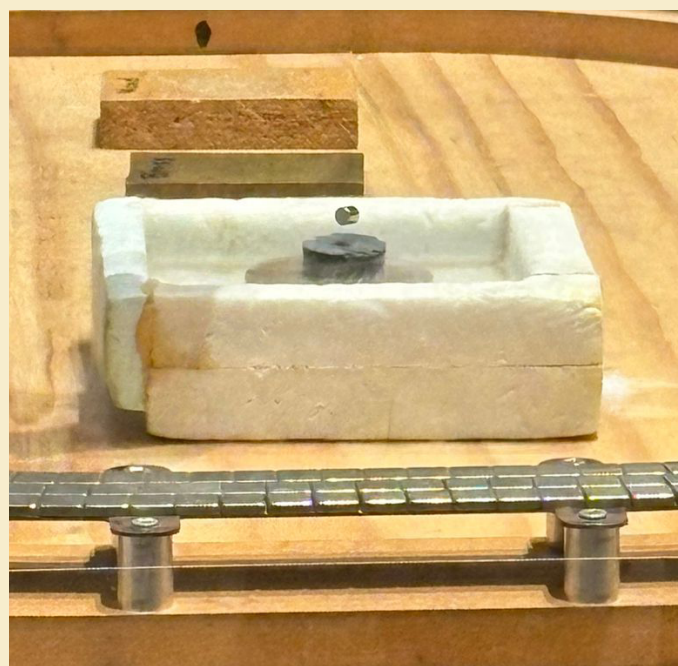
Overall, I would consider attending this year's CCUW*iP to be an experience that I will never forget. From all the incredible areas of physics I got to learn about, to the overwhelming sense of belonging I felt being in a STEM space composed of mostly women, to the hilarious late-night shenanigans had between me and the friends I got to attend with, this conference was well worth the assignment I missed to be there. If you ever have the opportunity to attend this conference or any other, I hope that my experiences convince you to make every effort to do so: I'm convinced it'll teach you more about the world of physics research than any class you'll ever take.



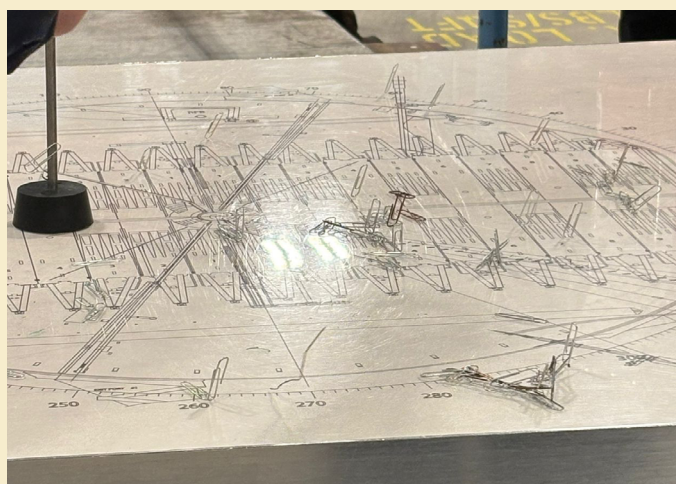
The TRIUMF control room where researchers receive and interpret data being collected by the various experiments being conducted in the lab.



One of the clean rooms within TRIUMF where scientists and engineers can work on new projects in a controlled environment which reduces airborne particulates.



A demonstration at the Quantum Matter Institute where a magnet was super-cooled in liquid nitrogen before levitating around a metal track via the Meissner effect.



Paper clips standing upright due to the heightened magnetic field created on top of the TRIUMF accelerator.

Editor's note:
Information about previous and upcoming CCUW*IP events can be found at <https://ccuwip.ca/>. Applications are typically due in late November.



Authors listed inline

A Compendium of Courses

In some physics or astronomy undergraduate degrees at UVic, electives need to be from a specific department within a certain range of course codes in order to count towards graduation. These can be natural science electives from biology, chemistry, earth and ocean sciences or microbiology; math or statistics breadth electives; units from 300- and 400-level astronomy or physics courses; or any general elective units. For this edition of Academic All-Star Advice, we have compiled recommendations from past and present members of Phasers and members of the Phase Shift community for each type of elective requirement, with choices we feel are hidden gems that might not be immediately obvious when filling an elective spot. Often these choices are the first course that introduces a large subdiscipline of an area of study, which may open up the ability to take other courses to satisfy any of the previously listed requirements.

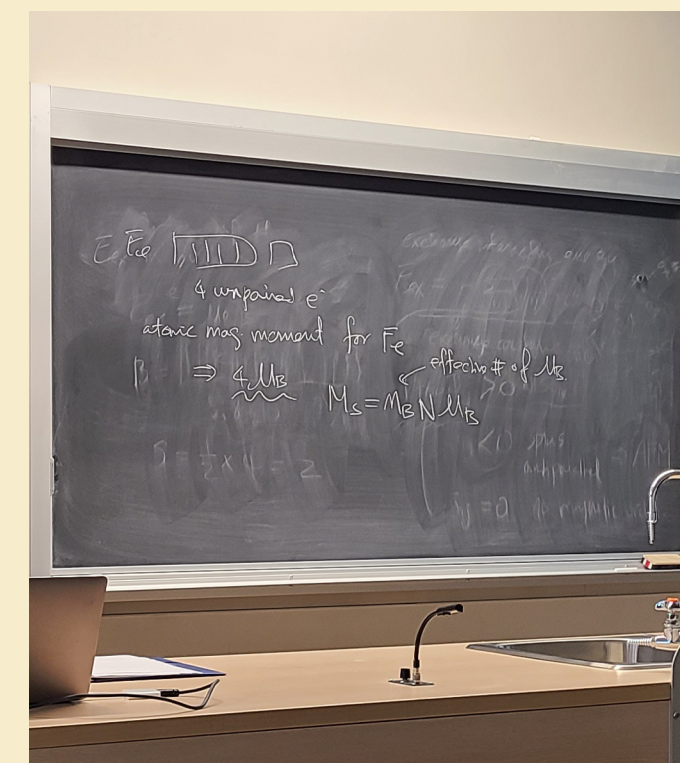
Physics

PHYS 328

Shuyang Wang

Condensed matter is the hottest topic in physics research. One major subfield of condensed matter physics is solid state, which you will have a basic understanding of after taking PHYS 328 - Solid State Physics I. The class covers the structure of solids and their mechanical properties (sound waves, phonons, thermal properties, etc.). It also covers the electric charge inside solids, band gap theory, and magnetic properties. A lot of things that you'll have tasted in 100- and 200-level physics and chemistry courses are studied in detail. This course, instructed by Dr. Choi, is heavy on mathematical modelling and equation derivation.

Though not prerequisites, taking PHYS 321A & B will greatly help you to understand these derivations. A tip for surviving in the course: take pictures of the board notes to free your mind from copying them down to think about the physics instead. Then spend half an hour after each class to organize the notes and check your understanding.



A PHYS 328 lecture board on the topic of solid magnetization.



Image of deep-space gravitational lensing from the James Webb Space Telescope, by the European Space Agency and the Planck Collaboration.

Astronomy

ASTR 405

Lauren Harrison

While completing my Physics and Astronomy degree here at UVic, I've taken a variety of both physics and astronomy courses. In doing so, one astronomy course really stood out to me: ASTR 405 - Introduction to Cosmology.

This course really changes the way that you view the universe. It begins by creating a mathematical model of the universe, and then uses the model to relate to our sole cosmological observable, redshift. Next, the cosmological implications of the cosmic microwave background (CMB) and different events in the timeline of the CMB's creation are discussed. Finally, the course shifts its focus to dark matter and explores the consequences of a cosmological constant.

Before taking ASTR 405, I didn't understand the implications of cosmology and how we can use it to further our understanding of the universe. There were so many events in the universe's timeline which I wasn't aware of, and it really illustrated how vast and beautiful our cosmos is. Learning the dynamic story of our universe from moments after the Big Bang all the way to its current state was captivating. This course truly inspired me to

pursue a path in cosmology and to use the tools I was taught in this class to further my own understanding. I cannot recommend this course enough.

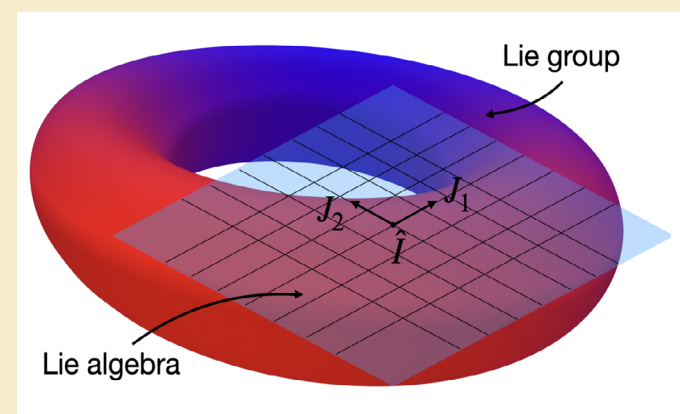
Math

MATH 212, 312

Rayyan Jamadar

The first course in UVic's abstract algebra sequence would be MATH 212 - Introduction to Algebra, which focuses on building the necessary ground work to prove some important results about algebraic structures—groups, rings and fields—in future courses like MATH 312 - Abstract Algebra I. Although MATH 212 alone is not enough to be useful in the applied sense, it does open up a more abstract understanding of matrices (which can be viewed as groups) and that offers a natural path to understanding one of the major intersections of algebra and particle physics, i.e., Lie groups and their associated algebras. These Lie groups (which are just groups with a corresponding manifold structure) are generally used to describe continuous symmetries. A very simple example would be 3D rotations, which form the Lie group $SO(3)$.

Though no courses specifically on Lie groups are offered at UVic, some courses would allow a naive approach to the topic for students not experienced in differential geometry over arbitrary fields or manifold theory. A general undergraduate treatment addresses this topic solely through matrix algebra (MATH 211/110) and minimal multivariable calculus. A standard textbook following this approach would be Lie Groups, Lie Algebras, and Representations by Brian Hall. UVic math professor Dr. Torsten Schoeneberg specialises in this very field in case one wants further guidance, and



A geometric representation of a Lie group and an associated Lie algebra.

recommends Stillwell's Naive Lie Theory for interested students.

Statistics

STAT 350

Muskaan Ali

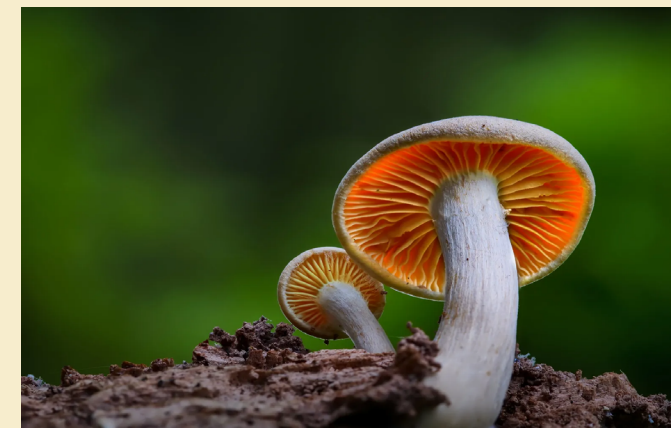
STAT 350 - Mathematical Statistics I is a crucial course for any student of math or statistics. It builds on the material from STAT 260 by exploring the mathematical foundations behind the formulas, giving you a deeper and more intuitive understanding of why these formulas work and how they are used. The course not only revisits familiar ideas in a lot more detail but also introduces new concepts such as moment generating functions, conditional and joint distributions, and useful techniques for deriving distributions and expectations of higher orders. You also begin to see formal proofs of results you may have previously used. While the material can take some time and practice to absorb fully, this course has definitely proved valuable to me as I move into more advanced topics like probability theory and stochastic processes.

Biology

BIOL 359, 184

Claire Sibbald

Have you ever wanted to learn what a sourdough starter really is? Or why John Green is so concerned about tuberculosis? Then look no further than BIOL 359 - Food, Diseases and People. While most 200- to 400-level biology courses have prerequisites, this course offers a prerequisite-free deep dive into the importance of microorganisms in creating some of our favourite foods, and their role in major disease outbreaks. While particular emphasis is on bacteria, you will learn about the many ways in which humans have domesticated bacterial and yeast communities to exploit them for our economic profit. You also get to learn about the safety systems that have been put in place by the provincial and federal governments to prevent and address major disease outbreaks. You will develop skills to critically read and analyze scientific literature—a crucial skill for any budding scientist. These papers will also give you a deeper understanding of the role of bacteria in our everyday lives. This course provides a glimpse into the microbial world, giving students a deeper understanding of the role bacteria play in our daily lives, and guarantees that you will be able to make yogurt and sourdough bread by the end of the course.



A gilled mushroom (type of fungi).

If you have any interest in the natural history of organisms, then BIOL 184 - Evolution and Biodiversity is the course for you! This course is a survey of biological diversity, addressing the evolutionary history of all kinds of organisms from prokaryotes to fungi to animals. Students will spend time learning the ways in which descent with modification can occur, leading to the evolution of new species. The course then shifts focus, and spends time with each major phylum while focusing on specific themes such as "The Emergence of Life on Earth", "Symbiosis and Multicellularity", and "Coevolution and Extinction". This course also offers students the opportunity to develop fundamental lab skills with emphasis on microscopy, and the ability to classify organisms based on their features. It's often taught by a team of instructors from the biology department, each of whom is specialized in the study of different classes of organisms. BIOL 184 is perfect for students with a high school-level grasp of biology who wish to gain a more concrete understanding of how multicellular life emerged on Earth, the mechanisms of evolution, and the transitions in the history of life. For students who are interested in the potential for complicated life elsewhere in the universe, this course builds an understanding of how single-celled organisms emerge on Earth-like planets and evolve into complicated lifeforms.

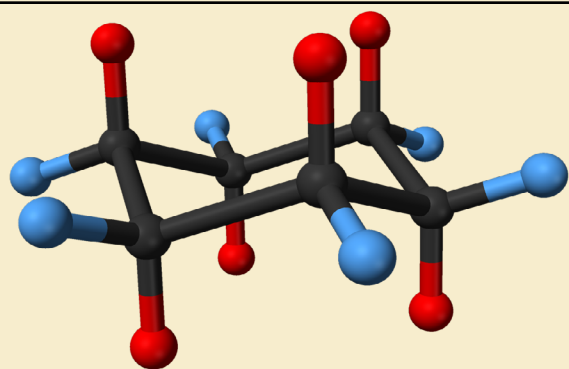
Chemistry

CHEM 231

Josef Breker

CHEM 231 - Introduction to Organic Chemistry is a challenging but well-taught introduction to the field. I always heard that organic chemistry was one of the most grueling classes in a chemistry de-

gree, but that was not my experience in CHEM 231. The class is taught by some amazing professors; I had Dr. Leitch and Dr. Iosub for the course and they really wanted their students to succeed and properly understand the material. I have heard great things about the other instructors for this course as well. The class covers many important general organic chemistry concepts such as acids and bases, drawing reaction mechanisms, nucleophilic substitutions, and an introduction to spectroscopy. The class can be difficult if you fall behind on the material, but a lot of the content is fun to learn. For example, structure elucidation problems using various forms of spectroscopy can be like solving little puzzles. For many students, CHEM 231 is the first class in which you get to focus on a specific branch of chemistry and that makes it more interesting than a general chemistry course. So don't



A visualization of a cyclohexane molecule.

shy away from this class just because you've heard horror stories about the terrors of O-chem: it can be quite fulfilling, even as an elective.

Earth and Ocean Science

EOS 210

Cameron Louie

For those with an interest in physics and earth science, EOS 210 - Introductory Geophysics is the course to take! EOS 210 (crosslisted as PHYS 210) is a geophysics course that covers the basics of inner-earth structure, composition, and seismology. Though the course title may seem a little daunting, the concepts covered are rudimentary. If you've taken first year math and physics, you should have no problem doing well in this course.

This course also makes use of the coding language MATLAB to simulate geophysical models. If you are familiar with other languages like Python, the syntax is similar and learning should be a breeze. The coding assignments are straightforward and

the tutorial makes the content much easier to digest. I thoroughly enjoyed this class and I believe you would too!

Microbiology

MICR 200A, 200B

Sasha Pryce-Baff

There are courses that aim to give you fundamental literacy in what you're studying. I describe these as "THAT's how that works!" courses. The second year STAT courses are a good example, and so are some second year CHEM / PHYS courses. In that vein, I heartily recommend MICR 200A and 200B for those even tangentially interested in microbiology. The 'A' course covers fundamentals: microbial structures, metabolism, growth, and so on. 'B' presents a broad survey of advanced topics (genetics, immunology, infectious disease, etc.) with corresponding upper-level courses. Undoubtedly, you've come across headlines about microbial diversity, disease, and industrial applications from green fuels to agri-foods to biomedical tech like pharmaceuticals and vaccines. These courses give the student both fundamental literacy and a deep appreciation of the underlying science. A second major reason to recommend these are the labs. They are highly organised and approachable, and few things embody the mad scientist fantasy more than analyzing Petri dish growth under a microscope. There are a fair few 'handling' skills such as plating and staining, so prepare to accept mistakes with grace unless you have excellent natural dexterity (I most certainly do not). Fortunately, the lab instructors are superb: they're enthusiastic, friendly, and quick to help with anything.

Computer Science

CSC 361, 130

Simon Lauer

A computer science elective that completely changed how I saw my degree was CSC 361 - Computer Communications and Networks. Before taking it, my focus had mostly been on algorithms and the programming side of computer science. It's easy to take for granted how effortlessly we can access data or communicate with servers and peers. The complex architecture that makes this possible is something many computer scientists know exists but rarely get to explore in depth.

CSC 361 gives students the chance to understand the networking systems, protocols, and algorithms that make modern computing possible.

By studying the TCP/IP stack, I was challenged to rethink how networks actually function and gained hands-on experience building simulated servers and through other networking projects. The course also serves as an excellent foundation for more advanced topics in classes like CSC 446 - Operations Research and Simulation, and CSC 466 - Overlay and Peer-to-Peer Networking, both of which expand on the practical and theoretical ideas introduced in CSC 361.

Another elective I found both enjoyable and valuable was CSC 130 - World Wide Web and Mobile Applications. Much like CSC 361, it highlighted how often we use platforms built on technologies and programming languages such as HTTP, CSS, and JavaScript without ever fully understanding their foundations. This course gave me the chance to explore those fundamentals, not only learning how to build websites and interface components, but also developing a better appreciation for how these technologies work together behind the scenes to support what we do as scientists.

Philosophy

PHIL 203

Eliza Partridge

Do you acknowledge the usefulness of the "shut up and calculate" approach but secretly rebel against accepting a lack of understanding just because your calculations work out? Try philosophy!

The philosophy department offers a wide range of 100- and 200-level courses with no prerequisites, from formal logic to feminism, and from ethics to existentialism. I've taken a few philosophy courses, and particularly enjoyed PHIL 203 - Elementary Formal Logic. This course may appeal to physics and astronomy students who want to explore the formalism of logic and proofs in a different way than they'd experience in MATH 122. It's also a prerequisite (though MATH 122 will do as well) for MATH 375 - Philosophy of Mathematics, and several 300-level philosophy courses. PHIL 203 provides an introduction to the structure of logical arguments. Starting from the basics with the concepts of validity, truth tables, and natural deduction, it builds towards the symbolic representation and logical manipulation of ever more complex statements. I found it satisfying—and pretty fun—to create proofs out of a few lines of symbols without a single English word. It felt like distilling the

1.	$\neg\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	✓
1.	$\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	AS
2.	$\forall y(\neg Fyy \leftrightarrow Fyy)$	AS
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4.	$\neg Frr$	AS
5.	Frr	$\leftrightarrow E$ 3, 4
6.	$\neg Frr$	R 4
7.	Frr	$\neg E$ 4-6
8.	$\neg Frr$	$\leftrightarrow E$ 7, 3
9.	$\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	AS
10.	Frr	R 7
11.	$\neg Frr$	R 8
12.	$\neg\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	AS
13.	$\neg\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	$\exists E$ 1, 2-12
14.	$\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	R 1
15.	$\neg\exists x\forall y(\neg Fyy \leftrightarrow Fxy)$	$\neg I$ 1-14

A proof of the contradiction that leads to Russell's paradox, written in the notation introduced in PHIL 203, using carnap.io software.

shared essence of language and math and using it to build shiny monuments to pure reason. For me, PHIL 203 reinforced some core concepts from MATH 122 and introduced me to, in my opinion, a more elegant notation. For those who do not plan to take MATH 122, PHIL 203 can be a gentle way to learn the quantifiers and argument structures that will come up in later math courses.

So, for students who want to take an elective with a mathy feel, I highly recommend PHIL 203. And if you want to hone your critical thinking skills, broaden the scope of your education, or investigate the framework behind science itself, you may well find another philosophy course at UVic that floats your boat.

English

ENSH 335, 331

Brian Whitman

If there is one course in the English program I can wholeheartedly recommend, it is ENSH 355, the class on poet and author John Milton. I learned more in that class than in any other course I have ever taken at UVic. The professor, Dr. Gary Kuchar, is incredibly knowledgeable about the texts he teaches, as well as many other texts that can lend insight into the admittedly dense course material. In engaging deeply with Milton's texts, particularly Paradise Lost, you will learn about the world, life, and most importantly, yourself. It is a very holistic educational experience, touching on literature, philosophy, and the nature of existence.

Another course I would recommend is ENSH 331 - Epic Imagination. It spans a broad range of texts considered epics such as Homer's Iliad and Odyssey, Dante's Divine Comedy, and Voltaire's Candide. The professor, Dr. Eric Miller, has great insights into both the texts and the concept of art. He himself is clearly an artist who wants to make you into one too. He gives excellent feedback on assignments, and you will improve as a writer by taking his class.

German

GMST 100, 101, 201, 202 Maya Mishra

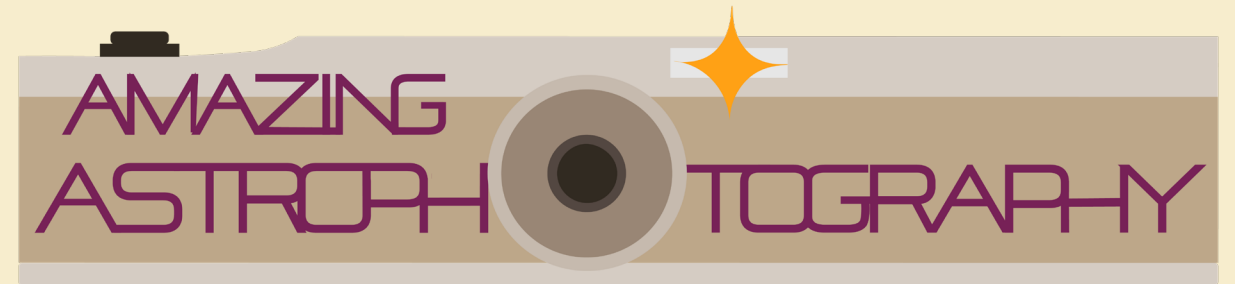
Guten Tag! I would like to suggest Germanic classes (GMST) for anyone who is looking for fun electives to take. Students should start with either GMST 100 - Introduction to Germanic Studies, or GMST 101 - Beginning German I. Both are typically offered in the fall term, and the latter is also offered in the spring. I enjoy the way in which the classes are structured, in that you learn German by conversing with others. This lets you improve your spoken German while getting to know new people. In addition, the classes tend to be on the smaller side, which creates a relaxed environment. I found it easy to get help outside of class, whether by emailing my professors or attending office hours.

For those with some exposure to German who want to go further in the Germanic studies program, I recommend GMST 201 and 202 - Intermediate German I and II, which are offered in the fall and spring respectively. There are 300-level courses that only have 100-level GMST prerequisites, making more advanced topics accessible to anyone who has taken even GMST 100. Overall, I am really enjoying my experience in Germanic studies at UVic, and I encourage everyone to think about trying it out! I am considering a GMST certificate, which requires fewer credits than a minor—it consists of just 7 classes.

Tschüss!



Kölner Dom in Köln, Deutschland (Cologne Cathedral in Cologne, Germany). The University of Cologne was founded in 1388 and was among the earliest universities in the German-speaking world. The institution taught science since it's founding.



Aditi Pathare

All images were taken by me at the UVic Observatory, primarily during Wednesday Open House sessions. As an Open House Facilitator (October 2024 - April 2025), I had the opportunity to explore and photograph the night sky alongside visitors and fellow enthusiasts.

The Pinwheel Cluster



Taken through the 32" DFM telescope at the UVic Observatory.

"A whirl of young stars in the Auriga constellation. The Pinwheel Cluster, roughly 4,340 light-years away, reminds us that open clusters are snapshots of cosmic youth."



The Moon



Captured using both the 8" Celestron and 32" DFM telescopes at the UVic Observatory. Several images highlight crater details and specific lunar regions, while others offer full-disk views. One of the full Moon images was taken during an ASTR 250 Night Lab.

"Exploring the Moon from our own backyard: From sweeping lunar landscapes to cratered close-ups, each photo reveals another layer of familiar mystery."

The Orion Nebula



Captured with the 8" Celestron telescope during open house sessions at the UVic Observatory. A selection of images reveals different tones and structures of this stellar nursery.
"Starlight in the making: The Orion Nebula glows with ionized hydrogen, forming stars in its vast clouds just 1,344 light-years away."

Jupiter and its Galilean Moons



Captured using the 8" Celestron telescope. One image (top) shows the four Galilean moons clearly, while the other (bottom) captures Jupiter's bands in greater detail.
"A planetary portrait: Jupiter with Io, Europa, Ganymede, and Callisto. Zooming in reveals its turbulent atmosphere and iconic cloud bands."

Venus



Taken with the 8" Celestron telescope.

"The bright 'Evening Star': Venus shines in its crescent phase, reflecting sunlight off its thick cloud cover."

The Christmas Tree Cluster



Captured with the 8" Celestron telescope.

"A festive gathering of stars: The Christmas Tree Cluster sits in Monoceros, a reminder that even the deep sky can hold joyful shapes."

Phy Story The History of Physics

Hilda O'Higgins Wilson

The Tides of History

Astronomy is often given the title of the oldest science, and this is true for most cultures. The night sky holds a compelling beauty that sparks curiosity, and the cyclic nature of seasons and the movements of celestial bodies suggest an underlying structure that has always invited ever-inquisitive humanity to come up with explanations. The Indigenous Peoples of Canada had and continue to have a deep knowledge of the cosmos. Some Indigenous groups share very similar stories in regards to the nature of the moon and stars. Numerous cultures around the world, including locally, use the moon to mark the passage of time, to know when it is best to perform certain ceremonies and begin certain agricultural practices. As a white student, I hope to be able to share this knowledge in a respectful and meaningful way. For this article I have chosen to focus on three Peoples, and hope to relate just a small piece of their vast knowledge. I'll begin with the local culture of the WSÁNEĆ People, then move on to stories shared in my hometown on Haida Gwaii, then address Anishinaabe (Ojibwe) history and knowledge.

The WSÁNEĆ People are often known as Salt Water People. The sea is of utmost importance to many coastal Nations, and for the nations that lie under the Coast Salish title, it is deeply connected to local culture, history, and knowledge. In WSÁNEĆ belief systems, all people are considered as much a part of nature as the ocean or the mountains. The WSÁNEĆ People observe a lunar calendar (Figure 1) comprising 13 moons and four seasons. Each moon relates a distinct lesson and principle which follows the turn of the seasons. The moons are used as a way to signal the change of a month, the passage of time, and when

it is best to engage in particular outdoor activities. For example, the moon NINENE, which would occur around January or February on the Gregorian calendar, is the moon of the child. It's a time of rebirth leading into the new year; a sign that there are warmer days ahead. There are 12 other moons following NINENE, namely, WEXES, PEXSISIN, SXÁNEL, PENÁWEN, CÉNTEKI, CÉNHENEN, CÉNTÁWEN, CÉNQOLEW, PEKELÁNEW, WESSELÁNEW, SJELCÁSEN, and SIS,ET. The WSÁNEĆ calendar bears some similarities to the Gregorian calendar, though notable differences include the prioritization of lunar cycles and attention to the environment in the WSÁNEĆ system, which yields 13 moons per calendar cycle in contrast to 12 months.

Back home on Haida Gwaii, I was taught stories by the Elders and grade school teachers. There are many recurring characters in these stories, the main one (and a personal favourite of mine) being Raven. An abbreviated account of a story I was told as a child in Port Clements, and later in Daajing Giids, is that Raven stole the sun, moon, and stars from the sky chief's house, bringing the world light, but his wings were forever singed black from the excursion. You will find variations on this explanation of how the sky came to be on different edges of Haida Gwaii, but this is the telling as I remember it from elementary school. The impact this story had on me as a child has led me to pursue a science—anthropology—that places cultural stories on an even footing with information found in the lab or on a dig site. I hope such stories may incite in future and current astronomers alike a similar passion for cultural understandings of the sky.

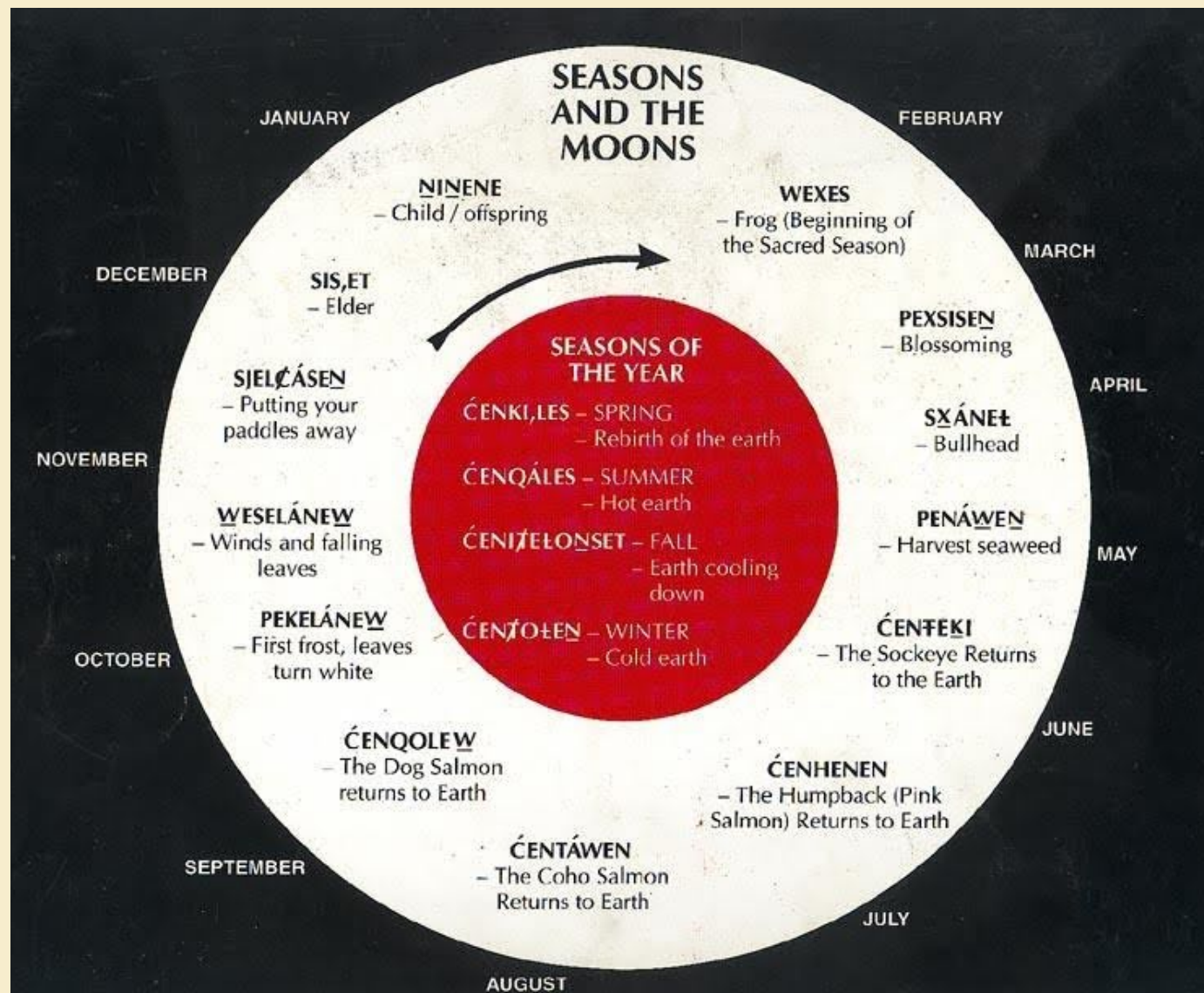


Figure 1: “The Saanich Year”. Author: Earl Claxton, Author/Illustrator: John Elliott. A representation of the WSÁNEĆ lunar calendar.¹

¹ When considering the English translations of Indigenous names for moons, please be aware that translations may vary between language speakers. Different family groups may associate a given moon with different traditional activities or natural events. The events associated with a moon may also shift over time as climate change or societal factors influence the time of year at which they can be observed.

A recent story, written by Alison Gear in collaboration with Haida Elders and community members, is Taan’s Moons. It explains how Taan (meaning “Bear” in Haida) is guided by the moons and how her habits shift with every moon cycle. This children’s book is a wonderful representation of the wisdom held by Elders, as the Haida also divide the calendar into 12 or 13 moons per year, each named for the activities best engaged in at a given time. Haida moons are also associated with the ways in which the season and tides affect local wildlife. For example, *Gaang Gaalangsdlł Kung* (Xaayda

Kil) / *Gaang Gaalang Stl’a Kungas* (Xaad Kil) is the month of berries growing. If you are interested in learning more about the moon’s relation to seasonal activities on Haida Gwaii, I suggest reading the full story of Taan’s Moons, available at UVic’s McPherson Library.

Lastly, the Anishinaabeg (Ojibwe) also have an immense array of stories and knowledge of how their gete-ayaa’ag (ancestors) understood the solar system. By observing the sun, moon, stars, and how animals acted, the Anishinaabeg developed their

own system with which one can tell time, predict weather patterns, and navigate the harsh terrain of what is currently called eastern North America. An important concept underlying Anishinaabe culture (and many Indigenous cultures for that matter) is that everything is interconnected. Their astronomical understandings reflect the fact that the seasons, moons, tides, and animal migration are all related. The planetary ecliptic marks the Spirit Trail, or Cedar Trail, that leads between the earthly and spiritual worlds. The planets are all part of the Spirit Nation, led by the sun.

The Anishinaabeg have a detailed understanding of the deeper night sky. For example, the star called Wiindigoon in Anishinaabemowin is the same star that has the Bayer designation Alpha Orionis and European name Betelegeuse; the star known to the Anishinaabeg as Gichi Biidaabaan Anang (roughly translating to Big Dawn Star) has the European name Altair. Anishinaabeg asterisms differ from those of European astronomy, but most include similar sets of stars, just with different visuals. For example, Ojiig, The Fisher, is what English-speaking astronomers have variously named the Bear, the Plough, and the Big Dipper.

Indigenous astronomy is incredibly lush with knowledge. Indigenous teachings on the stars, calendars, seasons, and the subsequent flow of time have similarities to the now-ubiquitous Gregorian calendar and the Eurocentric astronomy curriculum commonly taught at UVic. Some ideas, however, do not line up with European understandings, and exploring this very tension can expose valuable information that a Eurocentric education may overlook. A key takeaway from this article is the value in approaching scientific inquiry not as “us against space” but more through the lens of “us with space”. We are each part of the natural world around us. We may mean very little in the grand scheme of it all, yet our societies and cultures are vast and rich with knowledge and love. To be here is not only a scientific improbability but also a blessing. We are all merely configurations of atoms and energy born of an as-yet-unknown before.

The aspects of Indigenous astronomy related in this article are just some of the countless examples of valuable knowledge almost lost to colonialism, so I urge all readers to resist the currents of colonialism that continue today. Learn proactively about cultures that differ from your own, to en-

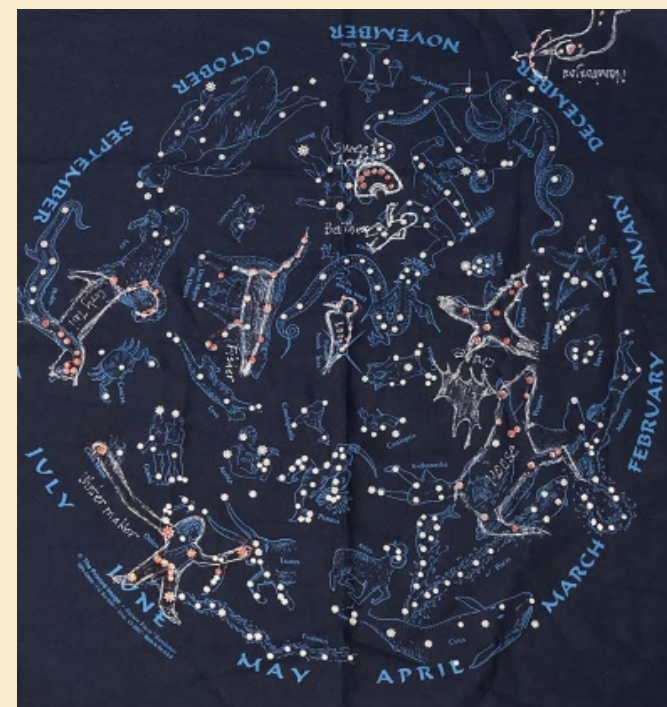


Figure 2: “Ojibwe star map”. Asterisms widely recognized by the Anishinaabeg, superimposed over European constellations.

sure that the beautiful diversity of knowledge held by the myriad peoples in Canada and beyond is preserved for future generations.



Thrilling!

THOUGHT EXPERIMENTS

Allen Keefe

Maxwell's Demon

The set-up for the Maxwell's Demon thought experiment is as follows: a container of gas is portioned off into two parts, A and B, by a dividing wall with a small door in it. Outside of the container is a hypothetical being that can see individual molecules and determine their energies at a glance. This being, the titular "demon", decides they will selectively open and close the door between A and B such that all the high-energy particles are collected in A and all the low-energy particles are collected in B.

Because compartment A is increasingly filled with high-energy particles, the temperature of the gas inside A will increase. Similarly, as compartment B collects more low-energy particles, the temperature of the gas in that compartment decreases. This would be fine, except that these changes in temperature happened without any work being done on the gas.

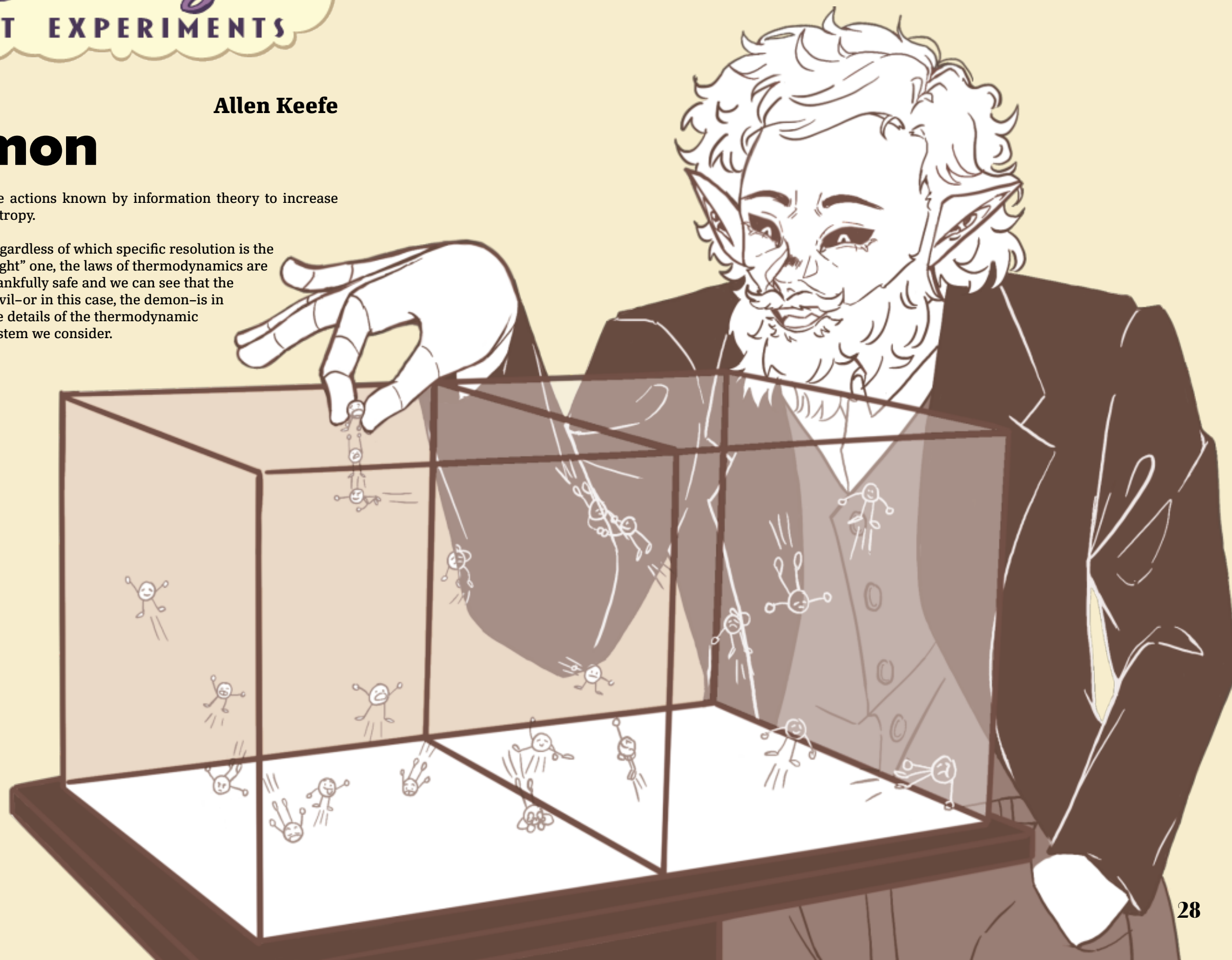
The second law of thermodynamics states that the entropy of an isolated system cannot decrease. More simply, it says that heat will always flow from hotter regions to colder regions unless work is done to prevent it. But we can see in this thought experiment that this is not the case. So what's happening? Is it really possible to break the laws of thermodynamics like this?

The missing piece that solves this puzzle is that we haven't taken the demon into account when discussing the thermodynamic system of the experiment. The demon is influencing the behaviour of the system, so they must be considered a part of it.

The specifics of how exactly the demon's involvement in the system leads to an increase in entropy is highly debated, with suggestions coming from many different theorists working with their own slight variations on the experiment. Many of these proposed resolutions incorporate ideas from the field of information theory and use the fact that the measurement of the particles' speeds and the storage and erasure of that information

are actions known by information theory to increase entropy.

Regardless of which specific resolution is the "right" one, the laws of thermodynamics are thankfully safe and we can see that the devil—or in this case, the demon—is in the details of the thermodynamic system we consider.



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