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- blue is for just presentation delegates
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Name	Title of Poster/Presentation	Abstract
Jonathan Classen-Howes	The Conformal Bootstrap: An Exciting Technique in Theoretical Physics	The conformal bootstrap is a powerful mathematical technique which has provided strong analytic and numerical results for previously intractable problems in theoretical physics. In particular, it has resulted in the most precise determination to date of the 3D Ising model's critical exponents. The 3D Ising model is a simplified, but challenging, theoretical model of a magnet which loses its magnetization at a critical temperature. The project presented here involved developing computational tools for calculating mathematical functions central to applying the conformal bootstrap. These tools were then used to implement code aimed at utilizing the conformal bootstrap to further understand the elusive 3D Ising model.
Sandra Cheng	The first step to quantum dot (QD) quality assurance: blasting it with a laser	Quantum dots (QDs) are aptly named; they are semiconductor crystals that are so small, they are 'zero-dimensional'. They are interesting to study primarily because their emitted wavelengths can be controlled by size, making them relatively tunable. Since their emission is quite bright under low power, they have snuck their way into many applications like display screens and organic dyes used for drug treatment. However, there is still a long way to go before QDs can be used in a large-scale quantum computer. QD growth is inconsistent, which means their colour-size relation cannot be exploited. Photons that are emitted from these QDs cannot interact with each other as required in quantum logic operations that form the basis of a quantum computer. But never fear - quantum computers are still possible! My research is on QD quality assurance and my job was to perform the first 'quality check' of a sample made by QD experts at NRC (Ottawa). An evaluation is done by characterizing a QD's photoluminescent response - in other words, by blasting it with a laser beam and recording its emitted wavelengths. This paves the way for future work involving resonant excitation at those wavelengths with ultrafast pulses.
Erin Crawley	Maximizing Time Delays for Toy Models of Quantum Scattering	We model a particle entering a complicated system from free space using an infinite chain of simple harmonic oscillators coupled to a finite, n-site cluster. For a particle wavepacket with small wavenumber, an expression for the time delay in terms of the coupling strengths of the cluster is found. When the coupling strengths are varied, a minimum and maximum time delay can be found for n=1. When n=2, we can obtain seemingly arbitrarily large time delays. In both cases, the time delays share similarities with the time delays for the scattering from an analogous quantum well target. We conclude that this could mean that large time delays are caused by interference within the wavefunction in the target's region of space.
Fernanda Rodrigues Machado	Stamping suspended 2D heterostructures, towards cavities to enhance light absorption by graphene	Fernanda C. Rodrigues Machado, Israel G. Rebollo and Alexandre R. Champagne Department of Physics, Concordia University, Montreal, Canada.

		We present a simple method to transfer and align 2D materials on substrates as well as above trenches. We demonstrate the ability to create micron-scale suspended 2D heterostructures. Applications range from fabricating low-disorder micro-electro-mechanical systems to creating optical cavities to enhance light absorption in 2D materials. Our optimized stamping method consists of using a droplet of nitrocellulose solution to pick up 2D crystals from various substrates. The advantages of this method compared to previous ones are its ease of implementation, the short time required to prepare and transfer the flakes, and the possibility to pick-up various individual 2D materials (e.g. graphene or hexagonal boron nitride). This permits moving layers one by one, avoiding for instance the need for encapsulation of the graphene crystal, and therefore allows its free suspension above trenches. We discuss our ongoing effort to fabricate graphene/vacuum/aluminum optical cavities able to greatly enhance how much light is absorbed by graphene. We show calculations and fabrication progress towards these efficient energy harvesting devices.
Symphony Huang	Transmission Helium Ion Microscopy: Milling Analysis	The Helium Ion Microscope (HIM) is typically used to quickly scan the surface of a sample exciting secondary electrons. Like scanning electron microscopy, this signal is then used to produce a nanoscale image. In this work, the HIM was instead applied to investigate the process of atom removal also called sputtering. A 25 keV ion beam was left statically focused on a specific position of a 50 nm crystalline silicon sample until the sample was milled through. A square array of Si p-i-n diodes below the sample holder in the HIM was used to detect the transmitted ions. Complete milling was determined by a defined 2D Gaussian fit of the intensities along a line of the detector. The time required to mill through the sample was measured as a function of varying current densities of the beam. The results can be described as inversely proportional to current density. This form agrees with a theoretical sputtering model derived from classical mechanics. This model considers the threshold impact parameter required to remove the silicon atom with a 25 keV beam and the probability as a function of sputtering angle. For a complete description of the full physical processes, carbon oxide formation during beam exposure on silicon must also be considered.
Yasmeen El-Rayyes	Properties of spiral capillary water waves produced by whirligig beetles	Water waves come in numerous forms in nature, with capillary water waves occupying an important niche in biological systems. A noteworthy system is the movement of insects that live on the surface of water and the various shapes of capillary waves left in their wake. A particularly interesting case is the spiral water waves produced by whirligig beetles when they spin - a behaviour that is thought to aid the beetles with a form of 2D echolocation. Experiments and theoretical studies have been conducted on these spiral waves however there remains debate over the properties of these waves. Specifically, regarding the counterintuitive existence of a “counterspiral”: a spiral wave that is opposite to the dominant spiral wave produced by the original spinning perturbation. With our experimental setup, we examined the dominant spiral and its resulting counterspiral under variable parameters, including the radius of rotation,

		rotational speed, and size of the perturbation. The experimental evidence supports the existence of the counterspiral and provides greater understanding of the waves and their dependence on various experimental parameters.
Helena Koniar	Talk:Mobility of the Bicoid Morphogen in Live Fly Embryos under Introduced Perturbations Poster: Cavitation Bubble Dynamics in Water during Burst-Mode Ultrafast-Pulse Laser Ablation	Talk: The Bicoid (Bcd) morphogen is critical for early development in the fruit fly Drosophila melanogaster. Morphogens are proteins that form concentration gradients in embryos and developing tissues to affect cell differentiation in a concentration-dependent manner. The Bcd protein forms a concentration gradient with maximum concentration at the anterior pole of the embryo, decreasing exponentially towards the posterior pole. Bcd exerts its effect as a transcription factor by promoting gene transcription in the nuclei in a concentration dependent manner. Diffusion due to thermal motion is important in many biological systems, especially in the dynamic processes of protein interactions. Previous measurements of Bcd's mobility have shown that Bcd is highly mobile in the cytoplasm which supports that theory that diffusion is the mechanism responsible for gradient establishment. This project aims to measure Bcd's rate of diffusion to investigate how its mobility is related to its function as a morphogen. Introducing perturbations to the embryos will allow us to study the robustness of Bcd as a morphogen. To obtain information on dynamic processes at physiological conditions, we used Fluorescence Correlation Spectroscopy (FCS) to measure the diffusion coefficient of Bcd in both the cytoplasm and the nuclei of live fly embryos to determine if its dynamics is constant throughout the embryo. It was found that cytoplasmic Bcd diffuses very rapidly, while nuclear Bcd exhibits a more complex behaviour of diffusion. This suggests diffusion is responsible for establishing Bcd's gradient and that in the nuclei more complex diffusion or transport phenomena are at play. Poster: Ultrafast-pulse lasers have become essential tools for precise material ablation in both industrial and medical application. Due to these lasers' sub-picosecond pulses and intense irradiance, the optical-breakdown threshold is surpassed which ionizes the material and creates plasma at the focal volume. When pulses are delivered at a high repetition rate (>100 MHz), pulse-to-pulse dynamics become more significant as later pulses interact with persistent plasma ionized by the initial pulses. Burst-mode lasers deliver packets of high-repetition-rate pulses, called bursts, at a kilohertz rate allowing plasma to dissipate before the next burst arrives. Thus, these lasers have great potential for surgical application as they can achieve efficient material removal during a burst and minimize thermal damage between bursts. For use in medical applications, it is essential to understand the dynamic process of ablating in a liquid environment, as a layer of fluid is usually present above target biological tissue surfaces. When a plasma forms in a liquid, there is a rapid heating within the focal volume, followed by an explosive expansion and the formation of a cavitation bubble. Investigating the dynamics of cavitation bubbles quantifies unwanted long range mechanical effects, such as shock waves, associated with laser surgery of biological tissues. In this study, laser pulses were focused into distilled

		water using a burst-mode ultrafast-pulse laser that delivers 300 fs pulses at 1030 nm wavelength with a pulse-repetition rate of 200 MHz and a burst-repetition rate of 1 kHz. Cavitation bubble dynamics were studied by probing the focal volume at various time delays microseconds after a burst is delivered. We observed the formation and persistence of cavitation bubbles for up to 10 us. This work characterizes the size, distribution, and frequency of cavitation bubbles induced by a burst of ultrafast-pulses.
Suemin Lee	Inverse Ecology using Mutual Information	When observing the diverse organism and in their biological system, there exist various way of different reactions and response on different individual organism. As a naive model, people tends to infer the ecology/ environment by generalizing all the other organism as one simple response between the Environment and the organism. Here our claim is that we do not observe one simply response from all different type of organism. There are different ways of reactions and responses from all different type of organisms. In order to understand the relationship between the two different unrelated variable which are the system and the environment, calculation of mutual Information gives a strong correlation between the two data sets. In this project, we have answered the question of how model is different from the single responds system to various responds system and understand how to infer the best adaptive evolutionary environment in a proper way using mutual information.
Eva Lee	Buckling Behavior of Hydrated Collagen Fibrill	Collagen is the most abundant structural protein in animals, providing mechanical stability, elasticity, and strength necessary for connective tissue to be functional. A few studies looking at the structural-mechanical properties of collagen fibrils have witnessed the appearance of localized buckling, similar to the birdcaging of a laid rope under compression, along the fibril's length. However, this behaviour was either observed in stretched tendons by electron microscopy or on single fibrils after vigorous extraction. In our lab, we developed a technique to compress single fibrils in one-step or multiple-steps. Atomic force microscopy (AFM) images of compressed fibrils provided direct evidence of compression- induced birdcagings in the fibril's stress response. Quantitative analysis of AFM data revealed the structural and nanomechanical characteristics of birdcaging development. In particular we show that the location of the first birdcages along a compressed fibril can be predicted by analyzing pre-existing structural variations along the fibril length such as number of molecules per cross-section and cross-linking density.
Renée-Claude Bider	The Origin of Life: Bridging the Gap Between Nucleotides and Protocells	The hydrothermal field hypothesis for the origin of life suggests that cyclical wetting and drying of the edge of volcanic ponds, due to tides, seasons, or day night cycles, coupled with extreme temperature promoted the synthesis of the first RNA1. Compounds found in those ponds such as clay, inorganic salts and amphiphiles are important to align nucleotides into pre-polymers2. While RNA was polymerized using rudimentary hydration-dehydration cycles (HD cycles) 3, these experiments were limited by number of cycles and precise environmental control. At the center of McMaster's new ground-breaking

		Origins of Life Lab is the Planet Simulator, a simulation chamber to mimic planetary conditions. Solutions of phospholipids (DMPC) with adenosine 3'-phosphate (AMP) and uridine 3'-phosphate (UMP), Montmorillonite clay with AMP and UMP, ammonium chloride with AMP and UMP, and pure AMP and UMP, were prepared and dried onto silicon wafers, mimicking the contents of these volcanic ponds and run through HD cycles in the planet simulator. The samples were analyzed through microscopic imaging and X-ray diffraction to determine changes in the structure of the free nucleotides, and with gel electrophoresis to determine length and volume of RNA. I will present first results of a pathway for the formation of first RNA under prebiotic conditions. [1] Damer and Deamer. Life. 5, 1, 872-877 (2015). [2] Himbert et al., Sci. Rep. 6, 31285 (2016). [3] Rajamani et al. Origin of Life and Evolution of Biospheres. 38, 1, 57-74 (2008).
Martin Le	Seeing the "Sound" of Light	Current histological imaging techniques involve a time-consuming process of sectioning, staining, and mounting of a sample to a glass slide. These prepared samples are then viewed under conventional bright-field microscopes to view the tissue structure. There is a need for a real-time feedback mechanism to aid clinicians with diagnostic and therapeutic applications. Ideally, this would be non-contact, label-free, and provide cellular resolution. We have begun to address this need by developing an optical resolution non-contact label-free photoacoustic microscopy system. Taking advantage of intrinsic optical absorption of DNA at UV wavelengths (266nm), we propose a novel technique called ultraviolet photoacoustic remote sensing (UV-PARS) microscopy with the aim of producing H&E-like histological images. A low-coherence short wave infrared (SWIR) interrogation beam is co-focused with an ultraviolet (UV) excitation beam to produce large pressure-induced transients in the local refractive index of optically absorbing targets. These modulate the back-reflected intensity of the SWIR interrogation beam. The system is characterized in phantoms using 7μm diameter carbon fibers with high sensitivity (>40dB signal to noise). Future goals involve histological imaging of various superficial cancers such as basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and ductal carcinoma in-situ (DCIS).
Heather MacIsaac	New Tools to Analyze the Line Profiles of The Diffuse Interstellar Bands to Determine Their Carrier Molecules	The diffuse interstellar bands, otherwise called DIBs, are absorption features found in astronomical spectra. They are detected throughout the interstellar medium and are observed mainly in the visible part of the electromagnetic spectrum, but also extend into near UV and near IR wavelength ranges. For almost all known DIBs, the identity of its carrier molecule is unknown. Discovering the identity of these carriers is important because they represent a significant source of unidentified large molecules in interstellar space. These molecules are largely unaccounted for in current theories of interstellar clouds, as as well as in planet and star formation. This project seeks to create a tool which can be given a set of single-cloud sightline data and the wavelength location of the DIB in angstroms (˚A) and use Voigt profiles to construct a model which approximates the spectra. These models can then be used to determine

		information about potential carriers. Our current work has been conducted on DIBs which have a triple-peak structure and will be extended to include DIBs with a double-peak.
Veronika Dornan	The Effects of Rotation and Metallicity on Convective Overshoot in Models of Delta Scuti Stars	Delta Scuti variables are stars which exhibit periodic changes in their luminosity through radial and non-radial pulsations of the star's surface. The aim of this research is to gain a better understanding of the behaviour of these stars' interiors through an expansion of the findings of Lovekin and Guzik (2017), which found a strong correlation between Delta Scuti stars' pulsation constant (Q) as a function of effective temperature and the amount of convective overshoot within the star. We collected the data in this research through creation of a grid of stellar models using the open-course coding language MESA, and analyzed the models' pulsation properties using the complementary coding language GYRE. By varying the models' mass, rotation speed, convective overshoot, and metallicity it was determined that the relationship found by Lovekin and Guzik has a metallicity dependence, since only models with Z=0.02 were used in the original research. A second relation between Q as a function of effective temperature and convective overshoot was discovered at higher effective temperatures as well. Other properties of the stellar models were plotted against effective temperature to determine the cause of this new relation. Analysis in this research is ongoing, and the properties of this new relation will be discussed further in this presentation.
Caroline El Khoury	A search for giant pulses in PSRB1133+16	Ever since their discovery in 2007, Fast Radio Bursts have remained as random mysterious events occurring in the sky that are still waiting to be understood today. FRB's are typically millisecond long events of intense bursts of radio emission and exhibit similar characteristic dispersion of radio pulsars. Associations of FRB's with supergiant pulses emitted by young pulsars with millisecond spin periods have been made in recent studies but have been ruled out. For a pulsar to produce giant pulses as big as those of FRB's, they would have to be spinning quite rapidly, in the millisecond range. Giant pulses are typically known to be rotationally powered and emitted by millisecond pulsars. They are characterized as pulses with energies ten times greater than the average pulse energy. They also appear to have narrower pulse widths with a pulse intensity distribution described by a power law. I will report on the detection of potential giant pulse candidates found within PSR B1133+16 in a sky frequency range from 400 to 800 MHz using the Algonquin Radio Telescope in Ontario, Canada. This pulsar, in particular, is a slower pulsar with period of 1.18 seconds. A previous work (Karuppusamy et. al. 2010) have found indication of giant pulses from this pulsar in the lower frequency range (110-180 MHz) but results were inconclusive. My project investigates the possibility of finding giant pulses in a slower pulsar such as B1133+16 which could lead to a re-evaluation of giant pulse criterion and a more refined theory of associating FRB's with giant pulses.
Eloise Chakour	Applying Random Matrix Theory to the SYK Model	In the Sachdev-Ye-Kitaev model, the Hamiltonian for the interaction between N particles can be approximated using independent random couplings given by a Gaussian distribution.

		For this reason, it is useful to consider it in the context of random matrix theory. By doing so, we can use some of the results obtained from random matrix theory computations in the study of the spectrum of eigenvalues of the Hamiltonian and the coupling between them. An interesting result is the late time chaotic behaviour at strong coupling and the saturation of the chaos bound, both of which are conjectured properties of quantum mechanical Einstein black holes. The late time behaviour also directly implies the presence of a discrete spectrum. This system approximates an AdS_2/CFT_1 duality between a (1+1) gravitational theory and (0+1) dimensional quantum theory. This allows the possibility to apply this correspondence to other quantum mechanical systems. The goal of this project is to reproduce some results presented in a recent paper and subsequently apply these techniques to similar problems.
Olivia Lim	The intermediate-mass binary star Capella: an example of binary evolution of an evolved magnetic Ap star?	Magnetic fields in stars can affect multiple stellar evolution processes. Despite their important contribution, their presence is often neglected due to their complexity and/or the lack of comprehension of their impacts on the stars. Our understanding of magnetism in stars can be improved by studying binaries. The binary star Capella is a particularly interesting candidate for such an investigation: not only has it been observed and analyzed for decades, but it also hosts a magnetic field. Using polarimetric observations from the spectropolarimeter Narval, we examined the orbital and magnetic properties of Capella through spectral line profiles computed by Least Squares Deconvolution. We confirmed the orbital parameters and detected clear Zeeman signatures for the primary component and weaker signatures for the secondary. By measuring the longitudinal magnetic field of the primary, we derived an estimate of its rotational period, confirming rotation synchronized with orbital motion. We applied the Oblique Rotator Model to estimate the magnetic dipole parameters of the field on the primary. We performed magnetic Doppler imaging to model the time-variable line profiles, deriving a field topology of the primary qualitatively consistent with that derived from parametric modeling. The unusually slow rotation of the primary combined with its relatively strong magnetic field suggest that it could be a magnetic Ap star descendant. To explore this hypothesis, we modeled the tidal evolution of the system, concluding that slow initial rotation of the primary (as expected from an Ap star progenitor) provides a natural explanation of the current properties of the system.
Jessica Speedie	Improved surface gravity and mass constraints for substellar objects from spectral line prole measurements at high resolution in the near-infrared	Standard methods for measuring the mass of isolated brown dwarfs and directly imaged giant planets are indirect, and rely heavily on spectral and evolution models. Consequently, current mass estimates for many of these substellar objects are highly uncertain. With the arrival of new high resolution instruments such as SPIRou comes opportunity for new methods and improved constraints. We present an observational method to constrain the mass of substellar objects precisely, and demonstrate its feasibility on simulated SPIRou observations. We use a cross correlation technique to find the average shape of an object's spectral lines, and determine its surface gravity to high precision through quantitative comparison to reference

		models. The average line profile width has the properties of being dependent on surface gravity and independent on the choice of reference model. Our results suggest that by using the average line profile, surface gravity can be constrained to better than 0.1 dex, and mass can subsequently be estimated to a precision of 10-15%. Performing our method on real high-resolution observations will provide the ultimate test.
Clara Chung	Characterization of Radiation Damaged Silicon Microstrip Detectors	The Large Hadron Collider at CERN will be upgraded at the end of this decade. The motivation is to increase the event rate of rare processes in high energy particle physics. In the ATLAS experiment, the present tracking detector will not be able to cope with the radiation field. The present detectors will be replaced by radiation hard silicon microstrip tracking detectors. In order to understand the performance of these detectors, we have subjected miniature versions to high fluences of gamma and proton radiation. High radiation fluences damage the crystal structure of the silicon detectors. This leads to high leakage current and reduced charge collection efficiency. We describe here our studies of gamma irradiated miniature silicon strip detectors. We discuss the interstrip capacitance and resistance and the bulk charge collection efficiency.
Chelsea-Lea Randall	Designing Scrapers for the Canadian Light Source	Designing scrapers for the Booster-to-Storage Ring in the Canadian Light Source to optimize the phase space of the beam. In doing so, help protect the insertion devices of the synchrotron when moving to too up more. The designed involved finding the ideal location for the scrapers and the ideal thockness for the scrapers to be.
Tarnem Afify	Otoacoustic Emissions Analysis	Otoacoustic emissions (OAEs) are sounds generated in the inner ear by the motion of the cochlea's sensory hair cells. OAE are mainly used in medical auditory testing to determine cochlear status and estimate hearing sensitivity. With the objective of deeply examining the nature of the emissions and observing patterns associated with the hair cells' motion, the research analyzes different aspects of the emissions using signal analysis and computational tools. Through a systematic study of several human and lizard emission waveforms, the signal analysis techniques used in the project investigates and hunts for synchronized motion among hair cells to support or reject current exciting theoretical models and contribute to the mosaic of the biophysics of the inner ear.
Hadiya Ma	Machine Learning - The Future of Physics Education Research	Machine Learning is quickly becoming a tool used by data scientists all over the world in a variety of fields. It is a field of artificial intelligence in which systems can take data and make predictions and decisions based on the data with minimal human intervention. Using test and target data, algorithms should be able to perform tasks without being explicitly programmed. These methods can be implemented in Physics Education Research to improve the quality of physics education at the undergraduate level in several aspects. In this preliminary research, we use machine learning to predict the performance of Queen's first year physics students in exams and compare them with actual scores in order to determine which students could benefit from early intervention. This practice could mean improving their study habits and helping encourage them in continuing in physics. It could also help identify anomalies, for example: students who perform well in assignments and quizzes yet score significantly lower on their midterm than their predicted

		grade. This could help instructors be more empathetic towards students, as external forces can often times affect students' successes in school. These forces – such as mental health issues – are hard to predict and identify. Using these tools, we can work towards maximizing the success of students at the introductory physics level.
Kaitlin McNeil	Modelling of Ice Arches in a Changing Climate	The world's largest polynya, the North Open Water, occurs in Canada's North between Nunavut and Greenland and provides a hunting ground for arctic animals such as polar bears and walruses. However, climate effects have changed the dynamics of this region. In order to better understand the dynamics of the North Open Water and the future effects of our changing climate, a well resolved model of the area must be formed. These models could then be used to help us understand the effects of Global Warming in the region. In this talk, I will present some initial analysis of the impact of winds on the sea ice in the region including the early collapse during May 2017 of an ice arch that forms each year upstream of the polynya.
Yilin Wang	A problem in metal 3D printing gone with the wind - optimization of inert gas flow for selective laser melting	Selective laser melting (SLM) is a metal 3D printing technique that melts and fuses metal powder with a high-power laser beam to build parts layer-by-layer. Compared with traditional, subtractive manufacturing, SLM promises engineers unlimited design freedom, allowing creation of almost any metal part at the push of a button. However, SLM parts still suffer from high porosity and poor reproducibility. During the SLM process, an inert gas flow is introduced to prevent oxidation of the metal powder and remove unwanted by-products of the process (metal vapour, ejected metal particles). Despite its strong impact on the reproducibility and quality of the build, the uniformity of the inert gas flow is often neglected in studies of SLM. This study investigates the uniformity of an existing gas flow design, consisting of a four-outlet manifold (a chamber branching into multiple openings) supplying nitrogen gas across the build area, through both experimental and computational approaches. Empirical measurements of the gas flow were captured using a high-speed camera. Nitrogen gas, into which a smoke source was introduced for imaging purposes, was illuminated at a chosen plane above the build area with a 400mW green laser. A computational model (using ANSYS Fluent 19.0 student version) was used to simulate the gas flow across the build area. It calculated and illustrated the velocity magnitude profile at the same plane of illumination from the experimental approach in the form of contour plots. Both the high-speed images and the computational simulation results qualitatively indicated non-uniformity in the velocity magnitude profile across the build area. To optimize the gas flow across the area of interest, the size and geometry of the gas outlets of the manifold, as well as the inlet flow rate, were varied in the computational model. Preliminary experimental results from the optimized design are presented, suggesting a considerable improvement in gas flow uniformity.
Marisa Dusseault	FTIR: a prescreening tool for chemical analysis of archaeological mollusks	Fourier Transform Infrared (FTIR) Spectroscopy has long been used by physicists and archaeologists alike as a materials characterization technique. FTIR works by probing a sample with infrared radiation, which absorbs specific frequencies of the

		radiation according to the vibrational modes within the sample, and then collecting radiation that is transmitted through the sample. This method works well for distinguishing between polymorphs – substances that have the same chemical composition but different crystal structures. The two most common polymorphs of calcium carbonate ($CaCO_3$) are calcite and aragonite, which are both commonly found at archaeological sites and whose different crystal structures can be detected by shifts in peak locations in the FTIR spectra. Although it is commonly used to identify the polymorph of $CaCO_3$, methods of FTIR analysis that study structural disorder have not been applied to the study of archaeological mollusks. Here we show that comparing relative peak intensities in FTIR spectra can be used to understand the degree of structural disorder within samples of aragonite from archaeological mollusks. These methods incorporate data from multiple spectra and allow us to understand samples on a much deeper level than if only one spectrum is considered. Common analysis methods for archaeological mollusks, such as radiocarbon dating and isotope analysis, rely on pristine sample preservation and the methods used in this research provide a starting point for developing pre-screening methods to ensure reliable data is collected prior to further geochemical analysis.
Daphne Palaco-Tobia	Demonstrating slot-die coating as an efficient technique to fabricate perovskite solar cells	Research on perovskite solar cells (PSC) has made significant progress in a few years and their efficiencies have risen rapidly, making them promising candidates for industrialization. Their light absorber layer is made of perovskite, which has advantageous photoelectric properties, are low-cost to prepare, and are solution-processable. However, most techniques used in research to produce PSCs cannot be scaled for industrial purposes. Slot-die coating is a technique widely used in manufacturing that is regarded as a good option for PSC fabrication, as it is a low-waste and continuous production technique. In this study, a slot-die coating process in ambient environment was developed to fabricate perovskite films using a stage speed of 3mm/s, a flow rate of 0.5µL/s and a gap height of 80µm. We discovered that the film needs to be annealed quickly in order to fully convert into perovskite, and that blow-drying the film after the coating significantly improves its morphology.
Anastasia Smolina	Neurvascular Dynamics of Mild Traumatic Brain Injury	New research suggests that even small impacts to the head (mild traumatic brain injury, mTBI) are associated with long-term degenerative effects, especially if repeated. Since 90% of head trauma hospital visits are for mTBI, understanding the damage it causes is crucial for treatment. We can combine optogenetics with multiphoton laser scanning microscopy to record the in-vivo, local neurovascular signal of single cerebral vessels. To evaluate mTBI damage, we image the hemodynamic response to photostimulation of Thy1-ChR2 mice, before and after three mild cortical impacts (due to the common 3-strike-rule in athletics). Preliminary results are promising, and show a significant difference in response for mTBI and healthy mice. Further research will focus on implementing more robust numerical analysis techniques and begin assessing possible therapies.
Emily Knuckey	Mobile In Situ Air Measurements	The GTA Urban Emissions Project aims to estimate the total

	Throughout the GTA	methane emissions of the Greater Toronto Area (GTA). This is done through taking in situ air measurements to both quantify the emissions of known sources as well as to identify new potential methane sources. The mobile observatory consists of an LGR Ultraportable Greenhouse Gas Analyzer and an Airmar WX 220 Weather Station. The data obtained from this mobile observatory provides new information about the sources of methane and their emission rates. This poster describes and demonstrates the projects method of identifying enhancements through a manual process and then through an automatic process.
Sara Evans	High-speed preparation of ultra-thin uniform polymer fibers for advanced materials development	We present a method for the production of an ultra-thin uniform polyurethane filament produced by melting and pulling the polymer through a small nozzle. This highly-tunable method can be used for a range of polymeric materials to create fibers that are both flexible and stretchable. These thin fibers can be produced at rates high enough to be of use to the fabrication of advanced materials for high-tech applications.
Zoe Wright	Continuation of Overshoot Models of Delta-Scuti Stars	A relationship between the pulsation constant (Q) and the effective temperature of Delta-Scuti stars was first noted by Dr. Catherine Lovekin and Dr. J.A. Guzik. This relationship can be plotted as a linear piecewise function for stars of small masses. In working with Dr. Lovekin to continue this research, we have been looking at larger mass Delta-Scuti stars, through MESA and GYRE softwares, in hopes that this relationship continues in these more massive stars, as they evolve past the main sequence. Specifically, our research is focused on stars of 4-20 solar masses, with varying hydrogen and helium core overshoots, standard metallicity, and no rotation. These parameters are evaluated in the MESA software, whereas the pulsation properties which are the focus of this research are analyzed with GYRE. Ultimately, this research is ongoing, however early data indicates a promising continuation of the previously found relationship.
Samantha Crook	Low Z Elements in Human Nail Samples	A portable X-ray florescence mono-energetic X-ray beam was used to detect lower Z elements, such as Calcium, Sulfur, etc in pre-washed toe nail samples. There were 60 nail clippings given from Nova Scotia residents. The portability of this XOS system could become an easy tool used to detect either deficiencies of minerals in the diet or poisoning from toxic elements. Nail clippings are easily accessible to do this sort of scan. In order to detect the lower Z elements, an Iron beam was used, and the energy spectra was analysed using the PyMCA software. The XOS system also detected an XOS concentration of each element in ppm. This value was compared to a ratio of the counts of the element on the energy spectra over the counts of the iron beam in the same spectra. Calcium, especially, showed a promising correlation between the two, as the line of best fit from the scattered data points was near a value of one, as expected. The use of a portable device to analyse elements in nail samples is promising; this method is quick, doesn't require a lot of equipment/space, and access to a nail sample from an individual is easily available.
Brynne Blaikie	Preparations for the Calcium Radius Experiment (CREX)	Observing neutron densities in heavy nuclei can improve models of nuclear structure with applications in other areas of physics.

		In heavy nuclei such as 208Pb and 48Ca, there are more neutrons than protons. At the Thomas Jefferson National Accelerator Facility (JLab), a preliminary measurement of the neutron skin thickness was performed for 208Pb during the Lead Radius Experiment (PREX). In the future, JLab aims to make more precise measurements in PREX II. They will also start measurements on 48Ca in the Calcium Radius Experiment (CREX). The measurements are performed by scattering electrons from the nucleus using the weak interaction because the weak charge of the neutron is 1 whereas the weak charge of the proton is close to 0. By measuring the asymmetry between the scattering of left- and right- handed electrons, the neutron skin and radii values can be determined. I have been conducting experiments to test various components for CREX. Tests of the DAQ system for a cosmic ray test stand were performed to test the silicon strip detector for the Hall A Compton polarimeter with an alternative amplifier discriminator board. This can later be used in CREX to measure the polarization of the electron beam. Due to some minimal oxidation of the calcium target for CREX, the oxidation rates and penetration depths of oxygen were tested for various calcium samples. Oxygen by weight values were given using Instrumental Gas Analysis (IGA).
Gabrielle Fontaine	Lung Tumour Motion Tracking and Compensation With an Optical Flow Algorithm	A weighted optical flow algorithm can be used to track tumour motion in real-time in order to optimize radiotherapy of lung cancer. Lung tumour motion due to realistic breathing patterns was simulated using a 3D printed tumour moved by an actuator controlled by LabView. Portal images were acquired on a 6MV linear accelerator using an Electronic Portal Imaging Device at 12 frames/sec as the simulated tumour was moved. The multi-leaf collimator was pre-programmed to follow the tumour motion both in phase and out of phase with respect to the tumour. From these images, an optical flow algorithm can be used to calculate the motion between two successive images. Tracking the position of the tumour helps maneuver the radiation beam to follow this movement and optimize the dose to the tumour while minimizing the dose to normal tissues. The velocity of the multi-leaf collimator and the tumour can be separated to determine if the multi-leaf collimator follows the tumour properly. If any discrepancies are found from the optical flow algorithm then in practice we can adjust the multi-leaf collimator accordingly to optimize dose efficiency for treatment.
Seery Chen	Distances to 47 Tucanae and NGC 362 with Gaia Parallaxes	Using parallaxes from Gaia DR2, we estimate the distance to the globular clusters 47 Tuc and NGC 362, taking advantage of the background stars in the Small Magellanic Cloud and quasars to account for various parallax systematics. We found the parallax to be dependent on the Gaia DR2 G-band apparent magnitude for stars with $13 < G < 18$, where brighter stars have a lower parallax zero point than fainter stars. The distance to 47 Tuc was found to be $4.45 \pm 0.01 \pm 0.12$ kpc, and for NGC 362 $8.54 \pm 0.20 \pm 0.44$ kpc with random and systematic errors listed respectively. This is the first time a precise distance measurement directly using parallaxes has been determined for either of these two globular clusters.

Rebecca McFadden	Improving accuracy of ocular radiation treatment plans	Brachytherapy is a cancer therapy technique where radioactive sources are used to internally deliver radiation in proximity to malignant tissue while avoiding healthy tissue, frequent applications include ocular and prostate cancers. These sources deliver a certain radiation dose, define as the amount of energy delivered by the source per unit mass of tissue. Treatment is planned according to the dose expected to be delivered by the sources. The current clinical approach assumes the patient is composed completely of water, and current efforts to move away from this include Monte Carlo (MC) methods to calculate dose, and model patient treatment, geometry, and composition. The two methods can produce results with up to 90% difference. It is of interest to know how these doses are expected to affect the surrounding tumour and healthy tissue; mathematical models and being used to assess the biological response. Biologically effective dose (BED) is used to measure the relative effectiveness of different treatment types, incorporating the dose delivered with radionucleotide used and cell characteristics, among others. The current research seeks to explore differences in calculated BED for eye plaque brachytherapy between the two treatment planning types to move towards more accurate treatment evaluations. BED calculated for one eye plaque treatment was found to have an 11% difference between the models. Future work looks to analyze the results of a full 3D dose in both tumour and healthy tissue for different radionucleotides.
Lindsay Babcock	Free Space Quantum Key Distribution Demonstrator	This poster will document the design and implementation of an educational quantum key distribution demonstration. The demonstration implements the BB84 Quantum Key Distribution protocol in a bright room setting and in free space. The demonstration uses a 525nm LED with pulse widths of 100nm to generate photons which are later polarized to transmit a key of ones and zeros between two parties, Alice and Bob. The protocol was implemented using optomechanics to set and manipulate four polarizations of light used to encode the bits. Following this protocol, one can demonstrate how any eavesdropper trying to interfere in Alice and Bob's communication can be detected. As QKD is generally implemented in dark backgrounds or over fiber, measures had to be taken to allow the demonstration to run in a bright room. These measures will be discussed in detail and include a narrowband filter with peak wavelength at the same as that of the photon source, a custom designed enclosure box made of orange plexiglass and anodized aluminum, and a lens tube acting as a spatial filter.
Niloufar Rostam Shirazi	Ultrasonic Characterization of bubble solutions	Never submitted
Mahasen-Hawraa El-Sayegh	Cosmology and Islam	Through history, science was developed by people who studied religion. One of these historical periods is the Islamic golden age where most of the significant scientific work was conducted by religious people. Islamic textbooks contained scientific facts which were the base for these scientists in conducting experiments and setting theories. In this poster, I will be addressing the versus which discuss the creation of the universe and compare them with recent cosmological theories.
