Western
Institute for Earth
& Space Exploration

ANNUAL REPORT 2023

BRINGING SPACE DOWN TO EARTH

BREAKING BOUNDARIES

Tackling society's greatest challenges through interdisciplinary collaboration

The challenges we face today, such as climate change, public health crises, an aging population or technological advancements, are incredibly complex and interconnected. Addressing them requires an approach that mobilizes knowledge and expertise from various fields and beyond the boundaries of academia. Only if we can break down disciplinary boundaries and foster collaboration and inclusivity, will we have a chance at tackling society's biggest challenges effectively.

Western's research institutes are designed for this exact purpose: they are hubs of interdisciplinary activity and innovation dedicated to addressing the world's greatest challenges. They create a welcoming space for researchers, where novel approaches to stubborn problems can thrive, and provide leadership to advance interdisciplinary excellence at Western and beyond.

INSTITUTE FOR EARTH & SPACE EXPLORATION

From the director

Reflecting on 2023, I am proud of the work the Western Space team and members have done over the past year on the fronts of research, training and outreach.

In 2023, we delivered on our vision to "launch Western into space" with the deployment of CubeSat Ukpik-1 from the International Space Station over the summer. To support our future CubeSats, a new satellite dish for tracking and operations was installed and commissioned on the roof of the Western Interdisciplinary Research Building. This Western-funded infrastructure will be a valuable resource for our community going forward. To grow new projects, we initiated team development through a joint think tank event with the Bone and Joint Institute on remote health.

Our Graduate Council organized the first Cosmic Career Connection event with industry and the Canadian Space Agency. We sponsored four undergraduate summer interns working on projects that ranged from using thermal imaging in urban environments for mitigating building heat loss to designing wearable sensors to monitor astronauts' musculoskeletal health in low-gravity conditions.

We have continued our close partnership with Cronyn Observatory for community engagement, including participating annually in Western's award-winning Science Rendezvous event and traveling to northern Ontario to bring solar telescopes and meteorites to rural communities. In November, we co-hosted our first event with McIntosh Gallery, "Bringing Space Back to Earth," a panel whose fascinating discussion included museum curation of asteroid specimens and the role of space in literature.

Please enjoy the profiles in this report that showcase some of the exciting work of our members in more detail.

Sarah Gallagher
Director,
Institute for Earth & Space Exploration

STRENGTH IN NUMBERS

24

prestigious awards, including 8 Research Chairs, 4 Fellows of the Royal Society of Canada, 2 Distinguished University Professors, and 4 Faculty Scholars

8

faculties are represented through members: Education, Engineering, Health Sciences, Ivy, Law, Schulich, Science, and Social Science

55

major media engagements, including coverage in the New York Times, National Geographic, CBC, CTV Toronto and the Globe and Mail

112

members total, including 47 faculty, 44 trainees, and 21 other members (partners, collaborators, and staff)

648*

grants held by members

31.9M*

in multi-year funding

74

papers associated with the institute

8 publications are listed among the top 10% most cited publications in the Web of Science database.

1 publication listed among the top 1% most cited publications in the Web of Science database

64 publications co-authored with one or more international scholars across 37 countries/regions with an average category normalized citation impact above the world average at 1.29

*This data does not include grants located at or shared with other institutions or institutes.

EARTH OBSERVATION

Earth observation for societal impact

Earth Observation (EO) involves gathering information about the Earth's surface, waters and atmosphere via ground-based, airborne or remote-sensing technologies, such as satellites. This type of monitoring is crucial in protecting our environment and serving social needs. It helps us collect objective information that we can use to monitor changes, identify problems and make decisions.

The benefits of EO are too many to list. For example, it helps us understand the true impact of climate change. It can act as an early warning system for natural disasters like hurricanes, floods, and wildfires. In agriculture, EO helps farmers optimize crop yields, and urban planners use EO data to design sustainable cities and manage resources efficiently.

Ultimately, EO empowers us to make informed decisions that foster a sustainable and resilient future for all.

Interdisciplinary team aims to improve methane management at local landfill

The Western Institute for Earth and Space Exploration is leading a new project to measure methane released by London's dump, with a multi-disciplinary team of researchers helping to track the potent greenhouse gas.

The team will use drones, satellites, as well as stationary and hand-held devices to determine exactly how much methane is produced at the city landfill on Manning Drive – officially named W12A – and whether any of it is escaping the collection system currently in place.

Federal funding of $200,000, announced in September 2023, will help the team collect the crucial data over the next two years.

"It's very important we limit methane emissions as much as possible because it is a really potent greenhouse gas. Dumps make methane, that's just a normal process of decomposing – it's not like you can prevent that from happening," said Sarah Gallagher, an astrophysicist and director of the Institute for Earth and Space Exploration.

The team, which includes engineers, geographers, computer scientists and other experts, will use the information gathered using different methods to determine the best and most accurate way to measure and monitor methane emitted when Londoners' trash rots at the dump:

• Satellite imaging of the landfill will show methane emissions viewed from space, using equipment from GHGSat, a company that describes itself as a pioneer and global leader in "high-resolution remote-sensing of greenhouse gas from space."

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• An autonomous drone equipped with an instrument to analyze gases will fly over the landfill to map methane concentrations at high resolution using a specialized detector called a tunable diode laser absorption spectrometer (TDLAS).

• "Ground-based" detectors, some set at fixed locations around the landfill and others carried by a person essentially walking across the landfill.

Each approach has its own benefits and drawbacks, like the low-resolution of the satellite maps or the labour-intensive, difficult and smelly job of walking over the landfill holding the portable equipment.

The Western researchers will also monitor any changes in methane emissions across seasons or areas of the landfill to see what variables, if any, have an impact.

"Does it change by time of year, such as July in the heat of summer versus January in the depth of winter, covered with snow?" asked Jamie Skimming, the city's manager of energy and climate change.

He's eager to see the results to help with the city's work managing greenhouse gases at the landfill.

"Tackling methane emissions from landfills will help clean our air and achieve the Government of Canada's 2030 target to reduce overall greenhouse gas emissions by 40 to 45 per cent below 2005 levels. Successful demonstration of these technologies will provide Canadian landfill operators more tools to monitor landfill methane, identify leaks, and improve landfill gas recovery," Minister of Environment and Climate Change Steven Guilbeault said of the funding.

Western's project is among five receiving a combined $575,748 from the federal government's fund for reducing methane emissions at landfills.

Right now, London doesn't know exactly how much methane is produced by its dump. Estimates are based on mathematical modeling for emissions from decomposing organic matter – or trash – but may not be accurate.

This project will determine the real numbers.

"We estimate the methane emissions from our active and closed landfills is somewhere around five per cent of all of our locally generated greenhouse gas emissions. We've got a good handle on how much methane we're capturing and flaring. But the other half of that equation is how much methane is being generated in the landfill overall," Skimming said.

It's possible some methane is seeping out around the equipment that's used to capture and collect it for burning. Skimming describes that system as similar to a series of giant straws, that penetrate the "lid" of each area of the landfill – a layer of soil and clay that sits on top of the garbage – and are used to pull out the gas generated.

Once or twice a year, the operator of the methane collection system checks for gaps through which gas could be escaping, but tracking emissions using the three technologies Western plans to deploy will give much more frequent and accurate results.

Partnering with Western is a key part of the municipality's climate emergency action plan and its goal to "advance knowledge, research and innovation," Skimming said.

"The beauty of this project is the researchers at Western are going to be doing all the hard work to test the satellite and drone measurements and how all that tech works," Skimming said, calling it an "really interesting" endeavour that staff will highlight to city council.

The approach to the landfill measurements is innovative not just because of the new equipment being deployed and compared, but because of the people driving the work.

"We have the expertise in hand – these are all experts who are already present at Western – but we're coming together to work on this problem that's really important," Gallagher said.

"The idea is to develop the methodology to allow us to answer these questions – how much methane is being emitted by the city of London landfills? Where and when is it emitted? – so they can go after the largest sources and develop methods for dealing with it." ✷

"Tackling methane emissions from landfills will help clean our air and achieve the Government of Canada's 2030 target to reduce overall greenhouse gas emissions by 40 to 45 per cent below 2005 levels."

Western Space members from Physics & Astronomy, Engineering, Geography & Environment and Computer Science preparing a methane-detecting drone sweep of a city landfill.

What else happened?

Building a birds-eye view

A new mini satellite will enhance wildlife tracking by collecting space-based data on migratory songbirds, waterbirds, and shorebirds.

Western Space member spacspceJayshri Sabarinathan made headlines in early 2023 for launching Western's first spacecraft, a miniature satellite (page 27). In June 2023, the CSA announced that Sabarinathan's team has won a second opportunity to build, launch and operate a new CubeSat through the CubeSats Initiative in Canada for STEM (CUBICS) grant, which is named the Western Skylark.

Western Skylark will provide space-based data collection for an established global animal migration tracking system, which surveil birds over great distances but lacks the satellite connection required to maximize its capabilities.

The work is being done in collaboration with researchers at Western Space, Western's Centre for Animals on the Move, led by biology professor Chris Guglielmo, and faculty members from Engineering, Social Science and Science, along with a diverse group of partners.

"Movement is fundamental to the lives of animals, and due to the seasonality at high latitudes, a high proportion of Canada's wildlife is migratory," said Guglielmo. "Understanding the life cycles and threats to these animals requires detailed information about migratory routes and timing, as well as sources of mortality. We hope to deliver this information with Skylark." ✱

Western Space event explores interdisciplinary opportunities in Earth observation and remote sensing

A Western Space showcase and think tank brought together researchers and Western Space partners to discuss gaps and opportunities for interdisciplinary collaboration related to Earth observation and remote-sensing technology.

The showcase featured nine speakers from multiple disciplines who shared their work in Earth observation technologies and their applications on a variety of issues, such as urban heat, precision agriculture, animal migration or fire monitoring.

After the event, the speakers were joined by another nine experts to discuss ideas, current research and identify crucial gaps or opportunities that could be better addressed using an interdisciplinary approach. The group discussed important questions, such as: How can we improve the monitoring and mitigation of environmental impacts on urbanization, ecosystem changes or health risks in Canada? Who can bring unique perspectives from different sectors on this topic? Where can the institute have the most impact?

Next steps will include hosting regular discussions, meeting with Western units who conduct research in thie area, targeting of research opportunities and the expansion of Western Space's network of partners and collaborators in this area. ✱

PLANETARY SCIENCE & ASTRONOMY

Unraveling the mysteries of our universe

How did our solar system form and how is it evolving? Are there other habitable planets out there? Is there life beyond Earth?

These are just a few of the existential questions scientists are trying to answer. While the universe still holds many mysteries, astronomy and planetary science have pushed our understanding of our planet, solar systems, galaxies and stars. Thanks to the discovery of the Cosmic Microwave Background, the Big Bang theory is now Earth's undisputed origin story. We also learned that galaxies aren't just made of gas and stars but contain a third key ingredient: dark matter. And researchers discovered that millions of exoplanets are "habitable" - and potentially inhabited.

Those discoveries would not have been possible without the development of out of this world technology. From satellites and spacecraft to space-based telescopes and deep space communication systems: space technology is undeniably at the centre of humankind's exploration of Earth and outer space.

As we continue to reach for the stars, research and technology will bring us closer to answering the most profound questions of our existence. Who knows what the next 50 years of discoveries and technological advancements will bring? The sky isn't the limit!

Illustration of an astronaut, a rover and a lander on the lunar surface. Canada plans to launch its multi-pupose utility rover as part of the NASA-led Artemis Program in the 2030s. (Credit: Canadian Space Agency/ESA)

SPACE TECHNOLOGY

Western Space team designs prototype to analyze minerals in Martian rocks

Working with an industry partner, Earth sciences professor Roberta Flemming successfully tested miniaturized device

An interdisiplinary team of Western researchers has developed the first-ever hand-held diffraction tool for the identification of minerals in their natural setting on planetary surfaces such as Mars.

Working with industry partner Proto Manufacturing, Earth sciences professor Roberta Flemming and team members on the Canadian Space Agency-funded project successfully tested a miniaturized in situ X-ray diffractometer (ISXRD) last month in LaSalle, Ont.

An X-ray diffractometer is a standard laboratory instrument used around the world to characterize minerals – but until now there was no hand-held version of such a device that could be used to analyze minerals in situ, either in-person on-site (on Earth) or remotely (the Moon, Mars and beyond.)

Minerals tell us about the history of a rock, and the environmental conditions that existed when it formed. For example, using the ISXRD, scientists could potentially study the role that water played in forming minerals on Mars.

"There is only one diffractometer anywhere in the solar system that is off Earth and that is CheMin (Chemistry and Mineralogy) on the Curiosity rover," said Western Space member Flemming, a planetary minerologist and faculty member at Western's Institute for Earth and Space Exploration. "It uses a drill to powder or pulverize the rock samples, scoops them up and analyzes the material inside the machine."

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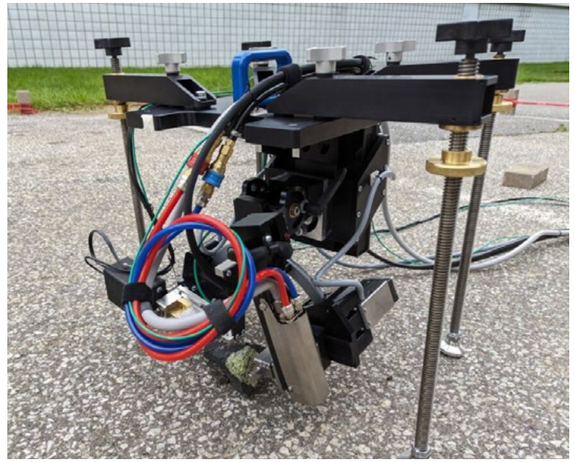
The prototype version of the ISXRD, built by Proto. (Roberta Flemming photo)



The prototype version of the ISXRD, built by Proto. (Roberta Flemming photo)

"The test mission was a huge success and worked better than we hoped. Partnering with Proto was critical to the success. We knew what we wanted, and they knew how to make it a reality."

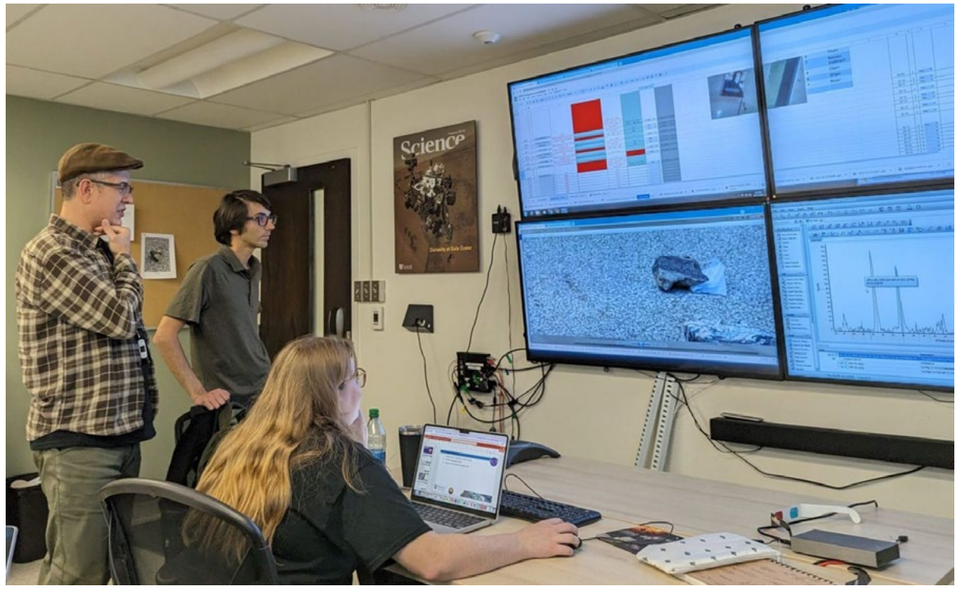
That process is too slow and lacks context (due to fragmentation and possible contamination) said Flemming, so she proposed a miniaturized version of a traditional laboratory diffractometer that could characterize the geology of the Martian surface using an external system for targeting remote and more precise X-ray analysis strategies.

Mitacs-funded student intern Dana Beaton, co-supervised by Flemming and electrical and computer engineering professor Jayshri Sabarinathan, and Proto product development manager Stanislav Veinberg, designed a prototype version of the ISXRD. It was built by Proto and mounted as a standalone instrument as part of a simulated rover mission. The functionality of the instrument was tested during the analogue mission in LaSalle on October 12-13, on rocks similar to those that would be found on Mars.

At Western, a team of faculty, staff and students sent commands to the simulated rover in LaSalle to target and analyze these rocks. Team members in the field carried out activities to simulate rover movements.

"The test mission was a huge success and worked better than we hoped," said Flemming. "Partnering with Proto was critical to the success because they knew how to build the machine. We knew what we wanted, and they knew how to make it a reality."

The researchers from Western and Proto used the ISXRD to characterize various rock samples, including gypsum, mudstone, basalt containing a mantle xenolith (cooled magma) and breccia. Data was acquired on the ISXRD in as little as 17 minutes per target.



Earth sciences professor Livio Tornabene (left) and Western Space research officer Eric Pilles observe data returns from the field test with student Lauren McFarlane at the mission control centre in the Physics & Astronomy Building. (Roberta Flemming photo)

"It's a very complicated design because critically, you have to get the science right, but you also have to make it small, which means less power," said Flemming. "When you try and scale down something wwfor space that normally fits in a lab, you have to figure out a way to power it with a lot less energy. And you have to make it robust enough that it could survive the launch and landing, and small enough to mount on a rover arm, but sophisticated enough to move the way we need it to move."

The project was funded by a Canadian Space Agency grant through its Flights and Fieldwork for the Advancement of Science and technology (FAST) initiative. The Mars analogue rocks used for characterization by the ISXRD instrument were provided by researchers from Western, Brock University and University of Guelph.

"Working closely with Dr. Flemming and her team at Western has been a great experience. The prospect of the ISXRD system eventually collecting data on Mars is very exciting, and it has inspired me to push the boundaries of creativity in the creation of future Proto systems," said Veinberg. "At Proto, we always strive to design innovative new products for our customers in the powder diffraction world, and collaborating with a team that is so committed and knowledgeable about their field has allowed us to develop an instrument that surpassed everyone's expectations." ✱

POET: a Canadian quest for Earth-like planets

The TRAPPIST-1 system, 40 light-years away, is the most studied planetary system besides our own. Seven rocky, Earth-size planets have been found circling TRAPPIST-1, a red dwarf star about the size of Jupiter. Of the seven, at least 3 are in the habitable zone, a region around a star with temperatures just right for allowing a planet to support liquid water.

2023 data collected by NASA's James Webb telescope ruled out the planet closest to the star as a suitable candidate for life due to its hot surface and lack of atmosphere, but there is still hope for the more distant ones, said astronomer and Western Space member Stanimir Metchev. Since 2017, he has been on a mission to discover and learn more about extrasolar planets, or exoplanets. Alongside Bishop's University's Jason Rowe, Canada Research Chair in Exoplanetary Astrophysics, he co-leads a team of researchers, developing a small — and relatively inexpensive — telescope that can spot distant stars and planets.

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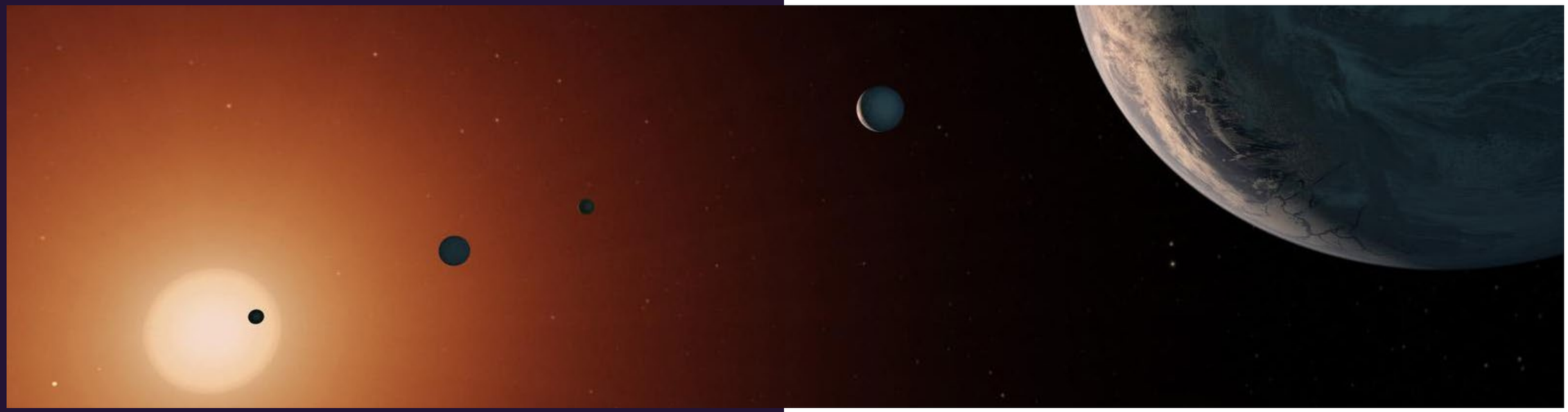
Artist rendering of what it might look like to stand on the surface of one of the exoplanets located in the TRAPPIST-1 system in the constellation Aquarius.
(Credit: NASA/JPL-Caltech)



In 2023 and with financing from the Canadian Space Agency, the team was able to finish developing a prototype of the telescope and its cameras, designed by industry partner ABB Canada.

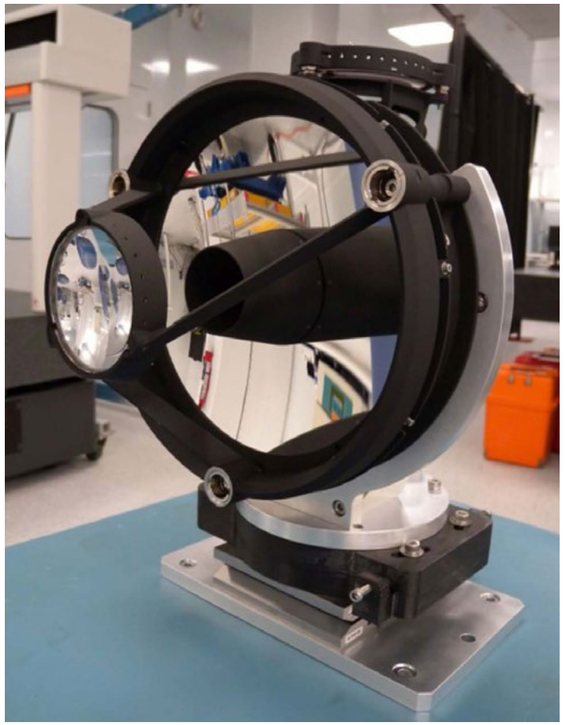
The Photometric Observations of Exoplanet Transits (POET) telescope will be able to detect different wavelengths of ultraviolet, visible, and infrared light to make precise measurements of exoplanets transits with the goal of detecting Earth-like habitable planets.

"So, the idea with POET is to look at extrasolar planets using the transit method. When a planet goes in front of its host star, the star's brightness dips just a tiny little bit and that dip lets us know that there is an exoplanet," explains Metchev. "The extent of those dips also tells us a lot about an exoplanet, such as its size. And we can investigate a planet's density or if it has an atmosphere and what the chemical composition of that atmosphere is."

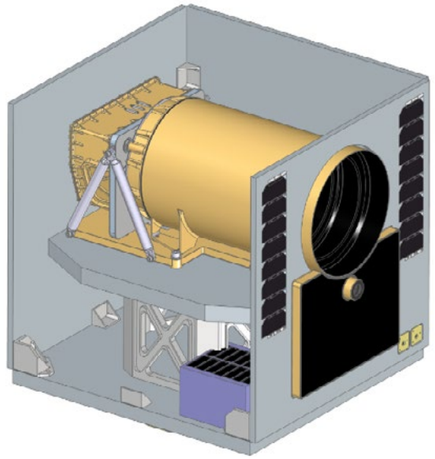
Unlike the Hubble Telescope and the James Webb Space Telescope, which are international collaborations among different space agencies, POET would be entirely Canadian-funded and Canadian-built.

In 2023 and with financing from the Canadian Space Agency, the team was able to finish developing a prototype of the telescope, which was designed and built by industry partner ABB Canada. The plan is to launch the telescope into space on board a spacecraft, which would be built by the Space Flight Laboratory at the University of Toronto.

"The plan right now is to have a 60x60x60-centimeter cube with the telescope inside. And then we basically



The assembly of POET's prototype in ABB Canada's lab.



Design for the "spacecraft cube" in which POET would be launched into space. (Image by Space Flight Laboratory at the University of Toronto Institute for Aerospace Studies)

attach that to a rocket and launch it into space," said Metchev. "Our goal is to have a telescope in space for at least two years to discover Earth-like planets and to observe known giant exoplanets, like Jupiter or bigger, and look at their extended atmospheres."

Metchev hopes that POET could be in orbit by 2029, characterizing known extrasolar planets, or perhaps even discovering Earth-like exoplanets, but the exact timeline will depend on funding, he said. With help from Western Space, Metchev is leading an application for a $30 million Canada Foundation for Innovation (CFI) grant. Among other things, the grant would finance the construction, launch, and continuous operation of POET and its spacecraft.

"Part of the challenge is coming up with ingenious solutions to electronics and compact design efficiency. We also want to look for these planets at infrared wavelengths, which is a new approach. The kind of infrared camera we plan to use is also new. We know that these cameras work well on the ground, but they haven't really been flown on an astronomical space telescope before." ✷

What else happened?

James Webb Space Telescope continues to reveal secrets of our universe

JWST/NIRcam composite image of the Ring Nebula. The image clearly shows the main ring, surrounded by a faint halo and with many delicate structures.

The inner region of the Orion Nebula as seen by the James Webb Space Telescope's NIRCam instrument. The image was obtained with the James Webb Space Telescope NIRCam instrument on Sept. 11, 2022.

Since its launch in December 2021, the James Webb Space Telescope (JWST) has captured spectacular images of deep space – and the imagination of millions around the world. The telescope made international headlines in 2022 after Webb captured never-before-seen images of the inner region of the nebula that had researchers buzzing with excitement.

"The images and the data are fantastic. I'm not exaggerating when I say that scientists can work on this data for the next ten years," said Els Peeters, an astronomer and professor at Western University.

Western Space member Peeters is one of three principal investigators on PDRs4All, an international collaboration that also includes astronomer Jan Cami and several other Western astrophysicists.

In 2023, the Webb telescope continued to fascinate the world with stunnig images and newfound knowledge about our universe. In June, data colllected by the telescope led to the discovery of a molecule known as methyl cation (CH3+), located in the protoplanetary disc surrounding a young star. The vital role of CH3+ in interstellar carbon chemistry was predicted in the 1970s, but Webb's unique capabilities have finally made observing it possible – in a region of space where planets capable of accommodating life could eventually form.

In August, JWST recorded stunning new images of the iconic Ring Nebula (Messier 57), offering an unparalleled opportunity to study and understand the complex processes that shaped this cosmic masterpiece.

Peeters said she is exited to continue to learn from JWST's data and share new information about our universe with the world: "There is so much information in those data sets. At this point, we're just scratching the surface, and we expect many discoveries about young stars, their associated disks in which planets form, and the environment in which they are formed." ✷

CubeSat Ukpik-1 launched aboard SpaceX

Western Space team launches Western's first-ever miniature satellite

On June 5, 2023, at 11:47 am EST, Western's first mini-satellite, Ukpik-1, was successfully launched into space aboard a SpaceX Falcon 9 rocket from launchpad LC-39A at the Kennedy Space Center in Cape Canaveral, Florida.

Ukpik-1 hitched a ride to the International Space Station (ISS) aboard SpaceX's Dragon cargo ship (CRS-28), having been integrated into the Nanoracks CubeSat Deployer as a payload earlier this year at CSA headquarters in Longueuil, Quebec. Upon arrival at the ISS, the CubeSat was ejected through an airlock to begin its space mission.

Small, modular and relatively inexpensive to build and launch, CubeSats are the great equalizers when it comes to space exploration and Earth observation. With a focus on delivering equitable opportunities to post-secondary students across the country, CSA launched the Canadian CubeSat Project (CCP) in 2017.

A Western research team led by Engineering professor and Western Space member Jayshri Sabarinathan started with a CCP initiative and has worked in collaboration with Nunavut Arctic College (NAC) since 2018 to create Ukpik-1.

"CubeSats are recognized as an accessible method for post-secondary students to learn about and demonstrate a satellite with the associated technologies and resources," said Sabarinathan. ✷

Western students Wen Bo, Alexis Pascal and Stephen Amey prepare Ukpik-1 for integration with principal investigator Jayshri Sabarinathan. (Western Space photo)

In today's connected world, reliable satellite communication plays a vital role in research and across many industries.

In 2023, Western Space installed London, Ontario's first satellite ground station on the roof of the Western Interdisciplinary Building.

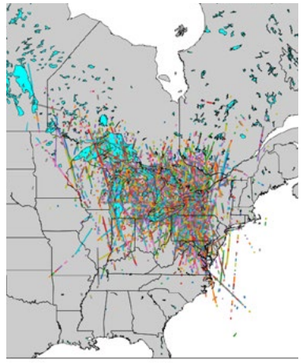
The new station integrates UHF/VHF and S-band for seamless communication with satellites in orbit. Future plans include adding optical communication capabilities.

Research projects are already set to benefit from this new technological addition. For instance, the Western Skylark project (page 13) will transmit migratory bird data from a CubeSat to the station.

This year, the institute will begin training students to operate the station and satellite dish. Western Space partners will also benefit from the ground station, which can provide redundancy for data downlink facilities. ✷

New project to monitor satellites over Canada

As satellite count surges, Western team uses meteor tracking camera tech to monitor where they are in Earth's orbit



This map shows the satellite ground tracks detected during one night of camera observations on September 2, 2023. (Michael Mazur map)

As predicted by Captain Kirk, space is indeed the final frontier. But imagine if Starfleet couldn't launch the U.S.S. Enterprise because there was a traffic jam in Earth's orbit causing congestion or, worse, gridlock.

Welcome to 2023. The growth of satellite constellations, mainly privatized, has exploded in recent years. It is nearly impossible to look up and not see a satellite with the naked eye any time after dusk.

A team of Western University researchers is helping to track where these satellites are in Earth's orbit. They are pioneering an inventive approach for satellite surveillance, leveraging existing cutting-edge technology initially designed for meteor observation.

"Satellites in the sky look like really, really slow meteors, so it is a natural extension of our meteor observation program," said Peter Brown, Canada Research Chair in planetary science and member of Western's Institute for Earth and Space Exploration. "Our heavens are on the brink of becoming notably populated by satellite constellations and we need to know what's up there, not only when but where."

This initiative, a collaboration between Western and Defence Research and Development Canada (DRDC), will adapt the technology used by the Western-led Global Meteor Network to efficiently monitor satellites over Canada using very low-cost cameras.

These cameras are unique as they are very sensitive. They monitor the entire sky and collect images tens of times per second, meaning they can track satellite constellations, rocket bodies and other debris in low earth orbit (LEO) while continuing to monitor meteors.

"As more satellite constellations go into orbit, we need a fast way to record their location, brightness and state of health," said Brown. "We believe this camera network, supported by Western's decades of experience in observing meteors and the new technology by the Global Meteor Network, will be able to accomplish this task." ✱

Saturn's largest moon likely non-habitable

Astrobiologist Catherine Neish finds Titan may not have enough amino acids for life to emerge

A study led by Western's Catherine Neish, a Western Space associate director, shows the subsurface ocean of Titan – the largest moon of Saturn – is most likely a non-habitable environment, meaning any hope of finding life in the icy world is dead in the water.

This discovery means it is far less likely that space scientists and astronauts will ever find life in the outer solar system, home to the four 'giant' planets: Jupiter, Saturn, Uranus and Neptune.

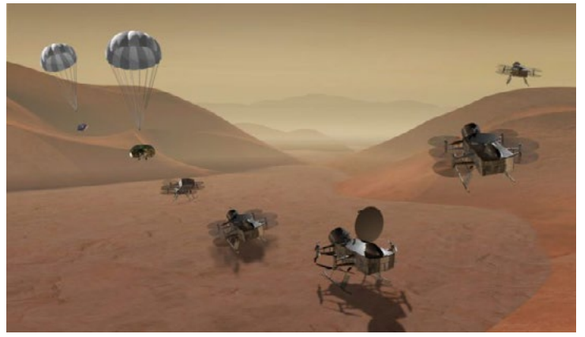
"Unfortunately, we will now need to be a little less optimistic when searching for extraterrestrial lifeforms within our own solar system," said Neish, an Earth sciences professor and member of Western Space. "The scientific community has been very excited about finding life in the icy worlds of the outer solar system, and this finding suggests that it may be less likely than we previously assumed."

The identification of life in the outer Solar System is a significant area of interest for planetary scientists, astronomers and government space agencies like NASA, largely because many icy moons of the giant planets are thought to have large subsurface oceans of liquid water. Titan, for example, is thought to have an ocean beneath its icy surface that is more than 12 times the volume of Earth's oceans.

"Life as we know it here on Earth needs water as a solvent, so planets and moons with lots of water are of interest when looking for extraterrestrial life," said Neish.

Despite the discovery, there is still much more to learn about Titan, and for Neish, the big question is, what is it made of?

"Unfortunately, we will now need to be a little less optimistic when searching for extraterrestrial lifeforms within our own solar system."



An artist's rendering shows a Dragonfly quadcopter landing on the surface of Titan, unfolding its rotors and lifting off again to survey the landscape and atmosphere. (Steve Gribben/Johns Hopkins photo)

Neish is a co-investigator on the NASA Dragonfly project, a planned 2028 spacecraft mission to send a robotic rotorcraft (drone) to the surface of Titan to study its prebiotic chemistry, or how organic compounds formed and self-organized for the origin of life on Earth and beyond.

"It is nearly impossible to determine the composition of Titan's organic-rich surface by viewing it with a telescope through its organic-rich atmosphere," said Neish. "We need to land there and sample the surface to determine its composition." ✱

SPACE & REMOTE HEALTH

Do astronauts get lonely in space?

The life of an astronaut is thrilling and adventurous, but it can also be isolating and lonely, as many astronauts have reported. This raises an important question: how do we keep our astronauts healthy, both physically and mentally, while on a mission?

Technological innovation is part of the solution. From handheld ultrasound devices to holographic communication that allows people to meet anywhere – even in outer space: long-distance health care solutions have come a long way. However, equally important is the role of compassionate care: designing remote health care solutions that put patients' needs and human interaction at the centre.

Interestingly, a lot of the big health care challenges we encounter in space mirror those of remote care on Earth. Whatever the answer, to ensure patient-centered remote care for people on Earth or in space, we must focus on compassionate care solutions developed through interdisciplinary collaboration. By involving patients and harnessing the expertise of engineers, medical professionals, psychologists, and more, we can create holistic solutions that support well-being in the most isolated of places.

New frontiers in remote health care: exploring compassionate care on Earth and in space

An interdisciplinary think tank co-organized by the Western Institute for Earth & Space Exploration (Western Space) and the Bone and Joint Institute (BJI) is looking into patient-centered health care solutions for remote communities on Earth and beyond.

The COVID-19 pandemic saw growing use of virtual care across Canada and highlighted its potential to address some of Canada's biggest health care challenges: delivering quality health care to remote communities. According to the 2006 Statistics Canada Census, roughly 194,000 Canadians live in remote communities and face barriers in accessing health care. There is, however, one more remote community we need to add to the list, said family physician Keith Thompson, Western Space's associate director of research. That is, if we look beyond Earth!

"In many ways, astronauts on a mission face the same challenges remote communities are facing here on Earth. For both groups, we need to come up with remote care solutions that can provide quality, patient-centered compassionate care. That's important, because if we don't design virtual care thoughtfully, it can do more harm than good."

Leveraging Western's exceptional strengths in patient care and space exploration, the Bone and Joint Institute (BJI) teamed up with Western Space to get a think tank off the ground. On June 6, 2023, a first meeting brought together a diverse array of researchers from across Western, alongside a representative from a regional health authority, to discuss the gaps, challenges, and opportunities in remote healthcare delivery. An important outcome of the think tank, said Thompson, was participants' realization that their work can have many uses beyond its original scope.

"I often come across researchers who are doing incredibly relevant and significant work, but they haven't realized that this may have applications in remote health care on Earth and in space," said Thompson. "For example, there was a plastic surgeon, who developed an algorithm that can analyze certain joint movements and give postoperative feedback. And I said to her, 'this would also be super useful for a remote care application.'"

The discussion was preceded by a well-attended showcase that brought together speakers from across Western Research Institutes to talk about innovations in equitable, accessible service delivery that improve patients' quality of life and well-being.

Both showcase and think tank revealed that remote health care poses many challenges that become even more complex in the harsh and ultra remote conditions of space. Questions like "How do you provide remote care on Mars?" don't have a simple answer and push researchers to the boundaries of what is possible today.

While technological advancement is incredibly important, Thompson points out that we also can't lose sight of the human factor in remote health care: "We've got all this wonderful technology that can diagnose in incredible ways. But what do these wonderful systems look like from a patient perspective, whether that's Indigenous communities or astronauts in space? Does it address their needs? It's so important to think about and build into our process. You can't replace those aspects of compassionate care. There is no algorithm for compassion."

As for next steps, Western Space will host the Canadian Space Health Research Network Symposium on November 7–8, to further explore holistic remote care solutions on Earth and in space. ✷

Coming up

November 6-8 2024

2024 Canadian Space Health Symposium

Western Space and the Bone and Joint Institute are collaborating with the Canadian Space Health Research Network (CSHRNet) to bring the 2024 Canadian Space Health Symposium to London, Ontario.

The two-day event will take place at Western University, bringing together national and international leading scientists and trainees . The conference will be structured around four themes: remote care, isolation and confinement, environmental and human factors. It also examines how space health research can benefit communities on Earth. Learn more at **canadianspacehealth.ca/symposium**

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