INSPIRE

University of Saskatchewan | University of Regina | NSERC CRSNG | Canadian Light Source | Centre canadien de rayonnement synchrotron

October 2023

INSPIRE

Interdisciplinary Network *for* the Synchrotron: Promoting, Innovation Research, and Enrichment

FOREWORD BY THE DIRECTOR

PROF. INGRID PICKERING

Welcome to the inaugural issue of **INSPIRE** Newsletter. The **NSERC CREATE to INSPIRE** is a graduate training program connected with the Canadian Light Source (CLS) synchrotron hosted at the University of Saskatchewan (USask), in partnership with the University of Regina. **INSPIRE**'s interdisciplinary network includes Fellows working in all aspects of the synchrotron – from the technologies that enable the synchrotron light, to research in environmental science and agriculture, life and health sciences, natural resources and energy, and advanced materials. This newsletter is a new way for the community to learn about **INSPIRE** initiatives, share news, and to celebrate milestones and achievements. It is a pleasure to thank **INSPIRE** Fellow Dr. Ardalan Hayatifar for this initiative, Lenore West for coordinating content, and all who have contributed to this issue. We hope you enjoy reading about **INSPIRE**'s varied and energetic community, and look forward to seeing you at one of our events.

Welcome to **INSPIRE**!

New Fellows

Samira Khoz

Advisors: Daniel Chen & Ning Zhu

Samira is taking her first steps into the world of a Ph.D. program in the Mechanical Engineering Department with the mentorship of Dr. Daniel Chen and Dr. Ning Zhu. Her research is focused on mechanical characterization of tissue scaffolds by means of synchrotron imaging and the finite element method. When she's not knee-deep in research, you'll find Samira in nature, probably hiking with her ever-present companion, her dog, Della!

Xiao Fan Ding

Advisors: Daniel Chen & Ning Zhu

Xiao Fan is a Ph.D. student in Biomedical Engineering at University *of* Saskatchewan. His research is focused on developing segmentation methods for hydrogel scaffolds scanned at the BMIT beamlines. He has used the beamlines for unique imaging techniques i.e., phase-contrast imaging, helical CT, and dynamic CT. He received his MSc. from Western University, where he worked on numerical simulations of paramagnetic material in magnetic resonance environment. Outside of research, Xiao Fan enjoys curing meats and fermenting meads.

Saloni

Advisors: Alexander Moewes & Teak Boyko

My name is Saloni. I am from India and currently, I am a Ph.D. student in the Department of Physics and Engineering Physics at the University *of* Saskatchewan under the supervision of Prof. Alexander Moewes. My research is focused on the "Study of electronic structure of novel nitrides C_3N_3 and P_3N_3". I did my B.Sc. (Honours) and M.Sc. (Honours) in Physics from Guru Nanak Dev University, India. I have been enrolled in research since my master's and published research papers on luminescent materials.

Levi Lundell

Advisors: Derek Peak & Katherine Stewart

Hello All, I'm Levi Lundell, an incoming MSc student with **INSPIRE**. I am from Saskatchewan, and, except for a few brief excursions from the country, I have been here all my life. I grew up on an acreage near the city of Prince Albert where my family raised horses, chickens, goats, and the obligatory dog and barn cats. This upbringing means that I cherish my time outside, and with trees especially. Spending time with friends

while cooking, playing cards, or sports makes me happy, and sports like basketball and volleyball where I can do a lot of jumping are my favourite. Throughout school I always enjoyed the sciences, and this mixed well with my growing awareness of a wide variety of environmental issues in Canada. These two interests put me on the road to get an Environmental Science degree from the University *of* Saskatchewan. Now I am beginning a MSc. in Soil Science under the joint supervision of Drs. Derek Peak and Katherine Stewart. I plan to use synchrotron science to improve metal mine tailings revegetation and restoration techniques. I am particularly interested in phytoremediation as a method for achieving these goals. I might be unreasonably optimistic, but I still hope to use my training from this program to fix environmental contamination problems all across the globe, or Canada at the very least.

Patrick Hunchuck

Advisors: Mark Boland & Shervin Saadat

I am a PhD student from Saskatoon, and also completed my undergraduate degree in Engineering Physics and my master's degree in Physics at the University of Saskatchwan. I study accelerator physics with a focus on the injection of particles into storage rings and collider rings, including the optimization of magnet settings within the rings to maximize capture efficiency and to provide consistent beam for the experiments.

Johnathan Rekve

Advisors: Ildiko Badea & Lee Wilson

Jonathan, a recent graduate of the University *of* Saskatchewan with a Doctor of Pharmacy (PharmD), discovered his passion for research during his final year's research rotation, where he explored drug development involving nanodiamonds. This experience inspired him to pursue further research under the mentorship of Dr. Badea as he embarks on his M.Sc. His current project focuses on utilizing lipid nanoparticles to guide neuronal reprogramming of astrocytes into induced neurons using transcription factors. By targeting brain-based diseases like Alzheimer's, stroke, and epilepsy, Jonathan aims to contribute to improved treatment strategies.

Jaydeep Kumar

Advisors: Amy Stevens & Adam Leontowich

Jaydeep is a dedicated and promising graduate student at the University *of* Saskatchewan, Canada, in the Department of Chemistry. Known as JD among peers, he joined the Ph.D. program in September 2023, bringing a strong academic and research background with Bachelor's and Master's degrees in Material Science from the Indian Institute of Science Education and Research (IISER)-Kolkata, India. JD's research focus revolves around the fascinating world of DNA origami and spectroscopy, where he aims to pioneer the development of nanodevices. This pursuit has led him to collaborate with the Canadian Light Source (CLS) through the INSPIRE grant, where he explores origami-based materials using

the SAXS beamline under the mentorship of Dr. Adam Leontowich. Beyond academics, JD enjoys playing guitar, badminton, and experimenting in the kitchen. JD is extremely passionate about his educational pursuits and always enthusiastic about the idea of engaging with fellow participants, synchrotron scientists, and researchers from diverse backgrounds. JD is driven by a vision of groundbreaking scientific advancements and sees **INSPIRE** as a pathway to unlocking new knowledge domains on his journey to becoming a future Research Scientist.

Sweksha Singh

Advisors: Stephen Urquhart & Richard Bowles

My name is Sweksha Singh, and I am a Ph.D. student in the chemistry department. I completed my Masters from India and then joined USask to work with Dr. Stephen Urquhart. I have no prior experience with synchrotron-based projects which makes me very excited to be a part of the **INSPIRE** program. With the help of this program, I expect to hone my skills to solve problems through cutting edge facility like the CLS and meet like-minded people. I'll be working on examining how nuclear motion affects the shape and character of the spectra of different molecules. As hobbies, I love reading novels, peaceful music and evening walks through nature.

Sona Kamali Miab

Advisors: Hui Wang & Mohsen Shakouri

Isabella Zittlau

Advisors: Ildiko Badea & Steven Mahtaler

Imogen Margaret McBeth McCairns

Welcome, baby Imogen, and congratulations to Prof. Joyce McBeth, **INSPIRE** co-supervisor, on becoming a new parent.

INSPIRE Alumni

Where are INSPIRE Fellows now

Elyssa Loewen

Elyssa: "There is a 66-million-year-old giant softshell turtle under the white cast!"

I work as a Curatorial Assistant in Palaeontology at the Royal Saskatchewan Museum in addition to finishing up my masters. I am responsible for manage the museum's extensive Saskatchewan palaeontology collection from the largest dinosaurs and marine reptiles to the smallest pieces of amber and tiny extinct mammal teeth. I also lead field teams on fossil digs and prepare new fossils to add to the collection that can then be used for research by palaeontologists around the world. My masters research is focused on the biodiversity, ecology and evolution of insects trapped in amber from the latest Cretaceous (~67 million years ago). Amber, or fossilized tree resin, is an exceptional preservation medium for insects because, as the originally liquid resin solidifies over millions of years to form amber, it retains its shape and chemical composition, preserving insects in three-dimensions with life-like fidelity. My research entails discovering and characterizing insect remains using a variety of approaches from standard light microscopy to synchrotron X-ray micro-CT imaging. Ultimately, I hope to provide key insights into the life of insects at the end of the Cretaceous – an important period in Earth history known for the rise of flowering plants and mass extinction that famously whipped out all the dinosaurs.

Emerita Mendoza Rengifo

My work has been dedicated to achieving a molecular understanding of the intricate interplay between arsenite and mercury compounds with sulfur, and selenium in biological systems as this knowledge is pivotal in elucidating the underlying toxicity of arsenite and mercury compounds. To gain deeper insights into these complex interactions, I used synchrotron X-ray absorption spectroscopy (XAS) in conjunction with advanced computational chemistry techniques. This multidisciplinary approach allowed me to characterize the chemical coordination of arsenic and mercury within systems rich in sulfur and selenium. The outcomes of my research have been highly gratifying, reinforcing my commitment to advancing our comprehension of these critical issues. Turning the page to the next chapter of my academic journey, I am thrilled to have secured a postdoctoral research associate position in the Department of Biology at Brookhaven National Laboratory. Here, I will continue to push the boundaries of my scientific exploration, focusing on redox proteins and employing synchrotron techniques like X-ray absorption spectroscopy, crystallography, and cryo-electron microscopy. These endeavors will not only expand my skills and knowledge but also prepare me for the path of becoming a professor and esteemed researcher in the field. I am eager to contribute to the scientific community and make a lasting impact on our understanding of these crucial biological systems.

Janviere Uwanyirigira

Janviere Uwanyirigira was a master's student at the University *of* Saskatchewan and a member of the NSERC-TERRE-NET. She was an **INSPIRE** Fellow in April 2022 and she worked at CLS BioXAS Main Spectroscopy beamline as a MITACS intern from May to November 2022. Janviere completed her program in July 2023; her research project was focused on examining the role tannins (i.e., tannic acid) play during iron oxyhydroxide and iron sulfide precipitation and potential implications to passive mine waste remediation systems. She recently joined BHP as a graduate technical in Legacy Assets. Her role is to provide support for hydro/geochemical studies conducted at legacy mine sites. Janviere is also a volunteer with Women in Mining and Women in Nuclear Saskatchewan.

Rhiannon Boseley

As a Post-Doctoral Research Associate at Diamond Light Source (UK), I will work within the spectroscopy group, specifically on the I18 beamline, utilizing synchrotron X-ray spectroscopy and imaging techniques to investigate metal hyperaccumulator plants and their resistance to bacteria. This role involves collaboration with the Preston Lab at University of Oxford to cultivate different metal-accumulating plants and pathogens and analyze element distribution and chemical speciation in healthy and infected plants. Additionally, I will be working to enhance cryogenic sample preparation techniques, develop sample environments for non-destructive X-ray measurements, and improve the data collection pipeline for beamline I18 in collaboration with the Diamond data analysis group.

CLS-**INSPIRE**

The Summer Student Program

The Summer student program was organized and run by a dedicated group of **INSPIRE** Fellows. Thank you to Linda Vogt, Mehrnaz Zargham, Yasaman Yousefi Sigari and Xuan Wei for contributing to the program.

Poster Presentations

Winners

- Aaryan Patel - SPORTA: New Software for Spot Detection & Screening of X-Ray Diffraction Images

- Liam Elias - Probing the Electronic Structure of $MgWN_2$ & Mg_3WN_4 Via Soft X-ray Spectroscopy

- Daniel Yu - Automating Sample Transfers for the CLS@APS (Sector 25-ID-C) Spectroscopy Beamline

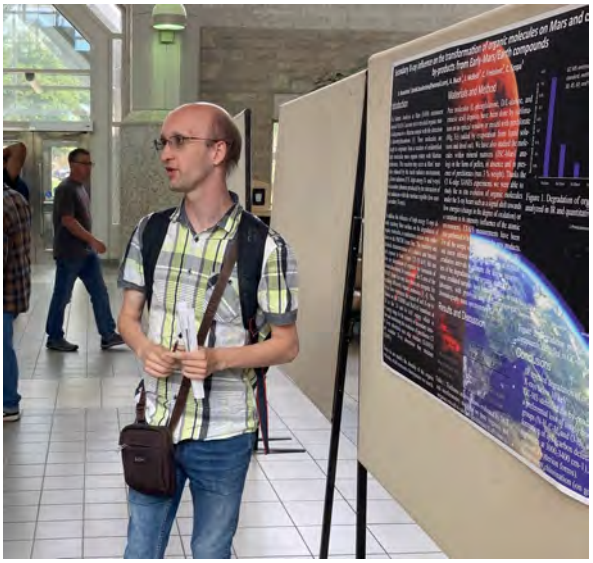
Poster Presentations

Other Participants

- Ali Rizvi - 4D Tracking of Individual Trabecular Bone Remodeling Events Using Synchrotron Micro-CT

- Arika Block - Automated High-Throughput Powder Diffraction at BXDS-WLE

- David Boulesteix - Secondary X-ray influence on the transformation of organic molecules on Mars and determination of by-products from Early-Mars/Earth compounds



- Katelyn Quayle - Pressure Monitor Dashboard

- Liam Newman - Fabrication and Design of a Vacuum-Sealed CaF_2 Microfuildic Device for Multiple Spectroscopic Techniques

- Natasha Vollet - Evaluating Reactive PRB Materials for Treating Aqueous Metals in a Neutral Mine Drainage Context
- Reilly Castle - Ray Tracing of the BXDS-HEW Beamline
- Ryan Olivier - Probing the structure of P_3N_3, a 2D group V-nitride
- Siyuan Yang - Software Development and Refactoring for Synchrotron Control Systems and Related Monitor Software
- Wahhaj Javed - Beam Spot Analyzer

INSPIRE Research

At a glance

Arsenic and Antimony Geochemistry of Historical Roaster Waste From the Giant Mine, Yellowknife, Canada

Lum, Jullieta E., Valerie A. Schoepfer, Heather E. Jamieson, Joyce M. McBeth, Anežka Borčinová Radková, Mary P. Walls, and Matthew BJ Lindsay.

Journal of Hazardous Materials 458 (2023): 132037.

Dr. Valerie Schoepfer and colleagues recently published an article in the *Journal of Hazardous Materials* entitled "Arsenic and antimony geochemistry of historical roaster waste from the Giant Mine, Yellowknife, Canada" (*Journal of Hazardous Materials* 458 (2023): 132037.). Historical mineral processing at the Giant Mine in Yellowknife, NT generated over 237,000 tonnes of highly toxic arsenic trioxide roaster waste, which is currently stored in unlined underground chambers. They investigated the chemical make-up of this waste and the phase associations between As and Sb using a variety of geochemical techniques, including synchrotron-based X-ray diffraction and X-ray Absorption Spectroscopy. The observed bonding between As and Sb is consistent with Sb-substituted arsenolite (As_2O_3) or stibioclaudetite ($AsSbO_3$). The presence of these phases is thought to influence the material's overall solubility and environmental reactivity. Ongoing work will investigate solid-phase solubility and how Sb substitution may play a role in its reactivity. Data will be used to support remediation efforts at the site.

The Giant Mine, in Yellowknife, NT, operated for 50 years and simultaneously produced 220 tonnes of gold and 237,000 tonnes arsenic-bearing waste. The arsenic waste is now sealed in underground storage chambers (mine entrance shown here), but research is ongoing to determine the best options for perpetual storage.

Microfabrication Process Development for a Polymer-Based Lab-on-Chip Concept Applied in Attenuated Total Reflection Fourier Transform Infrared Spectroelectrochemistry

Atkinson, Noah, Tyler A. Morhart, Garth Wells, Grace T. Flaman, Eric Petro, Stuart Read, Scott M. Rosendahl, Ian J. Burgess, and Sven Achenbach.

Sensors 23, no. 14 (2023): 6251.

Micro electro-mechanical systems (MEMS) combining sensing and microfluidics functionalities, as are common in Lab-on-Chip (LoC) devices, are increasingly based on polymers. Benefits of polymers include tunable material properties, the possibility of surface functionalization, compatibility with many micro and nano patterning techniques, and optical transparency. Often, additional materials, such as metals, ceramics, or silicon, are needed for functional or auxiliary purposes, e.g., as electrodes. Hybrid patterning and integration of material composites require an increasing range of fabrication approaches, which must often be newly developed or at least adapted and optimized. Here, a microfabrication process concept is developed that allows one to implement attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) and electrochemistry on an LoC device. It is designed to spatially resolve chemical sensitivity and selectivity, which are instrumental for the detection of chemical distributions, e.g., during on-flow chemical and biological reaction chemistry. The processing sequence involves (i) direct-write and soft-contact UV lithography in SUEX dry resist and replication in polydimethylsiloxane (PDMS) elastomers as the fluidic structure; (ii) surface functionalization of PDMS with oxygen plasma, 3-aminopropyl-triethoxysilane (APTES), and a UV-curable glue (NOA 73) for bonding the fluidic structure to the substrate; (iii) double-sided patterning of silicon nitride-coated silicon wafers serving as the ATR-FTIR-active internal reflection element (IRE) on one side and the electrode-covered substrate for microfluidics on the back side with lift-off and sputter-based patterning of gold electrodes; and (iv) a custom-designed active vacuum positioning and alignment setup. Fluidic channels of 100 μm height and 600 μm width in 5 mm thick PDMS were fabricated on 2" and 4" demonstrators. Electrochemistry on-chip functionality was demonstrated by cyclic voltammetry (CV) of redox reactions involving iron cyanides in different oxidation states. Further, ATR-FTIR measurements of laminar co-flows of H_2O and D_2O demonstrated the chemical mapping capabilities of the modular fabrication concept of the LoC devices.

Chemical Imaging of Mass Transport Near the No-Slip Interface of a Microfluidic Device using ATR-FTIR

Flaman, G.T., Boyle, N.D., Vermelle, C., Morhart, T.A., Ramaswami, B., Read, S., Rosendahl, S.M., Wells, G., Newman, L.P., Atkinson, N. and Achenbach, S

Analytical Chemistry 95, no. 11 (2023): 4940-4949.

Mass transport in geometrically confined environments is fundamental to microfluidic applications. Measuring the distribution of chemical species on flow requires the use of spatially resolved analytical tools compatible with microfluidic materials and designs. Here, the implementation of an attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) imaging (macro-ATR) approach for chemical mapping of species in microfluidic devices is described. The imaging method is configurable between large field of view, single frame imaging and the use of image stitching to build composite chemical maps. Macro-ATR is used to quantify transverse diffusion in laminar streams of co-flowing fluids in dedicated microfluidic test devices. It is demonstrated that the ATR evanescent wave, which primarily probes the fluid within ~500 nm of the channel surface, provides accurate quantification of the spatial distribution of species in the entire microfluidic device cross section. This is the case when flow and channel conditions promote vertical concentration contours in the channel as verified by three-dimensional numeric simulations of mass-transport. Furthermore, the validity of treating the mass transport problem in a simplified and faster approach using reduced dimensionality numeric simulations is described. Simplified one-dimensional simulations, for the specific parameters used herein, overestimate diffusion coefficients by a factor of approximately two, whereas full three-dimensional simulations accurately agree with experimental results.

Leo attended the Joint Annual Meeting of the Geological Association of Canada (GAC), Mineralogical Association of Canada (MAC), and Society of Geology Applied to Mineral Deposits (SGA), held in Sudbury, Ontario. He gave an oral presentation entitled "Distribution of Radiation-Induced Defects in Quartz at the ACKIO Uranium Project, Athabasca Basin, Saskatchewan: Tracing Uranium-bearing Fluids" by Cheung, K.L., Sykes, J., MacKay, C. and Pan, Y. Leo successfully defended his MSc. thesis entitled "Distribution of Radiation-Induced Defects in Quartz at the ACKIO Uranium Project, Athabasca Basin, Saskatchewan: Tracing Uranium-bearing Fluids" on July 18, 2023. Leo's MSc. thesis is now available online. Leo co-authored the following two refereed journal papers based on synchrotron data collected at the Canadian Light Source.

Iron (II)-activated phase transformation of Cd-bearing ferrihydrite: Implications for cadmium mobility and fate under anaerobic conditions

Zhao, X., Yuan, Z., Wang, S., Pan, Y., Chen, N., Tunc, A., Cheung, K., Alparov, A., Chen, W., Deevsalar, R. and Lin, J.

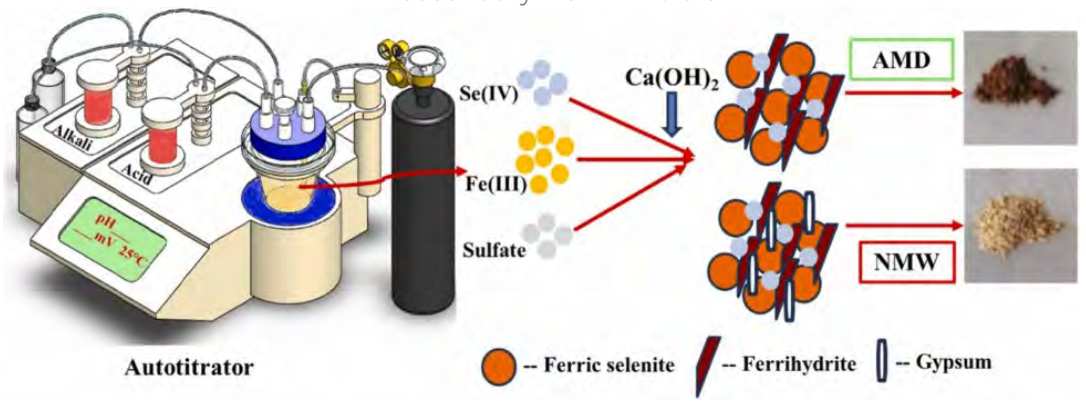
Science of The Total Environment 848 (2022): 157719.

Direct immobilization of Se (IV) from acidic Se (IV)-rich wastewater via ferric selenite Co-precipitation

Zidan Yuan and Rui Su and Xu Ma and Le Yu and Yuanming Pan and Ning Chen and Roman Chernikov and Leo Ka Long Cheung and Reza Deevsalar and Ayetullah Tunc and Liang Wang and Xiangfeng Zeng and Jinru Lin and Yongfeng Jia

Journal of Hazardous Materials 460 (2023): 132346.

Cd retards the recrystallization of Fe(II)-activated ferrihydrite, alters the transformation pathways and products of ferrihydrite and that Cd is partially stabilized via incorporation in secondary iron minerals

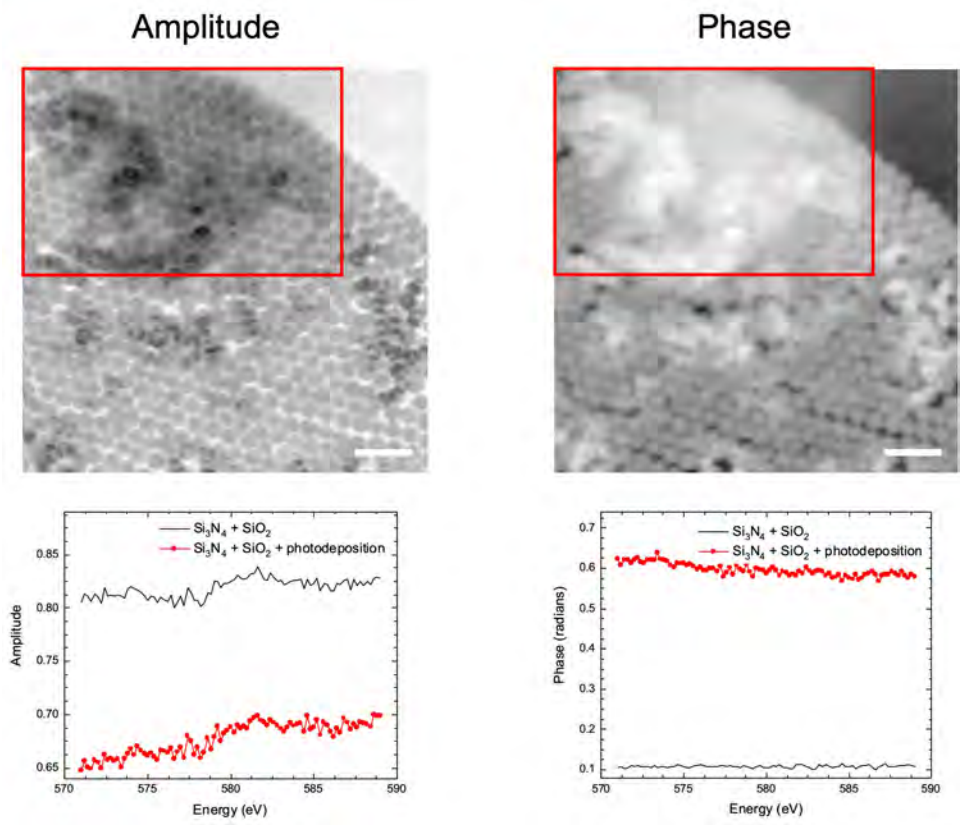


Precipitation of ferric selenites can achieve 98–99.8% of Se(IV) immobilization from acidic Se(IV)-rich wastewater under optimal conditions.

Making chemical sense of phase in soft X-ray spectroptychography.

Stitsky, Joseph, Jian Wang, and Stephen Urquhart.

Journal of Electron Spectroscopy and Related Phenomena 267 (2023): 147367.



Stitsky *et. al.*: Top: X-ray ptychography amplitude and phase images of a single-layer packed array of 220 nm SiO_2 nanospheres on a Si_3N_4 membrane. Bottom: Amplitude and phase spectra from the SiO_2 nanosphere array on the Si_3N_4 membrane, recorded from areas with photodeposition (Si_3N_4 + SiO_2 + photodeposition) and without (Si_3N_4 + SiO_2).

Joseph Stitsky also attended the joint conference in Banff for the international union of microbeam analysis societies (IUMAS), the microscopy society of Canada and the FIB SEM Meetings from June 11-15, 2023.

Yuzhou Feng

Hydrothermal alteration of magmatic titanite: Implications for REE remobilization and the formation of ion-adsorption HREE deposits, South China

Feng, Y., Pan, Y., Xiao, B., Chu, G. and Chen, H.

American Mineralogist (2023), *In Press*

INSPIRE EXTERNAL AWARDS & HONOURS

Ashley James (Ashlyn George)

2023 Melvin P. Klein Scientific Development Award

Stanford Synchrotron Radiation Lightsource (SSRL)

By
Jennifer Huber

Ashley James is fascinated by her toxicology research because it combines biology, chemistry, physics and morbid topics like poisonings that affect the environment and world health. She also loves the unexpected twists. "We've been surprised so many times by what we've found. It's been a fun, wild ride," she said.

As a PhD student and now postdoctoral research fellow from the University of Saskatchewan, James' research on mercury poisoning in animals and humans uses X-rays produced by the Stanford Synchrotron Radiation Lightsource (SSRL) at the Department of Energy's SLAC National Accelerator Laboratory.

For her work, James will receive the 2023 Melvin P. Klein Scientific Development Award during the 2023 SSRL/LCLS Annual Users' Meeting held at SLAC September 24-29.

"The SSRL-based research of Dr. James addresses a global health question with breakthrough discoveries while demonstrating state-of-the-art methodology for her discipline, thus bearing all the hallmarks of 'outstanding research accomplishments by a new investigator' that the award is intended to recognize," wrote her PhD supervisors Graham George and Ingrid Pickering, Canada Research Chairs and professors at the University *of* Saskatchewan, in a nomination letter for the award.

James said she felt surprised, excited and honored by SSRL when she found out about winning the award. "It's awesome to be included in the list of Klein awardees, alongside the diverse projects and incredible scientists who've won in the past," she said. goog

Re-thinking the Minamata mass poisoning

As a PhD student, James studied the mass poisoning of thousands of people who ingested mercury by eating tainted fish and shellfish from the Minamata Bay in Japan during the late 1950s and 1960s. This famous, deadly tragedy was caused by a chemical plant dumping mercury-contaminated industrial waste into the bay – as demonstrated by a physician working for the factory who fed cats food laced with the industrial waste to

confirm that it was responsible for the neurological disease.

Because the chemical plant used inorganic mercury in its processes, scientists initially believed that the contaminated waste contained inorganic mercury. The idea was that this inorganic mercury was transformed in the environment into a common and more toxic form of organic mercury called methylmercury.

James and her collaborators investigated the Minamata poisoning by studying preserved samples from a cat in the historic study. First, they showed that the mercury in the cat's brain tissue was mostly organic by performing studies at SSRL's X-ray spectroscopy (XAS) beamline 7-3 and high-energy-resolution fluorescence detection (HERFD-XAS) beamline 6-2, with help from SLAC scientists Matthew Latimer, Thomas Kroll and Dimosthenis Sokaras.

"These synchrotron techniques allowed us to look at historical samples with X-ray eyes to determine what mercury compounds existed in the cat's brain tissue, which then told us a lot about its toxicology," explained James. "HERFD-XAS has been particularly useful because its higher resolution enhances the shape of the mercury spectra, so we can fit the complex mixture of compounds with more confidence."

The team then used computer-based calculations to model the chemical plant's processes. Instead of methylmercury, their computational chemistry studies predicted that the factory released a different organic mercury compound called alpha-mercuri-acetaldehyde, whose toxicology has not been studied. Their findings challenged the long-standing view of what form of mercury poisoned the human population in Minamata.

The ensuing controversy attracted media attention and some scientific criticism, which was a bit overwhelming and stressful for James as an early-career PhD student. However, she handled it like a veteran, according to her nomination letters. Her supporters described the criticism published in letters to the journal as personal and unscientific. And they praised James' response as excellent and surgically precise.

"Science is meant to create debate and it certainly did that," said James. "But our main point was that it is important to study the toxicology of organic mercury compounds other than methylmercury, because they may have important environmental and health impacts."

Comparing acute and chronic mercury poisoning in humans

Her second PhD research project investigated the more prevalent issue of chronic mercury exposure due to a lifetime of eating marine fish with low levels of methylmercury, which can lead to as much as ten times higher concentrations of mercury in the brain. Specifically, she used the same X-ray spectroscopy techniques and SSRL facilities as the Minamata project to study brain samples from residents of the Seychelles islands.

She compared these results to similar beamline studies on two historic acute organic mercury poisoning cases, which involved a short-term exposure of large concentrations of organic mercury. All brain tissue samples for her PhD work were acquired through her collaborators at the University of Rochester.

"We wanted to see if there was a difference in the chemical form of mercury found in chronic versus acute human exposure cases," said James. "Honestly, we found the complete opposite of what we expected."

The human body uses a chemical process called demethylation as a defense mechanism to slowly turn organic mercury into less toxic inorganic mercury. The researchers therefore thought people showing no evident symptoms of mercury poisoning would have mostly inorganic mercury that had been demethylated, James explained. Instead, they found individuals with chronic exposure had low concentrations of mercury in their brains, but it was entirely organic.

Similarly, the scientists predicted individuals after acute poisoning would have less time to demethylate the mercury, meaning they would have high levels of organic and low levels of inorganic mercury. Instead, they found complex mixtures with low concentrations of organic and high concentrations of inorganic mercury.

"The takeaway of this crazy twist is that it could be misleading to use acute exposure studies to understand the vast majority of human exposures that are chronic in nature," said James. "Over a billion people worldwide depend on fish as their primary or sole source of protein. So, better understanding the ramifications of ingesting fish that may contain low levels of mercury is an important global food security question."

As a postdoc, James is extending her mercury toxicology research. She is now studying the role of metals in multiple sclerosis using a diverse range of SSRL X-ray spectroscopy

and X-ray imaging beamlines.

"Dr. James' remarkably impactful research is further distinguished by her use of an incredible range of different techniques — from advanced X-ray spectroscopy methods at SSRL to quantum chemistry, alongside more conventional toxicology methodology," said George and Pickering. "This work represents one of the very first demonstrations of these techniques to her field."

The Klein award is named in honor of the late Melvin P. Klein, a world-renowned biophysicist at Lawrence Berkeley National Laboratory and the University of California, Berkeley and a longtime user at SSRL. SSRL is an Office of Science user facility.

Yasaman Yousefi Sigari

Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Sponsored by: / Commandité par :
Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

Honourable Mention / Mention honorable

Best Student Poster Presentation Award
Prix meilleure présentation étudiant(e) (affiche)

presented to / décerné à

Yasaman Yousefi Sigari

In recognition of an outstanding student research paper presented at the 2023 CAP Congress

En reconnaissance d'une présentation étudiant(e) exceptionnelle présenté(e) au Congrès de l'ACP 2023

Barbara Frisken
CAP President / Présidente de l'ACP

June 22, 2023
Date

Iulia Spataru

Iulia Spataru, Ph.D. student in the College of Pharmacy and Nutrition, has been awarded the Antoine A. Noujaim Award of Excellence (Sponsored by the Faculty of Pharmacy & Pharmaceutical Sciences, University *of* Alberta) at the 2023 CSPS/CC-CRS Annual Symposium held in Toronto for her poster titled: *"Functionalized nanodiamonds as gene delivery agents: Biocompatibility and biodistribution"* Iulia received a certificate and an award of $1,000 for best poster presentation by a graduate student. The poster was evaluated on scientific merit, discovery, innovation, and contribution.

From left to right, Dr. Neal Davies (President of the Canadian Society for Pharmaceutical Sciences), Iulia Spataru, and Dr. Ildiko Badea.

UPCOMING EVENTS

INSPIRE & The CLS

Upcoming Events

2023 CLS Annual Users Meeting

- **October 16**: Poster Submission
- **October 26 - November 3**: Meeting and Workshop

Call for Proposals for New Student Applications

- **November 15**

INSPIRE Annual Workshop

- **December 7-8**

INSPIRE Online Speaker Series

- **October 25**: Ildiko Badea
- **November 22**: David Cooper

INSPIRE Annual Workshop 2022; from left to right: Dawn Pratt, Dr. Joyce McBeth, Prof. Ingrid Pickering, Amanda Zimmerling, Dr. David Cooper, Prof. Graham George, and Prof. Dean Chapman.