



Canadian excellence, global recognition:

Canada's 2020 winners of major
international research awards



**Universities
Canada.**

Foreword



This past year has challenged the world to harness the power of research to advance solutions during a time of great uncertainty. Researchers everywhere have had to ask how to build upon and leverage our assets to get through something as destructive to our physical, mental and economic wellbeing as the COVID-19 virus.

In Canada's research community, the response to the pandemic has been outstanding and filled with innovation.



The researchers highlighted in this publication have demonstrated collaboration, perseverance and dedication during these challenging times that has provided the world with research that not only advances science globally, but also improves our quality of life and helps drive economic growth in Canada. The contributions of top researchers – the discoveries they make, the teams they assemble, the spin-offs they enable – will help Canada emerge even stronger after COVID-19.

In the coming months and years, we must not lose sight of the value of our research enterprise to building a better Canada and working across borders. We encourage all researchers and innovators to share their story more loudly; It's important for Canadians to learn about your work and share in your success.

Our next generation of researchers and innovators need the inspiration from our international award winners to see the value of careers in research and discovery. At our universities, research-enriched learning helps make this happen, while also equipping all students for rewarding careers in the rapidly changing world of work.

Today's outstanding researchers give them incredible examples to follow.

Congratulations to the award winners on their innovative research and their continued success.

The Right Honourable David Johnston 28th Governor General of Canada and Chair, Rideau Hall Foundation

Paul Davidson, President, Universities Canada

Meet international award winners from previous years at: www.univcan.ca/globalexcellence



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QUANTUM CRYPTOGRAPHY



Gilles Brassard

Using quantum theory to protect online communications

Prof. Gilles Brassard, Canada Research Chair in Quantum Information Science at Université de Montréal, has won the [BBVA Foundation Frontiers of Knowledge Award in Basic Sciences](#) — along with colleagues Dr. Charles Bennett and Dr. Peter Shor — for outstanding contributions to the field of quantum computation and communication.

Prof. Brassard, a computer scientist, and Dr. Bennett, a chemical physicist, invented quantum cryptography in the 1980s as a means of protecting data communications.

“We discovered how to use quantum theory to make an unbreakable encryption scheme, which we call quantum cryptography,” says Prof. Brassard. “In principle it is unbreakable as long as quantum theory is correct.”

The significance of their work only became apparent a decade later, when mathematician Dr. Peter Shor discovered that a hypothetical quantum computer could penetrate the cryptographic systems used to protect internet communications today. That means when a quantum computer is finally built, quantum cryptography will be the only absolutely secure way to protect online communications.

“The only thing that saved society from collapse is at the time [of Dr. Shor’s discovery] we did not have a quantum computer,” says Prof. Brassard. “We didn’t know how to build it. It seemed to be pure science fiction, so people didn’t worry about it.”

But technology has rapidly advanced. “Today we know we are getting there. Intensive international effort is being spent on trying to build quantum computers. No one thinks it’s never going to happen.”

When they invented quantum cryptography 35 years ago, Prof. Brassard and Dr. Bennett considered it “a curiosity.” That was before Dr. Shor showed that the current data security system could be breached. “We discovered a cure before the disease was found,” says Prof. Brassard.

The BBVA Foundation Frontiers of Knowledge Award is one of the most prestigious research awards in the world, with many winners going on to win the Nobel Prize.

In 2018, Prof. Brassard was the first Canadian to receive the Wolf Prize in Physics, considered the most prestigious award in physics after the Nobel Prize, “for founding and advancing the fields of Quantum Cryptography and Quantum Teleportation.”

MUSIC



Taylor Brook

Composer expanding reach with “gripping” music

[Dr. Taylor Brook](#)’s compositions — for concerts, videos, theatre and dance — have been described by the *New York Times* as “gripping” and “engrossing.” As a winner of the 2020 [Guggenheim Fellowship](#) in music composition, Dr. Brook hopes more ears will soon hear his work.

The fellowship will support, among other things, Dr. Brook’s current work on music for the TAK Ensemble in New York, a piece that sets the context for E.M. Forster’s 1908 short story, *The Machine Stops*.

“It’s very prescient in a few ways,” says Dr. Brook of the story about a world where Earth’s resources have been depleted and people live underground, communicating by a kind of instant messaging. “So I’m writing a big piece of music for that, about 40 minutes in duration.”

Dr. Brook says his work is “often concerned with finely tuned microtonal sonorities, combining...interest in exploring the perceptual qualities of sound with a unique sense of beauty and form.”

As his work evolves, Dr. Brook says he is interested in “new modes of expression that one can have in music composition and art music in general.” He also hopes to be able to reach a “broader swath of the population” with his compositions. “I want to create things that are engaging to people who have not been introduced to art music.”

In that, he is already experiencing success.

“I was happy to see one piece recently reach over 100,000 listens on YouTube,” he says. “That was a big difference for me, compared to recent years.”

The Canadian composer is currently a lecturer at Columbia University. He relocated from New York to British Columbia in March 2020, due to the pandemic.

PHYSICS



Simon Caron-Huot

At the intersection of physics and math, researcher searches for rules

McGill University physicist [Dr. Simon Caron-Huot](#) describes his research as “trying to do very precise calculations when we don’t know the rules of the game.” He studies the interactions between elementary particles and is a winner of the 2020 [Sloan Research Fellowship](#).

“When we talk about everyday physics, we can predict how objects move by figuring out which forces act on them, but elementary particles don’t move by forces, they move by exchanging other particles. It’s a different set of rules.”

“What is interesting is these rules are very constrained... They come from the principles of relativity and quantum mechanics.”

As with all fundamental research, it’s not clear at present where Dr. Caron-Huot’s research could lead.

“We have to take the long view. Two hundred years ago, people were studying electricity even as there was nothing to be done with it then.”

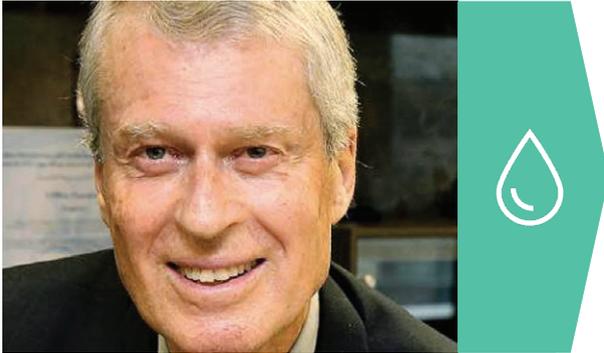
In the nearer term, Dr. Caron-Huot hopes his work can help make some physics calculations simpler.

“The part that fascinates me is the strong force. It holds quarks together in protons and nuclei, but we don’t understand how that strong force works. To predict the properties of all these nuclei from what they are made of, that’s very difficult right now. I want this to become much simpler. Using very sophisticated calculations we can get some grasp of what is going on, but I would like tools that make more and more people able to do this. That’s how we get new discoveries.”

“Sometimes we have to guess at what the principles are,” he says. “And there is beauty in the formulas that you get.”

With financial support from the Sloan Fellowship, Dr. Caron-Huot plans to attract the best postdocs to help advance this work.

WATER



John Cherry

Trailblazer in groundwater research continues to raise awareness

Dr. John Cherry is the first groundwater researcher and second Canadian to win the world's most prestigious water award. Valued at \$150,000, the Stockholm Water Prize honours individuals and organizations for extraordinary water-related achievements. In announcing the 2020 winner, the Stockholm International Water Institute said Dr. Cherry has “revolutionized our understanding of groundwater vulnerability. His research has raised awareness of how groundwater contamination is growing across the world and has led to new, more efficient methods to tackle the problem.”

Dr. Cherry received the Lee Kuan Yew Water Prize (Singapore) in 2016, valued at \$300,000. He is the first Canadian to receive the two most prestigious water prizes.

An awareness of groundwater vulnerability was lacking when Dr. Cherry, now professor emeritus at the University of Waterloo, started his research career in groundwater contamination in the 1960s. Back in 1979, Dr. Cherry co-authored the definitive textbook *Groundwater*, which garnered global academic attention for the topic, and is among the top three most-cited groundwater scientists in the world. Over the decades,

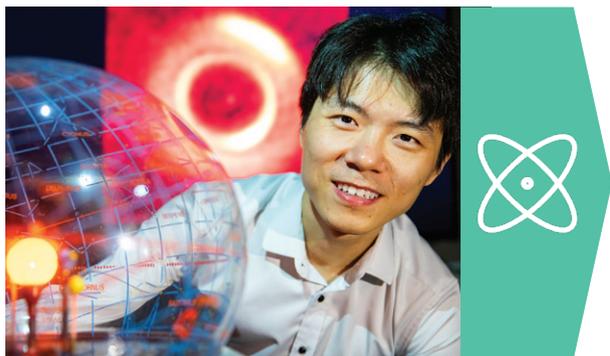
his work has helped highlight the dangers posed by groundwater depletion and contamination.

“The two together are the major part of the global water crisis,” he says. And the world is starting to pay attention, with the United Nations now recognizing groundwater reduction as a crisis. In fact, UN-Water has declared that “Groundwater: making the invisible visible” will be the theme for World Water Day in 2022.

Today Dr. Cherry leads the Groundwater Project — an endeavour to publish hundreds of e-books and other educational resources about groundwater in multiple languages for free downloading. The project, at gw-project.org, is based at the University of Guelph, where Dr. Cherry is a principal investigator with the G360 Institute for Groundwater Research, a hub for research collaborations between academia, governments and industries around the world.

Dr. Cherry plans to use funds from the Stockholm Water Prize to continue raising awareness about the global groundwater crisis.

PHYSICS



Ruobing Dong

Searching through dust and gas for signs of life-supporting planets

In the search for life on other planets, we need to know what kinds of exoplanets — those that orbit around a star other than our sun — could support life. That's a question [Dr. Ruobing Dong](#) is trying to answer. Specifically, he's trying to determine how such planets may form in their birth cradles around young stars.

"It's a big question; how do planets form," says the University of Victoria astrophysicist. "And the specific part that I'm doing is trying to add some little pieces to the answer to that question."

It's research that could also draw back the curtain on the Earth's own birth story.

Specifically, Dr. Dong's research looks for the signatures of planet formations. He uses the analogy of the trail a plane leaves as it crosses the sky — a kind of signature. But for exoplanets, his team examines the protoplanetary disk, made of dust and gas, surrounding a newborn star. Using the world's most powerful telescopes — such as ALMA, GEMINI and HUBBLE — they look for the signatures within those disks.

"My job is to look at those disks and find those trails left behind," he says — signatures that could reveal the formation of planets, some of them with the right kinds of characteristics to support life.

As a 2020 winner of a [Sloan Research Fellowship](#) in physics, Dr. Dong looks forward to expanding his research team and advancing this work.

"I feel very fortunate and humbling," he says of the award, "because I know a lot of scientists are doing amazing work and somehow, I was fortunate enough to get it."

As an early-career researcher, Dr. Dong says an award like the Sloan Fellowship is also immensely valuable for the confidence boost. "It tells you it's not just you who thinks you're doing great work, but your colleagues do too."

Dr. Dong is hopeful the award will confirm for his parents that he has a real job, something he says is not always clear to them.

"Now I have something to show my parents. I can say, 'Look, there are people giving me \$75,000 to support my research.' So that's something. That sounds like a real job to study things far far away from the Earth."

MEDICINE



Daniel Drucker

Right place, right time — Serendipity leads to discovery of life-saving treatments, 35 years later

As a trainee in endocrinology at the University of Toronto in 1984, [Dr. Daniel Drucker](#) was sent to Boston to do thyroid research at Massachusetts General Hospital.

“But when I arrived there was really no room on that project,” he says. “So they put me on this glucagon gene project. I thought the folks in Toronto weren’t going to be happy about this.

“I didn’t really know enough about the project; I was very junior and I did what I was told.”

That unplanned assignment turned out to be the ground floor of research leading to treatments for obesity and intestinal failure, as well as drugs that reduce the rates of cardiovascular death. And for Dr. Drucker, now professor of medicine at the University of Toronto, and two colleagues — Dr. Joel Habener, Harvard Medical School and Dr. Jens Juul Holst, University of Copenhagen — it also led to the \$500,000 [Warren Alpert Foundation Prize](#) for 2020.

The three identified a family of glucagon-like peptides and went on to lead this field of metabolism research. Their work unlocked the mysteries of gut hormonal signaling pathways that regulate the flow of blood sugar, which can affect the function of all organs.

“It was serendipity, being in the right place at the right time, and then sticking with it over 30 years.”

Their discoveries also hold hope for treatments for liver disease, Parkinson’s and Alzheimer’s.

“To take a basic science discovery and translate it to medicine is like a one-in-10,000 thing. To be honest, we thought these hormones were really cool and we hoped that one day this could happen, but it wasn’t really until 15 or 20 years ago that we talked about the idea that maybe they could someday be medicines to treat human disease.”

While winning such a prestigious award is “always a cherry on top of all of the hard work,” Dr. Drucker says it’s most rewarding when he meets someone benefiting from these new treatments.

“That is about as good a “wow” as you can get.”

LAW



David Dyzenhaus

Examining law as a tool of oppression and emancipation

If you ask [David Dyzenhaus](#) about the focus of his research these days, the professor of law and philosophy at the University of Toronto will tell you he's trying to make sense of the work he has been doing since 1984. That means working on big questions, like what happens when law is used as an instrument of oppression — or how law can be used against law.

As a winner of the [2020 Guggenheim Fellowship in Social Sciences — Law](#), Prof. Dyzenhaus plans to dedicate more time to his research over the coming year.

The legal scholar grew up in South Africa and studied law and political theory during the height of apartheid. Throughout his studies and research career, he sought to show how fundamental questions of political and legal philosophy are implicated in actual practice.

“I grew up — even though in a privileged group — in a highly authoritarian, highly oppressed society,” Prof. Dyzenhaus says. “Government used the law for its interests but also people used the law as leverage against government.”

His current research project examines how legal orders sometimes conflict with each other, looking at the examples of China; Israel and the Occupied Territories; and the antebellum United States — as exemplified by ‘fugitive slaves.’ In each case, big moral and ethical issues became practical legal problems.

“Looking back in time at the situation in the U.S. before the Civil War, if we divide it into the North and South, there was a huge problem because of the way the constitution entrenched slavery and required that escaped slaves be returned to the South...Should the property rules of the South — which made that person a piece of property — apply, or should the rules of the North apply? That was a situation that northern judges had to try to resolve.”

“That legal problem becomes immensely complicated. This interaction is partly what sparked the Civil War.”

Prof. Dyzenhaus hopes his upcoming work, besides addressing longstanding academic questions, will help inform the work of human rights lawyers around the world.

MUSIC



James Grier

Where manuscript meets music — Studying the origins of musical literacy

[Dr. James Grier](#)'s newest research combines his love of music with his love of manuscripts. The professor of music history at Western University is studying the earliest written music, dating back to the 10th and 11th centuries, to better understand musical literacy — how musicians come to read and perform music.

“In music, what we are really talking about is a very sophisticated system of non-verbal symbolic communication — pictures that mean things,” he says. “How does a skilled musician decode this? How do most musicians go about reading music? It’s not so simple.”

Sight readers, he says, exemplify the complexity. “Professional musicians expend an enormous amount of time and money becoming more efficient readers. They’ve never seen a piece of music before and yet can play it on sight...They perform at a highly automated level.”

Dr. Grier, with the financial support of a 2020 [Guggenheim Fellowship](#) in music research, plans to dig deeper into the mystery of musical literacy.

“I’m interested in medieval things, so I’m looking at where this comes from...It has a lot to do with the church because the church wanted to control how liturgical music was used. So they invented the notation to control the music and procedures.”

But questions remain.

“Why did they invent the symbols they did? How did a skilled performer become educated in these symbols in a monastery? What processes contribute to the translation of those symbols?”

Thanks to the Guggenheim Fellowship, Dr. Grier will be able to more fully explore the answers in the years ahead.

COSMOLOGY



Renée Hložek

Studying the end of the universe

“All of the questions that you lie awake thinking about — how the universe started, what it’s made of, how it’s going to end — that’s my job.” This is how University of Toronto Cosmologist [Dr. Renée Hložek](#) responds when asked what she does.

“I get to ask the questions, which is fun, but I also get to answer them in a quantitative way.” To find those answers, the 2020 winner of the [Sloan Research Fellowship](#) in physics works with telescopes around the world.

“We take a lot of data about the whole sky; we make a map of the sky in different wavelengths and do statistical analysis of what the universe is like: what is it made of, how did stars form, and how is the universe going to evolve in the future.”

Much of this work involves studying the end of the universe.

“People ask me what it is like to study the end of the universe and I find it extremely liberating,” she says. “If I figure out exactly what is going on in the universe, there is still nothing I can do about it. And that to me is kind of liberating.”

In the years ahead, there are a few key questions Dr. Hložek would like to pursue.

“Something is pushing the universe apart faster than gravity can pull it together. We call it dark energy. But we don’t know what it is; we need more data to figure it out.”

She’s hoping some of the answers will come from an international collaboration she is part of, called the Reuben Observatory, and access to a major new telescope in the U.S. that scans the sky every two or three days.

“We would go from having a little data on stars and the sky to having data on millions of objects...We can learn so much more about the properties of this expansion.”

“I’ve kind of been waiting my whole life for this.” The observatory is expected to start generating data in a year or two.

Funds from the Sloan Fellowship will allow Dr. Hložek to attract new talent to Canada and to her lab.

MEDICINE

Photo Credit: Michael Holly
Copyright: @University of Alberta



Michael Houghton

Canada's newest Nobel Laureate contributing to solving global health problems

It was the middle of the night on Oct. 5 when University of Alberta professor [Dr. Michael Houghton](#) learned he and his collaborators were the Nobel Prize winners in Physiology or Medicine for 2020. Dr. Houghton won the Nobel along with scientists Harvey Alter and Charlie Rice for their significant contribution to the fight against blood-borne hepatitis, a major global health problem that causes cirrhosis and liver cancer in people around the world.

Dr. Houghton said he tried to go back to sleep after the 3 a.m. call from a colleague but failed. “In the end I gave up,” he said in an interview with Adam Smith of [Nobelprize.org](#). “And then... [I] got on email and there’s hundreds and hundreds of emails, which is all very nice of course.”

The three scientists discovered the hepatitis C virus (HCV), which causes 400,000 global deaths a year, in 1989.

After their discovery, protecting the blood supply from transmission was job one. The scientists quickly developed a blood test and by 1992 the virus was virtually eliminated from the blood inventory in the developed world.

Their attention then turned to therapeutics. “It took... the whole field and the pharmaceutical industry working for more than 20 years. But eventually, we’ve got these wonderful drugs now that can cure nearly everybody quite quickly and safely.”

Still, HCV remains a global epidemic. “So...the way eventually you have to control an epidemic like this is with a vaccine,” he said. “After many years of work, I think our field feels that it is now feasible...at the University of Alberta I’ve been working on an improved version that we think has a good chance of success, or at least being partially effective.”

Dr. Houghton was recruited to the University of Alberta in 2010 as the Canada Excellence Research Chair in Virology in the Li Ka Shing Institute of Virology. Two years later, he and his team developed a vaccine for the virus known to cause cirrhosis, end-stage liver disease and liver cancer. The vaccine is now in late-stage testing.

He is also leading an effort to [produce a vaccine for COVID-19](#).

Dr. Houghton said he became interested in microbiology when was 17, “having read about Louis Pasteur’s life and his work, so he was my inspiration.” In terms of what drove his work, especially during years of frustration, he said it wasn’t the promise of awards or accolades. “It’s nice, but what counts for me more is that we’ve been able to prevent millions of hepatitis C infections that otherwise would have occurred through the blood supply. Prizes are very pleasant, but they’re only prizes. I’m much more happy when we can actually intervene with patients and prevent people from getting infected or provide a cure for them.”

BIOLOGY



For [Dr. Claire Kremen](#), the loss of biodiversity is comparable to the existential threat of climate change.

“We wouldn’t be able to eat without the many species that support food production,” The University of British Columbia conservation biologist says, referring to creatures from micro-organisms to insects. “We wouldn’t be able to breathe without biodiversity and we wouldn’t have clean water without it — it is doing all kinds of critical things for our survival.”

But many human activities have a huge negative impact on organisms we need in our ecosystem, and unnecessarily so.

Dr. Kremen’s research on maintaining and enhancing biodiversity “is not only for biodiversity’s own sake, but also to help humanity,” she says. Her effort to find ways agriculture can feed humanity while protecting biodiversity has been recognized with the 2020 [Volvo Environment Prize](#).

After completing her PhD in insect metamorphosis, Dr. Kremen says biodiversity became her “big issue.”

She worked for more than a decade with conservation organizations in Madagascar, before making the move to Stanford University in California, where she focused on how agricultural practices affect native pollinators, and what farmers and citizens can do to protect and preserve native pollinators on and around farms.

Claire Kremen

Feeding humanity while protecting biodiversity

“I have come to the realization that agricultural sustainability depends on maintaining these organisms that provide ecosystem services ... and that is very much determined by a combination of what the farmers do on their land to promote those services, and also what happens in the larger landscape around the farm,” she explains.

Dr. Kremen says there remains a “false understanding” that conservation measures are “lower-yielding or not economically viable.”

For example, Kremen’s work with colleagues has shown that 75 per cent of crops we consume are more productive due to visits from pollinators, and that native pollinators are particularly important in providing these services.

Promoting a mixed landscape that includes native vegetation supports these pollinators and can boost crop yields for these crops.

This habitat can also help farmers reduce insecticide use, by providing habitat for the insect and bird predators of crop pests. Rather than relying solely on insecticides, she suggests farmers use the “power of nature” for natural pest control, also allowing farmers to cut their costs.

The Volvo award, valued at more than \$220,000, brings increased attention to biodiversity and agricultural reconciliation.

“It gives much more credence...to this positive notion that we can manage our working landscapes much more sustainably, and still be productive and provide good livelihoods.”

The prize money will go towards the development of a new interdisciplinary biodiversity solutions program she leads at UBC.

COSMOLOGY



Adrian Liu

Building a 3D map of the universe

The vast majority of our universe remains unexplored, but [Dr. Adrian Liu](#) is working to change that. A cosmologist at the McGill Space Institute, he leads a team developing the largest-ever three-dimensional map of the universe.

“By using data from a new generation of radio telescopes, I seek to understand how the first stars and galaxies formed,” he says, “with the eventual goal of mapping an unprecedentedly large volume of our observable universe.”

Dr. Liu is a 2020 recipient of the [Sloan Research Fellowship](#).

This mapping will enable scientists to probe the fundamental nature of the universe and how it came to be. “For instance, were first-generation galaxies similar to the galaxies that we see today, in terms of their masses and luminosities in UV and X-rays? Or were they substantially different? How did these galaxies form? And when they formed, how did they affect their surroundings? These questions all feed into the larger goal of understanding galaxy formation.”

Dr. Liu’s work involves mapping the distribution of neutral hydrogen atoms, which emits faint radio waves. Observations with large radio telescopes enable the construction of a 3D map.

“Although such an ambitious program will take decades to complete using multiple instruments, there are plenty of questions for us to tackle now. For one, what does one do with such a vast map of our universe?”

Dr. Liu says his research “sits at the boundary between astrophysics and cosmology, as well as the boundary between observations and theory.”

ASTRONOMY

Photo Credit: Erich Saide



Christian Marois

Searching for planets beyond our solar system

In the global race to take pictures of ever-fainter and lower-mass planets, [Dr. Christian Marois](#) and his team at the National Research Council of Canada (NRC) will soon have a competitive advantage. The accomplished astronomer has won the 2020 [Guggenheim Fellowship](#), and the prize money will pay for sophisticated equipment the team needs to advance its work.

Dr. Marois, a researcher at the NRC Herzberg Astronomy and Astrophysics research center in Victoria, looks for exoplanets — planets similar to those in our own solar system orbiting around other stars. But seeing those planets requires eliminating the brightness of the star — just as our own sun sometimes makes us squint to see objects in front of us.

The new equipment is for testing new instrument ideas that they hope will help better block out those bright lights, so they can clearly see small exoplanets orbiting around them.

When Dr. Marois talks about his work, it sounds like it's not work at all, but more like he's living a dream. "Astronomy has been a passion for me since I was a child," he says. "I was always curious about it."

"I remember when I was about five years old, wondering why we see the moon in daylight. In most kids' books the moon appears at night. Then I started wondering about the sky. I remember seeing an eclipse through a shoebox my mother made for that purpose in the '70s."

When he entered grad school, this field was just starting. "Before then, in the '70s and '80s, people were skeptical at the idea of trying to find planets around other stars."

Over the past 25 years, Dr. Marois and his team have made some big discoveries. "We're still at the Jupiter-ish level, not yet at Earth-size level," he says of the size of planets they can study. They're also limited to younger planets whose glowing energy makes them easier to detect.

The researchers hope more advanced instruments will help them see older and lower mass exoplanets, toward studying more Earth-like planets when 30-m diameter telescopes will be operational in the next decade.

"The Guggenheim is a big deal for us because it allows us to take what we have been working on to go to the telescope and validate these results...a crucial step to enable the technologies needed to detect life on an exoplanet a decade from now."

ANTHROPOLOGY



[Dr. Shaylih Muehlmann](#) looks well beyond the news headlines in researching the [war on drugs](#) in Mexico. The anthropologist and Canada Research Chair in Language, Culture and the Environment at The University of British Columbia studies the impact of the violence on everyday life.

“The violence affects everyone, not just criminals,” she says.

As a 2020 winner of the [Guggenheim Fellowship](#), Dr. Muehlmann is now able to advance this work, with a focus on the war’s impact on women.

“Tens of thousands of women are searching for missing loved ones because of this,” says Dr. Muehlmann. “Looking for them, you would think would be the role of the state and police, but in Mexico the extent of government corruption leaves this up to these women. They are incredibly inspiring women.”

Dr. Muehlmann’s current focus stems from her earlier work on water scarcity.

Shaylih Muehlmann

Researcher inspired by resilience of Mexican women

“When I first went to Mexico, my research was about the impact of water scarcity in a fishing village, where the Colorado River used to end,” she says. “I found that people who couldn’t fish anymore were turning to other things for income. For youth, it was one of few modes of upward mobility. And I was really astounded to see the extent to which that was impacting the community and culture.”

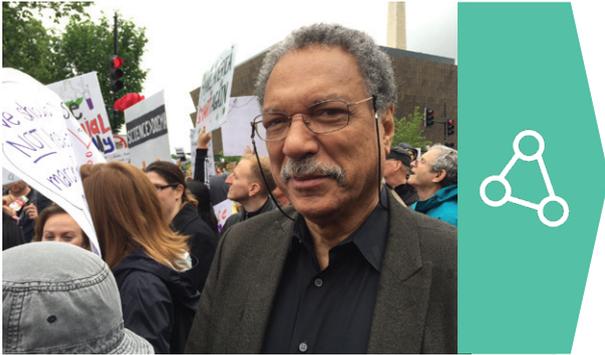
“Kids in the village would listen to songs about narcotics traffickers. People would wear pendants to the patron saint of narcotics traffickers. The traffickers often support poor villages and build churches etcetera. It was a big part of the way people were surviving.”

“I saw how fearful everyone was and meeting these women really impacted me,” she says. “They have lost so much...yet they are so fierce and resilient.”

Funds from the fellowship will allow Dr. Muehlmann to complete a book about her research and do more field work.

“On another level, [winning the Guggenheim] is just immensely encouraging,” she says. “Especially working on a topic that can seem very dark.”

BIOLOGY



Daniel Pauly

Using data to fight back against overfishing

Overfishing threatens the world's fish stocks. Fixing the problem requires comprehensive data on catches, which has traditionally been missing in official records. The University of British Columbia Professor [Daniel Pauly](#) — the most-cited fisheries scientist in the world — has dedicated much of his career to changing that.

A 2020 winner of the [BBVA Foundation Frontiers of Knowledge Award in Ecology and Conservation Biology](#), Dr. Pauly — founder of the [Sea Around Us](#) project at The University of British Columbia — has spent his long career exploring the worldwide decline in fish stocks. In announcing the award, the BBVA Foundation highlights his “seminal contributions to our understanding of the world's oceans, and their efforts to protect and conserve marine biodiversity and oceanic ecosystem services in a rapidly changing world.”

Fisheries data has fallen short in the past by excluding information about catches by small-scale fisheries, the catches of women, illegal fishing and discarded fish, recreational fishing and close inshore fisheries.

“Countries send in their industrial catch,” Dr. Pauly says of official data provided to traditional databases. “It's also true for Canada. We send nothing from the Arctic.”

To address the shortcoming, Dr. Pauly drew on global networks he built during his many years at the International Center for Living Aquatic Resources Management in the Philippines, asking contacts around the world to produce a complement to the official data.

“On the basis of this data we built a huge database and a website (www.seaaroundus.org) which document more realistically than official data what is happening in the fisheries in the world.”

The results showed stocks declining more than official stats indicated and the data, now freely available, helps countries see the overfishing taking place off their shores.

The *Sea Around Us* database and website are built on top of another of Dr. Pauly's major achievements, i.e., a database and website called FishBase (www.fishbase.org), an online encyclopedia of 40,000 fish species — and a “monster success,” attracting millions of users monthly.

In the years ahead, Dr. Pauly says he will focus on keeping the *Sea Around Us* and FishBase going. “We have millions of users for our free products” he says of projects that jointly rely on 75 full-time staff around the world. “I have to maintain that and that keeps me going.”

OCEAN SCIENCES



Chelsea Rochman

Advancing research on microplastics in water

Winning the [Sloan Research Fellowship](#) in ocean sciences will allow [Dr. Chelsea Rochman](#) to further explore how microplastics move through water systems and impact organisms.

The University of Toronto ecologist began her research by looking at plastics in the middle of the ocean. She learned that most of them were microplastics.

“Microplastics are found across nearly all ecosystems, and ingested by hundreds of species. I am interested in how they reach remote ecosystems and how they impact creatures.”

Dr. Rochman’s interest in waste and the dangers it poses started in childhood. “I was the kid who volunteered for recycling programs and picked up litter. It was my passion.”

As an undergraduate, she had a study abroad experience in Australia, focused on marine ecology. “We learned about a garbage patch in the middle of the ocean in 2006. At that time there was very little science on the topic. I decided to get a PhD to work on this issue, and then never left the academy.”

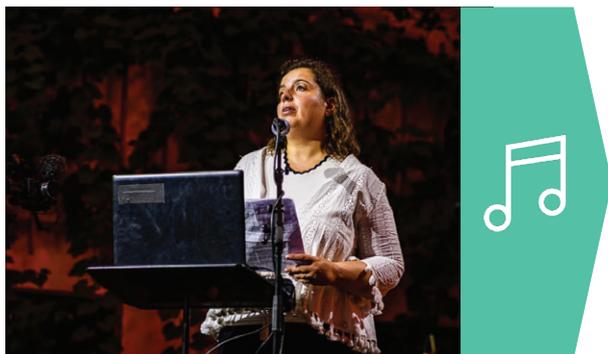
In the years ahead, she plans further work on how plastics pollution impacts ecosystems and intersects with other stressors like climate change.

Thanks to the Sloan Research Fellowship, she will conduct some of this research at the Experimental Lakes Area freshwater facility in northern Ontario. In this research space, Dr. Rochman can examine the whole ecosystem experience.

“We can manipulate an entire lake and see how microplastics move through the ecosystem and affect organisms there.”

She says awards like the Sloan Fellowship “give you freedom with a pot of funding to pursue questions that are important to you. It’s empowering because it signals you are trusted.”

MUSIC



Anna Shternshis

Reviving lyrics penned by Holocaust victims

“Some of the first grassroots documents about Nazi atrocities against Jews in the Soviet Union were songs,” explains [Dr. Anna Shternshis](#), AI and Malka Green Professor of Yiddish Studies at the University of Toronto. For the past five years, she has been resurrecting Yiddish music composed during the Holocaust. “These songs were written by witnesses, sometimes written by victims who never got to tell their stories because they were killed.”

“Following the collapse of the Soviet Union, a lot of new materials became available to researchers — including songs written in Yiddish by prisoners in ghettos and concentration camps in Ukraine,” she says. “Sometimes moments before they were shot, they wrote songs.”

These songs were originally collected from 1944 to 1947 by Moisei Beregovsky, an ethnomusicologist at the Ukrainian Academy of Science. After the war, he was accused of fostering Jewish nationalism, was arrested and the work was confiscated. He died in 1961 thinking his work was lost forever, but the documents were rediscovered decades later in the Vernadsky National Library of Ukraine in Kiev.

When Shternshis began working with the materials, her goal was to bring stories of people who lived through horror of the Holocaust “in their own voice.”

Dr. Shternshis began her SSHRC-funded project to research Yiddish culture in Nazi-occupied regions of the Soviet Union. The songs were premiered at an academic conference at the University of Toronto in the Spring of 2015. Seventeen pieces were later featured on an album *Yiddish Glory: The Lost Songs of World War II*, which was nominated for a Grammy Award in 2019. This was just the second time in history that a Yiddish language recording received such an honour from the Recording Academy.

The following year, Shternshis received the [Guggenheim Fellowship](#) for her research on Yiddish songs written by children under the Nazi occupation in Ukraine.

Funding from the Guggenheim Fellowship will allow Dr. Shternshis to take time off to write a book and create a website with recordings of the songs in many languages, as well as images of the original Yiddish lyrics, something she hopes will allow these long-lost works to reach new audiences.

CHEMISTRY



Douglas Stephan

Changing the world of chemistry

[Dr. Douglas Stephan](#) is a 2020 winner of the [Guggenheim Fellowship](#) for ground-breaking research that amounts to a new way of thinking about chemistry — with applications that are only starting to be realized.

“Generally, when you react an acid with a base, they form water. There are molecules that have both acidic and basic properties, and generally when they react they do the same thing; they form an interaction with each other and after that don’t do anything. But we asked, ‘What happens if we make these molecules so big that they can’t get together?’ They are frustrated [known as Frustrated Lewis Pairs]; they can’t get together. And they have to get rid of their potential energy somehow. So they react with other molecules.”

“So that’s what we discovered, that they could react with other molecules and do things that people would never have expected.”

Up until the time Dr. Stephan and his team made the discovery in 2015, it was thought that a metal was required to have a reaction with hydrogen. “We showed that you could do this with very simple molecules.”

“So it was a complete change in chemical dogma.”

The discovery is already garnering interest from industry.

“We’re seeing the interest in applications, particularly in the pharmaceutical industry,” he says. “When you make a complex drug, you use a metal catalyst to make it and then you have to get rid of that metal because it’s toxic. So companies spend about 70 per cent of their production costs on this purification. It’s a huge saving if they can avoid using metals altogether.”

“What’s been really gratifying is to see the international uptake of this concept; people are applying it in ways I would never have dreamed of. In the U.K. they’ve made plastics based on Frustrated Lewis Pairs.”

The discovery isn’t just limited to hydrogen. Dr. Stephan says it can work with CO₂ as well. “It’s a concept that has much broader implications.”

The Guggenheim award will allow Dr. Stephan and his team to build on this research in tackling some very challenging — and longstanding — chemical problems.

BIOLOGY



Jennifer Sunday

Tracking ocean species through the markers they leave behind

Considering [Dr. Jennifer Sunday](#) “grew up on the ocean” on Canada’s west coast, it is not surprising she has a deep connection to those waters and their inhabitants.

“It is the piece of nature that I got to know and fell in love with,” she says.

An associate professor and William Dawson Scholar in the Department of Biology at McGill University in Montreal, she heads [The Sunday Lab](#), which focuses on understanding how climate and global change affect biodiversity distribution.

In recognition of her research, Dr. Sunday is a [2020 Alfred P. Sloan Research Fellow](#). The award, valued at \$70,000 over two years, will help hasten her team’s development of technology to predict what species were found in an area by studying the environmental DNA (eDNA) they leave behind in water samples.

“There is a high level of complexity in species’ responses to climate change — it is seemingly unpredictable and yet there is science,” Dr. Sunday says. The lab uses data synthesis, theory and controlled experiments to understand how species’ range shifts impact people, and how conservation practices can mitigate those impacts. “We can make predictions and see them come through.”

“We don’t know what we are going to need to conserve — unless we can predict where everything is going to be,” she explains.

The Sloan award, she says, means they “can get [this work] off the ground at a much bigger level than we could have otherwise” through new technologies to speed up data collection related to “species distribution and their response to climate change.”

That includes, she says, testing theories that will allow the team to make better predictions.

PHOTOGRAPHY

Photo Credit: Brent Foster



Larry Towell

Photographer's work tells stories of displacement

"If there's one theme that connects all my work, I think it's that of landlessness; how land makes people into who they are and what happens to them when they lose it and thus lose their identities."

This is the introduction to photographer [Larry Towell's](#) profile page on [Magnum Photos' website](#).

The Canadian photographer, poet and oral historian — well known for his photographs of political conflict in the Ukraine, Nicaragua, El Salvador, Standing Rock, Palestine and Afghanistan — is a winner of the 2020 [Guggenheim Fellowship](#) in Creative Arts — Photography.

In 1988 Towell was the first Canadian accepted into Magnum Photos, the international photographic cooperative founded in 1947 by Robert Capa and Henri Cartier-Bresson. He became a full member in 1993.

Towell has had photo essays published in *The New York Times*, *Life*, *Rolling Stone* and many other international magazines.

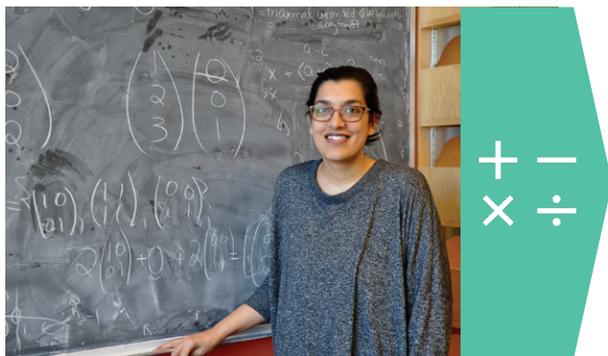
He works in both film and digital photography formats. He has said, "Black and white is still the poetic form of photography. Digital is for the moment; black and white is an investment of time and love."

From 2008 to 2011, he traveled five times to Afghanistan to photograph the social effects of the civil war.

In 2015 his photo [Isaac's First Swim](#) was published by Canada Post as a stamp.

Towell has published 14 books of photographs, poetry and oral history with two new books coming out in 2021 and one in 2022. He has also recorded several audio CDs of original poetry and songs.

MATHEMATICS



Ila Varma

Award will help mathematician advocate for equity in STEM disciplines

University of Toronto professor Dr. [Ila Varma](#), winner of a 2020 Sloan Research Fellowship (mathematics), pursues longstanding questions in arithmetic statistics — questions that have stymied mathematicians since the 18th century.

In short, her work is about studying whole numbers, the integers. And it goes back to what we all studied in elementary school.

“We learn in elementary school that we can take any whole number and factor it into its prime components,” she says. “So one of the main focuses of number theory, what my research tends to shed light on, is about number systems that act like integers but are a little bit more complicated.

“We can define a notion of primes in these bigger number systems and we ask how often every element can be factored into these generalised primes. We are trying to understand fairly fundamental things!”

“What attracted me to this field really was this idea that there are these unsolved mysteries related to the math that we studied as kids,” says Dr. Varma. “I view what I

do as ‘thinking deeply about simple things.’ But simple doesn’t mean easy. These questions are fundamental in nature because they come from the interaction of addition and multiplication.”

She plans to use the [Sloan Fellowship](#) funding to add to her team working on these problems, and to increase her work around diversity and equity in mathematics. In particular, Dr. Varma is concerned about mathematical culture in departments that disproportionately affects people from marginalised backgrounds interested in studying mathematics and related disciplines. She’d like to help remove barriers in mathematics that have been identified by social scientists to cause underrepresentation in STEM fields.

“At the end of the day, mathematics relies on a human community, it’s a human endeavour,” she says. “The most diverse ideas are going to be the ones solving problems in mathematics, so we should have space for everyone to do the types of mathematics that they want to do.”

FILM



Shannon Walsh

Guggenheim helps documentary filmmaker advance fictional project

Dr. Shannon Walsh — filmmaker, writer and associate professor in the Department of Theatre and Film at The University of British Columbia — is a 2020 winner of the Guggenheim Fellowship for her outstanding storytelling through film.

She has written and directed four award-winning feature documentaries: *Illusions of Control* (2019), *Jeppe on a Friday* (2013), *À St-Henri, le 26 août* (2011) and *H2Oil* (2009), as well as numerous short films.

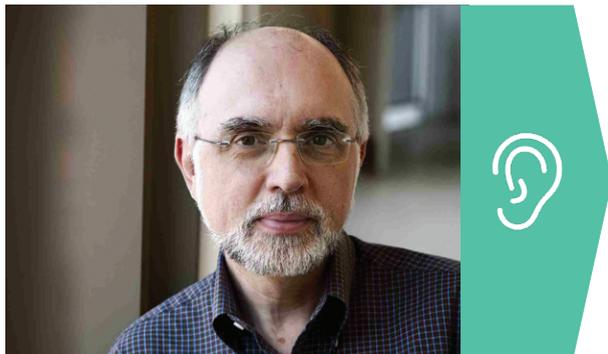
Dr. Walsh is currently finishing a documentary about the gig economy, *The Gig is Up*, and how it impacts the world of work. “I like to dive into a range of social issues and bring them into public view,” she says. Some of her past work focused on devastated landscapes of the world, including Alberta’s oil sands.

The Guggenheim Fellowship will support her upcoming fictional film, to be shot in 2023.

“I’m definitely interested in untold stories and being able to understand the world in which we live and the social issues around us through the details of everyday life,” she says. “I’m interested in trying to bring to light ways in which we might change the world around us, really taking into account the people who are most affected. I think that’s a thread that runs through all the work that I’ve made. It’s a huge part of what drives me and what interests me.”

About winning the Guggenheim, Dr. Walsh says: “They are endorsing you as a maker and I think that is such a huge honour, where they are saying we trust your artistic process... It asks of me to live up to the award.”

NEUROSCIENCE



Robert Zatorre

Music and the brain: pursuing applications for healing

[Dr. Robert Zatorre](#) is a cognitive neuroscientist at McGill University who also happens to be a musician. That positions him well to use music to understand how the human brain works.

And winning this year's [C.L. de Carvalho-Heineken Prize in Cognitive Sciences](#), valued at US\$200,000, will help him advance this work.

“We have found that music actually activates the same circuitry in the brain as other biologically important stimuli, like food and sexual activity. And similarity with certain addictive kinds of drugs. Music acts upon the same systems.”

Dr. Zatorre's lab looks at the basic science behind these interactions: the circuitry of the brain and its fundamental properties. His research points to interesting potential applications.

For example, Dr. Zatorre is currently studying how the phenomenon of music-induced reward in the brain could be used to develop techniques for people with problems regulating their reward system. For example, those with Parkinson's often have a motivational problem that can lead to depression.

“We want to see if we can help them to use music to help them motivate their emotions,” he says. “The idea is to use a brain signal to make music sound better.”

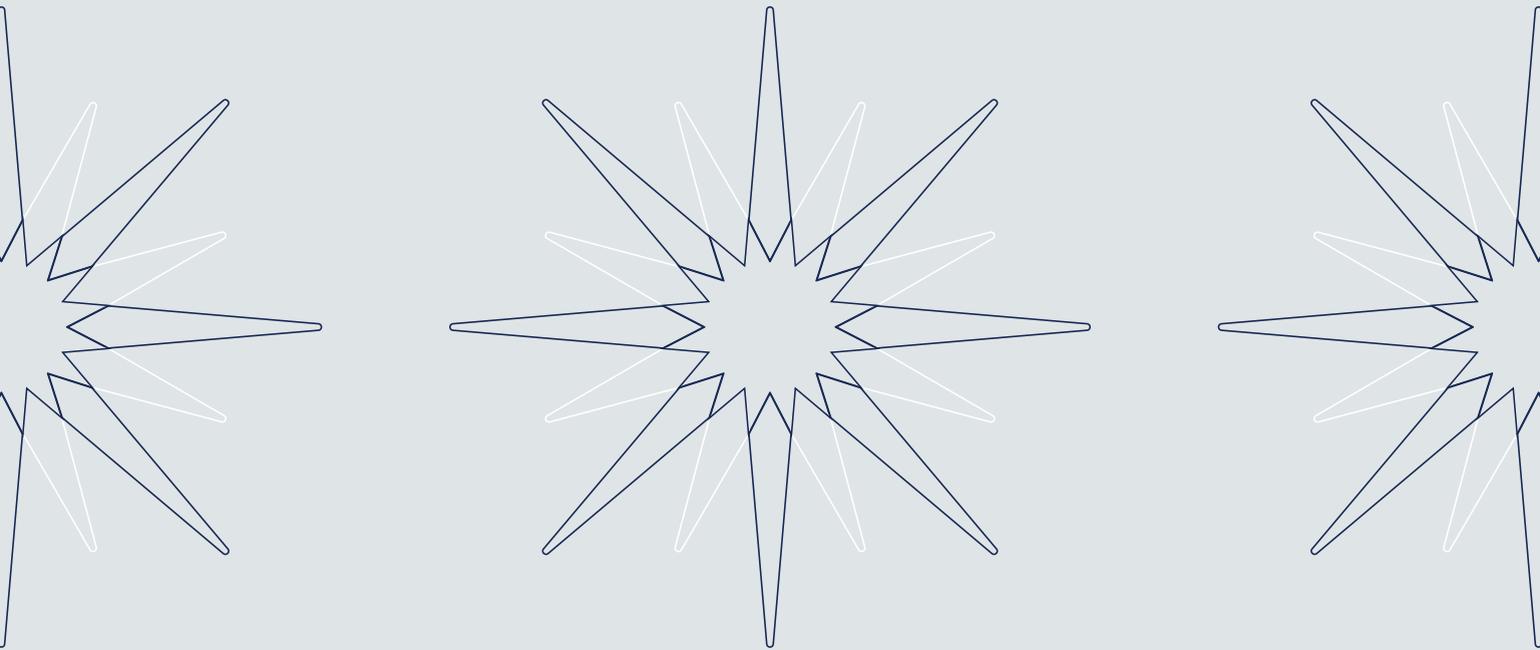
Dr. Zatorre is proud to see many of his former student researchers working on other applied problems. “One is working on using music-assisted feedback for stroke rehabilitation,” he says. “Movement of the body and the sounds produced are closely linked. She is researching how that knowledge could be harnessed to improve the movement patterns of stroke patients.”

The C.L. de Carvalho-Heineken Prize in Cognitive Sciences is a personal award, meaning there are no restrictions on how the money is used. Dr. Zatorre has decided to put it into a research fund that will allow him to hire more young researchers to help advance this work.

“I can use it for whatever crazy idea I might have,” he says. “I don't have to ask anyone's permission. And that's the best science...The greatest discoveries were all because someone had a crazy idea.”

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