Canadian excellence, global recognition

Canada's 2023 winners of major international research awards

Universities Canada.

One of the best ways to encourage this generation – and future generations – of Canadian researchers is to celebrate their achievements and recognize the important work they do every day. I am honoured to congratulate the 21 Canadians who won major international science and research awards handed out across the globe in 2023.

This year's winners are working at the cutting edge of their fields to fuel the breakthroughs of tomorrow across a variety of specializations. From quantum science to artificial intelligence, from climate change research to psychology and mathematics, these honorees are helping to improve the lives of Canadians, while working on discoveries that will make Canada a leader in the global economy.

The Government of Canada is committed to supporting scientists and researchers by creating a robust science and research base in Canada – one that supports the research community and first-class researchers as they tackle some of the world's toughest problems.

The winners of these awards show the importance of a strong Canadian science and research community and the big impact Canadians are having on the global stage.

Acknowledging and honouring researchers in Canada is critical to fostering a culture of innovation and lighting the way for the next generation. I am grateful to be able to celebrate the achievements of these talented individuals that are showing the rest of the world what Canada can do.

Simon Kennedy

Deputy Minister, Innovation, Science and Economic Development Canada

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SLOAN FELLOWSHIP

Jimmy Ba

Developing learning algorithms for better problem-solving machines

Computer scientist Jimmy Ba is working to address a big AI question: How can we build problem-solving machines that are more human-like in their efficiency and adaptability?

"I try to understand and build reliable, generally intelligent machines to help us understand the world better," he explains. Dr. Ba's research has had a major impact in the field of deep learning and garnered him the 2023 Sloan Fellowship.

"Getting these machines to understand our human values is probably the hardest part," he says of the challenge. "This is the hardest technical challenge our entire species will ever face." Dr. Ba develops efficient learning algorithms for deep neural networks. He has also addressed the computational cost of training ensembles of neural networks, contributed to fundamental reinforcement learning algorithms and advanced computer scientists' theoretical understanding of deep neural networks.

On winning the **Sloan Fellowship**, he is quick to thank his students and colleagues, "who have propelled me to where I am." He describes the fellowship as "a very exciting opportunity."

Dr. Ba received his PhD from the University of Toronto, where he was supervised by professor emeritus Geoffrey Hinton, often called the godfather of AI.

EDUARD RHEIN FOUNDATION
TECHNOLOGY AWARD

Gilles Brassard

Computer scientist wins the Eduard Rhein Foundation Technology Award for work in quantum informations

Université de Montréal Professor Gilles Brassard, inventor of quantum cryptography with Charles H. Bennett and one of the world's earliest pioneers of quantum information science, has been awarded the **Eduard Rhein Foundation Technology Award** for outstanding achievements in research and development of information technology.

The computer scientist shares the 40,000€ prize for 2023 with co-winner and colleague Dr. Bennett "for the conception of the first key agreement protocol whose security is derived from the validity of quantum physics."

In 1984, Prof. Brassard and Dr. Bennett, a chemical physicist, developed the first quantum cryptography protocol – an unbreakable encryption scheme – to protect data communications.

The significance of their work became clear a decade later, when Prof. Peter Shor, a mathematician, discovered that a hypothetical quantum computer could penetrate the cryptographic systems currently used to protect internet communications.

Data communications systems didn't collapse following Prof. Shor's discovery, because a quantum computer has not yet been built (as far as we know). But technology has rapidly advanced, Prof. Brassard notes, and a quantum computer will eventually become a reality.

When that finally happens, quantum cryptography will be the only guaranteed way to protect online communications, including our financial information systems. Essentially, Prof. Brassard and Dr. Bennett had developed a cure before the ailment was discovered.

Today, "quantum cryptography is on the rise," Prof. Brassard says of the current impact of the discovery. "It's more and more widely studied, implemented and used, even in real life now, particularly in China where a ten-thousand-kilometre quantum cryptographic highway is already in place. Nobody would have predicted this when we made the invention."

In 1992, Prof. Brassard and Dr. Bennett, along with their collaborators (including Prof. Claude Crépeau at McGill University), invented the concept of quantum teleportation. This phenomenon, confirmed experimentally by other researchers a few years later, is at the core of the entire theory of quantum information.

Prof. Brassard was a mathematical prodigy, beginning a bachelor's in computer science at 13. His numerous past awards include the Wolf Prize in Physics, considered second only to the Nobel Prize, the BBVA Foundation Frontiers of Knowledge Award in Basic Sciences and the Breakthrough Prize in Fundamental Physics.

DAN DAVID PRIZE

Elise Burton

Researcher explores history of Middle Eastern genetics

Elise Burton researches the history of the life sciences in the broadest terms, but she is especially interested in how people understand their own ancestry, their relationships to other people in the world and their places in society.

"People are actually now quite familiar with the idea of genetic ancestry testing and the various companies that do that kind of testing," says the University of Toronto historian. "People will sort of take those results at face value, and they'll will take it very seriously. They think that this is science, but as a lot of people within my broader field will tell you, this is actually kind of a form of astrology; it's not too different from the way that horoscopes work."

Dr. Burton's work looks at this problem farther back in history, particularly in the Middle East region. "These ideas actually go back over 100 years. They were originally based on technological approaches that we would now consider outdated, flawed and related to racist and discriminatory ways of thinking."

In support of her work, Dr. Burton has been named a 2023 winner of the prestigious **Dan David Prize**, the world's largest history award. She is one of nine recipients from around the world to receive the $300,000 (USD) prize in recognition of their achievements and to support their future research and teaching.

Popular methods of studying human genetics in the past included measuring skull shapes and testing blood types, for example. "In the 1920s and 30s, this

was cutting-edge science," she says. And while some people may think of ancestry tests today as just for fun, Dr. Burton looks at their darker side in historical contexts.

"There are actually very serious political implications" to the fact that people believed that one's identity and ancestry can be defined purely in genetic terms, she explains. "So that's where my work gets complicated."

Dr. Burton links the histories of these beliefs to big political movements and nationalist ideologies in the Middle East, related to the emergence of "very discriminatory policies like citizenship laws – who gets to be a citizen of a certain country. And that means forms of ethnic cleansing."

She sees her work as important in promoting "good and socially aware science" today as well, because there is always a risk of discrimination due to the misuse of DNA testing and potential harms from the categorization of people in ethnic terms in scientific research.

The prestigious Dan David Prize brings together an international cohort of judges, experts in different fields, from all over the world. "So I think it's very meaningful to have your research recognized in this way, by people who are mostly not specialists in my own field."

SLOAN FELLOWSHIP

Saurabh Chitnis

Synthetic chemist addresses paradox of move away from fossil fuels

As a synthetic chemist, Saurabh Chitnis makes new molecules that can make our daily lives easier. It's fundamental research with huge possibilities for the move away from fossil fuels.

Specifically, the Dalhousie University researcher and his team make molecules that are useful in two areas of life: industrial manufacturing and new materials. In recognition of the promise of his work, Dr. Chitnis is a 2023 recipient of the **Sloan Fellowship**.

Making objects typically requires a catalyst. "There's a process that turns A into B, and we can develop a catalyst that lowers the energy cost of that," he explains. "And that's important because energy is emissions, energy is dollars."

When it comes to making new objects, Dr. Chitnis points out that "any object that is made out of plastic was, at one point, a dinosaur. Because they are made from fossil fuel-based precursors. This is a problem because we're divesting away from fossil fuels.

"If we're turning away from fossil fuels for energy, but we also get all our materials from fossil fuels, then we have a paradox. We want to turn away from burning fossil fuels for energy, but we don't want to eliminate fossil fuels entirely. Because what's the point of having all the free energy in the world if you don't have a chair to sit on?"

To solve the problem, Dr. Chitnis is developing molecules that allow the manufacture of polymers, like polyethylene, out of air. "It's basically capturing nitrogen from the air and turning that into a chair, for example," he says. But first they have to ensure that chair won't explode.

"Typically, molecules made out of nitrogen tend to explode, because they want to go back to being oxygen and nitrogen gas," he says. "So nitrogen as a basis for making materials is not a thing; nobody wants a chair that's going to blow up. What we discovered, or what our key insight was, is how to make stable nitrogen-rich molecules. If you can make stable nitrogen-rich molecules, you've suddenly opened the door to using the nitrogen gas all around us, converting it into useful materials."

Dr. Chitnis says he was thrilled to win the Sloan Fellowship, which recognizes fundamental science with the potential for a transformative influence on the world. "To me, there was a validation in that. It really puts a lot of wind in our sails. It tells us that we're doing something good."

BBVA FOUNDATION FRONTIERS OF KNOWLEDGE AWARD

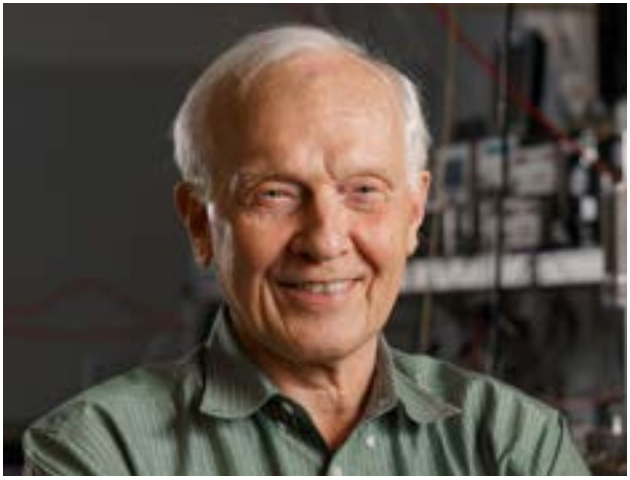
Paul Corkum

Physicist's groundbreaking work in attosecond science garners BBVA Foundation award

Paul Corkum has won the prestigious **BBVA Foundation Frontiers of Knowledge Award in Basic Sciences** for his pioneering work in the development of a type of physics called attosecond science. He shares the award with European physicists Ferenc Krausz and Anne L'Huillier.

The University of Ottawa researcher and his colleagues have shown how to observe and control the motion of electrons in atoms, molecules and solids with ultrashort light pulses on time scales of about one hundred attoseconds. One attosecond lasts one billionth of a billionth of a second – approximately the time for light to travel across an atom.

"We've learned how to make the fastest measurements in the world; the fastest measurements that humans can make by a factor of 100 over what it was before," he explains. "In the process, we found a way to force lasers to make soft x-rays, where you would not use lasers before – you would have used something more complicated." This time scale was previously inaccessible to experimental studies due to the lack of light pulses with short enough duration.



"These groundbreaking contributions have opened exciting new frontiers in different areas, including atomic physics, photochemistry and materials science," said the BBVA Foundation award jury in announcing the winners.

Dr. Corkum is a principal research officer at the National Research Council Canada (NRC) and co-director of the NRC-uOttawa Joint Centre for Extreme Photonics. In 2022, Dr. Corkum won the Wolf Prize in Physics, along with Drs. Krausz and l'Huillier.

In his acceptance speech at the BBVA awards ceremony in Spain, Dr. Corkum thanked numerous Canadian institutions that have supported his work, including the NRC, the Natural Sciences and Engineering Research Council, the Canada Research Chairs program and the Canada Foundation for Innovation.

HARVEY PRIZE

Pieter Cullis

Biochemist's groundbreaking work on mRNA vaccines holds promise for cancer treatments

Pieter Cullis' pioneering work that contributed to the highly effective COVID-19 mRNA vaccines continues to garner global recognition. The University of British Columbia biochemist won the prestigious **Harvey Prize** alongside collaborators Katalin Karikó and Drew Weissman from the University of Pennsylvania.

The three developed nucleoside-modified mRNA and lipid nanoparticle (LNP) drug delivery – the foundational technologies for the mRNA vaccines. Drs. Karikó and Weissman discovered how to engineer mRNA, while Dr. Cullis and colleagues developed the packaging system to effectively introduce the mRNA into the body.

For delivery of mRNA, the LNPs are designed to form a protective bubble and enable delivery to the interior of target cells.

Dr. Cullis says the Harvey Prize is "an amazing honour." More than 30 per cent of Harvey Prize winners have gone on to win the Nobel Prize.

Over the past 40 years, Dr. Cullis has worked in lipid chemistry and the formation of LNPs. New developments in his research aligned perfectly with the need for a COVID-19 vaccine, something he describes as "being in the right place at the right time."

Dr. Cullis' current research focuses on designing LNP systems that can transfect tissues in bone marrow. "This ability will allow many new gene therapies to be developed for the treatment of cancer, such as leukemia and lymphoma, as well as inherited diseases such as sickle cell anemia," he says.

In 2022, he and Drs. Karikó and Weissman shared the Gairdner International Award and the Tang Prize for their work on mRNA vaccines.

Through two start-ups he co-founded – Vancouver-based Acuitas and NanoVation Therapeutics – Dr. Cullis and his colleagues partner with pharmaceutical and biotechnology companies, academic institutions and thought leaders from around the world to advance and commercialize mRNA therapeutics for a wide variety of diseases.

Dr. Cullis also co-founded two Canadian National Centre of Excellence networks: the Centre for Drug Research and Development (now AdMare) and the NanoMedicines Innovation Network.

SLOAN FELLOWSHIP

Duncan Dauvergne

Mathematician studies randomness and probability

When you pay attention to seemingly unrelated situations - random occurrences – you may start to see similarities. Those similarities are at the heart of Duncan Dauvergne's research – which garnered him a 2023 **Sloan Fellowship**.

"The specific problems that I study are motivated from phenomena in physics that have random elements," says the University of Toronto Mississauga mathematician. He gives the example of spilling coffee on a piece of paper.

"You'll see the coffee stain spread out on that piece of paper. And at the edge of that coffee stain, there's this rough interface where the coffee is moving into the paper. You see phenomena like this appear in situations that are seemingly unrelated."

Dr. Dauvergne has spent years modelling problems similar to the coffee stain, like the growth of crystals and wildfires.

"Another good example is if I put a colony of bacteria on a petri dish and then, over time, the bacteria will multiply and grow outwards," he says. "The outer edge of the colony looks remarkably similar to the outer edge of the coffee stain. Or snow falling on a windowsill; as more and more snow falls, you see the snow build up bit by bit on the windowsill and you see this rough interface. In all three of these situations, even though the phenomena are quite different, you see roughly the same behaviour. The interfaces look very similar."

It's an example of the philosophy of universality: that different phenomena that you see in different places produce very similar behaviour.

"I study specific mathematical models for these phenomena," he says. "We model things with randomness, even though they are deterministic."

Dr. Dauvergne says winning the Sloan Fellowship was a "very pleasant surprise."

"The funds are very helpful in terms of building my research profile over the next three or four years. So pragmatically, it's very helpful, but also as a career recognition, it's really humbling and a true honour."

SLOAN FELLOWSHIP

Maria Drout

Astronomer seeks to unlock mysteries of distant stars

Massive stars play a role in shaping our universe through stellar winds, supernovae explosions and the production of heavy elements. But they also raise questions – questions that Maria Drout, University of Toronto researcher and Canada Research Chair in Time-Domain and Multimessenger Astrophysics, is working to answer.

Dr. Drout and her research team explore the evolution and death of massive stars, the origin of unusual astronomical transients and the physics of stellar explosions. They aim to develop a comprehensive picture of the evolution, influence and ultimate fate of these distant stars.

"Most often, we study the massive stars that end their lives in big cosmic explosions called supernova," she explains. "We try and understand how stars die, and how objects like black holes and neutron stars are formed."

Dr. Drout also studies the origins of unusual transient phenomena in space. Her work has garnered her the 2023 **Sloan Fellowship**.

Her passion for studying the life cycles of massive stars has its roots in undergraduate learning opportunities. "One summer, I went to the Lowell Observatory in Arizona and was able to undertake a project examining a set of massive stars in nearby galaxies. Then the next summer, I went to the Harvard Smithsonian Center for Astrophysics and did a project on supernova explosions. I then realized there were a lot of opportunities to connect these two fields."

She says winning the Sloan Fellowship is especially rewarding following the "rough" years of the pandemic, a time she describes as "incredibly isolating" for many researchers. She says it's encouraging to know that her team's work is appreciated.

"The pandemic was pretty isolating for a lot of people," she says. "So this recognition really shows that we managed to push through and get a lot of very cool, impactful research done despite all that."

The Sloan Fellowship would not have been possible without her "amazing students" and other collaborators, she says.

Dr. Drout was a NASA Hubble postdoctoral fellow at the Observatories of the Carnegie Institution for Science from 2016 to 2018.

WOLF PRIZE AND VINFUTURE SPECIAL PRIZE

Daniel Drucker

Physician-scientist's research enables treatments for major health challenges, including obesity

"I always viewed myself as a clinician first and scientist second," says endocrinologist Daniel Drucker. "So it's tremendously rewarding" to see his research making a difference in people's lives after decades of fundamental research.

The senior scientist at the Lunenfeld-Tanenbaum Research Institute, Sinai Health and a professor at the University of Toronto's Temerty Faculty of Medicine has won the prestigious 2023 **Wolf Prize for Medicine**. The Wolf Prize is awarded annually to outstanding scientists and artists from around the world for achievements in the interest of humanity and friendly relations among people.

Dr. Drucker was recognized for his research on the physiology and therapeutic potential of glucagon-like peptides (GLP), hormones produced in the gut that now form the basis for several highly effective drugs to treat type 2 diabetes, obesity and intestinal disorders. These include a class of type 2 diabetes drugs, called GLP-1 agonists, that improve blood sugar control and have been shown to benefit weight loss – drugs that have received much public attention over the past year.

The endocrinologist is also part of a team of scientists awarded the 2023 **VinFuture Special Prize for Innovators with Outstanding Achievements in Emerging Fields**. The prize, valued at $500,000, is presented by the not-for-profit VinFuture Foundation in recognition of breakthrough scientific and technological innovations.

"Now, if you say the word Ozempic, everybody knows somebody who's on it or talked about it or lost weight on it, etc.," he says. And the promise of his work continues to grow.

"More trials are reporting success with GLP-1. A month ago, Novo Nordisk announced that the outcomes trial on people with obesity showed that their GLP-1 drugs reduced heart attacks, strokes and cardiovascular death by 20 per cent. That's never been shown before in any trial on any obesity medicine."

Such impactful innovations don't happen overnight. "This story has taken 35 years," he says of his fundamental research. "So we shouldn't lose sight of the fact that this is a slow process; that it's hard to predict innovation. The investments in basic science and all forms of science pay dividends that one cannot foresee, but it's tremendously rewarding to see how this has gone."

Dr. Drucker doesn't work for the companies that bring these solutions to market, but he does "consult for companies and advise them on how they might think about developing their drugs and what they should be thinking about going forward."

At his lab, Dr. Drucker continues looking for answers to key questions involved with GLP's success, including, "How do these things work? Where do they exert their actions? Are the receptors in the organs as important as the receptors in the brain?"

In 2021, Dr. Drucker won the Canada Gairdner International Award, one of the most prestigious international prizes in the biosciences. He donated the $100,000 Gairdner Prize to establish The Drucker Family Sinai Health Discovery Awards, a program to motivate innovation throughout the hospital and research ecosystem at Sinai Health.

NEW HORIZONS PRIZE

Michael Groechenig

Mathematician gets timely call from *Oscars of Science*

Michael Groechenig, a researcher at the University of Toronto Mississauga, has won the 2024 **New Horizons Prize in Mathematics** from the Breakthrough Prize Foundation.

Billed as "the Oscars of science," the Breakthrough Prize was founded by Sergey Brin, Priscilla Chan, Mark Zuckerberg, Julia and Yuri Milner and Anne Wojcicki to recognize the world's top scientists working in the fundamental sciences.

"It was completely surreal," Dr. Groechenig says of learning he had won. The call came on the heels of a most joyous occasion. "Just a week after my son was born, I got this phone call from a famous mathematician who won the actual Breakthrough Prize a few years ago." The New Horizons Prize is awarded to promising early-career researchers who have already produced important work.

Dr. Groechenig received the award for his insights into arithmetic geometry. His research focuses on moduli spaces.

He is quick to thank his collaborators Hélène Esnault, Dimitri Wyss and Paul Ziegler for the "many interesting things they have taught me and for our joint work on the papers for which the prize was awarded."

In 2022, Dr. Groechenig won the Sloan Fellowship.

SLOAN FELLOWSHIP

Allanah Hallas

Physicist searches for new materials to improve quality of life

Alannah Hallas works along the boundary between chemistry and physics in the search for new materials.

"We're looking for new materials that have better properties than existing materials for a wide range of applications or just properties that we've never even seen before that could unlock completely new applications," says the condensed matter researcher at the University of British Columbia.

It may sound like Dr. Hallas is looking for a needle in a haystack, but she says it's more like looking for the hay.

"It's really hard to know how many materials are out there that we simply haven't yet discovered," she says. "But there are definitely, you know, in the thousands, or even maybe in the millions; there's a vast array of undiscovered materials. So, we're not likely to be out of work anytime soon."

Dr. Hallas, principal investigator for the Quantum Materials Design Lab at the university's Stewart Blusson Quantum Matter Institute, is a winner of the 2023 **Sloan Fellowship**.

When it comes to the potential benefits of her fundamental research, Dr. Hallas points to superconductivity as an example. "Researchers in my field are looking for room-temperature superconductors; materials that could make our computers faster, cheaper and longer-lasting; materials to improve the storage capacity and

long-term stability of batteries. Any sort of obstacle that's facing humanity, there is almost always a solution in the form of a material."

Dr. Hallas says it's "very exciting" to win the Sloan Fellowship, "because it comes at a time in your career where you're just beginning to start your own independent research, and you will have lots of ideas and new directions. It's motivating to receive this validation that other people also think the directions you're pursuing are exciting and worth pursuing."

Funding from the award will help Dr. Hallas expand her research team, which currently includes 11 students from the undergraduate to post-doctoral level.

"I think the Sloan is really important because it draws attention to the importance of fundamental research and the value that that brings to society," she says. "We're at an early stage in something that could eventually have a lot of impact on people's day-to-day lives."

TYLER PRIZE

Daniel Pauly & Rashid Sumaila

Marine biologist, fisheries economist collaborate in pursuit of global fisheries sustainability

Marine biologist Daniel Pauly and fisheries economist Rashid Sumaila bring an interdisciplinary and global approach to fisheries sustainability efforts – work that has garnered the University of British Columbia researchers the 2023 **Tyler Prize for Environmental Achievement**. The award, administered by the University of Southern California, is often described as the "Nobel Prize for the environment."

The long-time colleagues at UBC's Institute for the Oceans and Fisheries (Dr. Sumaila is jointly appointed to the School of Public Policy and Global Affairs) research the subsidies that drive the global growth in fisheries.

"This is taxpayer money that our governments advance to the fishery sector," says Dr. Sumaila of the subsidies. "What we have done together is to develop a global database of this, covering all maritime countries."

Their subsidies tool has been embraced around the world. "The World Trade Organization members use this as the source of comprehensive data to help them come to some decisions on how to remove harmful subsidies," he says.

Adds Dr. Pauly: "Our estimates of subsidies have replaced other estimates that the World Bank, the OECD and others produce because they omitted the Global South."

The two also collaborate in studying the situation on the high seas, which is the area outside the 200-nautical-mile zones of maritime countries. "What are the biological biodiversity principles, the equity principle, in these areas?" says Rashid. "It's supposed to be owned by all of humanity, but only a few countries take up the value."

The pair came up with a bold solution: close the high seas to fishing and turn it into a "fish bank" for the world.

The fish would be protected, not caught while in the "bank" and because they would come in and out of the fish bank, biodiversity would increase and smaller nations would have a greater chance to catch the fish.

"It's good for the economics side and good for climate change," says Dr. Sumaila.

Of course, they've received pushback to the proposal, but the researchers refute arguments on why it won't work. For example, naysayers respond that such a ban can't be policed. But Drs. Pauly and Sumaila say monitoring can be done through satellites.

"We can even see seagulls from space, so the boats can be seen," says Dr. Pauly. "Also, you can identify the gear that they use."

Progress is being made on the idea; some countries have committed to protecting a percentage of the high seas. "Slowly we are getting there," says Dr. Sumaila.

The two have dedicated some of the funding from the Tyler Prize to establishing what they call the "Africa UBC Visiting Fellows Program." The goal is to support interactions between faculty in Africa and those at UBC. The funds have been matched by UBC's deans of arts and science to help make the program a reality.

GUGGENHEIM FELLOWSHIP

Federico Rosei

Researcher takes interdisciplinary approach to promising nanotechnology research

The synergy that comes from bringing different disciplines together to solve problems makes all the difference in Federico Rosei's work. Dr. Rosei, who held the Canada Research Chair in Nanostructured Materials from 2016 to 2023, studies the structure and properties of objects at the nano scale. One nanometer (one meter divided by one billion, or one millimeter divided by one million) of matter typically contains three to four atoms.

"When you work at such small dimensions, the boundaries between disciplines are quite blurred," he explains. "So what we do is considered physics, but also chemistry and materials science and even engineering. That's one of the fascinating aspects of my work, that I get to collaborate with people from different backgrounds and then we can exchange ideas and perspectives, and this brings about insights that would be difficult to obtain if we worked independently of each other."

Dr. Rosei, a professor in materials science and nanotechnology at the Université du Québec's Institut National de la Recherche Scientifique (INRS), has won a 2023 **Guggenheim Fellowship**, the only one in the engineering category. His research on very small objects, which exhibit quantum effects that do not occur at the macro scale, could lead to new materials that support technological breakthroughs in energy, electronics and health.

Some of these objects are called quantum dots, which are ubiquitous in modern technologies. They were recently in the spotlight as their invention was awarded the Nobel Prize in Chemistry in 2023.

"They're used extensively in display technologies, including computer screens and smart phones," he says. "But instead of focusing on quantum dots like these that emit light, we're more interested in quantum dots that absorb solar radiation, so that we can transform it into other usable forms of energy."

Dr. Rosei also holds the UNESCO Chair in Materials and Technologies for Energy Conversion, Saving and Storage since 2013. The latter comprises a network of over 30 organizations from 22 countries that have agreed to pool resources and jointly develop renewable energy technologies.

"If you consider the commercial standard of solar panels, it's silicon. To work with materials beyond silicon, the next generation of solar panels, quantum dots have a lot of potential."

SLOAN FELLOWSHIP

Sushant Sachdeva

Computer scientist's algorithm solves *maximum flow* problems

Sushant Sachdeva designs algorithms to find the best route from point A to point B when efficiency is paramount. It's about solving what are called "maximum flow" problems – the challenge of maximizing the amount of material you can move from one place to another in a given time.

"Let's say I'm in Toronto and I want to drive to Waterloo. Traffic is bad in the GTA always, so given the current traffic conditions, what is the fastest path I should take?" says the computer scientist at the University of Toronto Mississauga. "I focus on designing algorithms that can be proven to give the right answer." His solution navigates the complexities of travel, including bottlenecks and multiple road options.

His algorithm – which is regarded as a mathematical breakthrough – has potential applications for transportation efficiencies. For example, the algorithm can help a city determine traffic bottlenecks, and hence identify which roads should be expanded to improve traffic flow.

Dr. Sachdeva expects that his algorithm will eventually lead to new software that may see widespread use.

In recognition of his work, Dr. Sachdeva is a 2023 winner of the **Sloan Fellowship**.

"It's very fulfilling," he says of winning the Sloan Fellowship. "The Sloan Fellowship is extremely competitive. I'm very grateful."

CRAFOORD PRIZE

Dolph Schluter

Evolutionary biologist recognized as world leader in study of rapid diversification of species

"We regard Dr. Schluter as the leader in ecological studies of the origin of species over the last four decades." That's how Prof. Ove Eriksson of Stockholm University, chair of the prize committee for the **Crafoord Prize in Biosciences**, describes the impact of evolutionary biologist Dolph Schluter's work. Dr. Schluter, a professor at the University of British Columbia, has been awarded the Crafoord Prize by the Royal Swedish Academy of Sciences (RSAS) and the Crafoord Foundation for his research into the role of natural selection in adaptive radiation and the origin of species.

The Crafoord Prize, which includes $780,000 to fund further research by the winner, is awarded in disciplines the RSAS doesn't consider for Nobel Prizes.

The study of adaptive radiation looks at how new species are formed and how they become different from one another.

"It involves questions about the role and mechanisms of natural selection, the origin of species and their subsequent divergence," says Dr. Schluter. "Our concept of what a species is has changed a lot since Darwin. When you go out into nature and you see different species, the reason they don't all collapse into a single hybrid mess is because they possess this characteristic that we call reproductive isolation. They've evolved characteristics that prevent them from interbreeding."

Dr. Schluter became interested in the problem of the origin of species while doing PhD work on Galapagos finches. Later he started working on three-spined stickleback fish in B.C., "which are marvelous creatures because they include some of the youngest species on Earth." It is thought to take on average about two million years for a single lineage to split into two new species, he explains. With the Galapagos finches, it's down to about 100,000 years.

"These sticklebacks, they occur exclusively in lakes that are only 10,000 years old. They're abundant in those lakes and we can bring them in the lab and do experiments. They had characteristics that reminded me of the finches; they were young and they co-occur in the same sort of isolated places.

No more than two species of stickleback occur in any one lake, but pairs of species in different lakes seem to have evolved completely independently of other pairs. They have properties that allow Dr. Schluter's team to address very basic questions concerning the roles of resources, species interactions, phenotypic plasticity, sexual selection and other factors in the evolution of diversity.

Dr. Schluter and colleague Dr. Sally Otto, a 2023 winner of the Killam Prize, are donating funds from their awards to endow a postdoctoral fellowship in biodiversity studies at UBC.

GUGGENHEIM FELLOWSHIP

Karen Solie

Childhood on rural Saskatchewan farm shapes poet's work

Canadian poet Karen Solie spent her childhood in "very rural" Saskatchewan, and that experience has shaped her work across poetry, fiction and non-fiction.

"I grew up with land-use and environmental concerns and money issues and all that sort of thing," she says. "So it kind of grounds what I'm thinking about."

Solie is a 2023 winner of the **Guggenheim Fellowship in Poetry**.

"I can't help but be influenced by climate crisis and economic inequality," she says.

Solie is currently working on a collection of poetry. After that, she plans a cross-genre research-oriented book, which is the project to be supported by the Guggenheim Fellowship.

"I'm researching a collection of hybrid essays that explore encounters with art, violence, memory and identity over time," she says. "Though it hasn't been intentional, it's turned out that they all have something to do with being locked in or confined. I'm looking forward to working in new genres and building on my research background."

Solie's work has appeared in journals internationally and has been translated into eight languages. It is included in anthologies including the *FSG Poetry Anthology* (2021), the *Oxford Anthology of Canadian Literature in Englis*h (2019), the sixth edition of *The Norton Anthology of Poetry* (2018) and the *Forward Book of Poetry* 2018. Her most recent collection of

poetry, *The Caiplie Caves*, was shortlisted for the 2019 T.S. Eliot Prize and the Derek Walcott Prize. She was writer in residence for York University in 2023, the Holloway visiting poet for the University of California at Berkeley in 2022, and the Jack McClelland writer in residence for the University of Toronto in 2021.

Solie says winning the Guggenheim was a "real shock."

"I knew it was a long shot," she says. I was very honored to receive that email and then to see the others; not only the poets but the other researchers who had been awarded a Guggenheim – it's astonishing."

Solie lives in Toronto but is currently a lecturer in creative writing at St. Andrews University in Scotland.

SLOAN FELLOWSHIP

Sophie Spirkl

Graph theorist's research recognized with Sloan Fellowship

Sophie Spirkl is widely regarded as one of the strongest graph theorists among early-career researchers in the world, with an impressive breadth and depth of research.

An assistant professor of combinatorics and optimization at the University of Waterloo, Dr. Spirkl has won a **2023 Sloan Research Fellowship**.

She studies graphs that describe how different things relate to each other. "For example, in a group of people, any pair of them may know each other or not know each other. Among cities, any two of them could be connected via a direct flight or not."

But this data, she says, is not completely random. "Usually, if I ask people, 'Do you personally know 100 people, and no two of them know each other?' the answer is no. This is local information – standing at one point in the graph, looking at one person's point of view, I can say something about what's going on nearby."

Her research explores how this local knowledge may be helpful. "What can I say about the 'big picture' of the graph? Can we solve algorithmic questions faster by using this structural information? What do we learn about properties and parameters of the graph?"

Dr. Spirkl says she is "very honoured" to receive this recognition of her work. "And I'm very thankful to my department chair, Chaitanya Swamy, for nominating me. It also makes me appreciate all the support I've received in my career so far; I've been incredibly fortunate."

The Sloan Fellowship will allow Dr. Spirkl to expand her research team and their opportunities to travel to conferences and workshops.

"One of the best things that is coming out of this is more funding for students to attend summer schools, workshops and conferences," she says. "My field is very collaborative, and it's vital for my students to be able to meet others in the field, make connections and learn from them."

GUGGENHEIM FELLOWSHIP

Diana Valencia

Astrophysicist investigates what would make super-Earths habitable

If Earth was double its size, would it still be habitable? Would we still have mountains and oceans?

"It could be a whole different beast," says astrophysicist Diana Valencia. "Those are the kinds of questions I ask; if you change them in size, what else do you change?"

This curiosity drew Diana Valencia to the study of small planets outside of our solar system called super-Earths. These planets have a mass greater than Earth but less than Neptune, with rocky compositions similar to Earth. Her goal is to determine if planets with masses between one and 15 times the size of Earth are scaled-up versions of Earth or scaled-down versions of Neptune in terms of their composition, evolution and physical properties.

"I study mostly what they're made of – which tells us a little bit about how they formed, and how they evolved – to try to understand not only our solar system, but also the question of what makes a planet habitable," says the University of Toronto Scarborough researcher. "Why is Earth the only planet that we know it's habitable?"

Her work has garnered Dr. Valencia the **2023 Guggenheim Fellowship**. She is one of only two Canadians to win in 2023, and the only recipient in astronomy and astrophysics.

Her Guggenheim-funded research project includes analysis of data on multi-planet systems. In this work, she compares rocky planets orbiting the same star to look for differences in their composition. Another element of the project looks at the role of collisions in planet formation.

Dr. Valencia learned about her Guggenheim win while on a ski hill. "And then the day was just warmer, the sun came out – it was just really nice, beautiful," she says. "It's very rewarding to be acknowledged.

TANG PRIZE

Bob Vallerand

Unlocking the healthy side of passion

Robert Vallerand's study of the psychology of motivation was sparked by basketball.

"I was a basketball player on the Quebec provincial team and on a scholarship to play basketball at university," he explains. "I really was very passionate about basketball." And he wanted to know more about that kind of passion.

That was decades ago, and he could find no research on the psychology of motivation. His work since then has had a major role in shaping this field of study.

The $100,000 **Tang Prize** was awarded to Dr. Vallerand, a professor of social psychology at the Université du Québec á Montréal, for his important contributions to the psychology of motivational processes.

"I started to study the philosophers," he says. "There were these two sides of passion, the Greek philosophers who would say, 'you know, passions are bad for you, because they control you.' And then the Romantics later on, around the 1600s, 1700s, they were saying, 'life is not worth living without passion.'

"So I realized that basically there are two types of passion, obsessive and harmonious. There is the positive side and of negative side of passion." Our initial research ended up empirically supporting this hypothesis, thereby opening up a new field of research on the psychology of passion.

That lead to a career studying people who are "optimally functioning," not only in their work but in their overall happiness and wellbeing. He sought to understand "what makes them tick" and what we can learn from them.

"What we find is that they have a harmonious passion for a lot of stuff in their life, including their work, or what they study or their leisure." He uses the example of Olympic athletes. "They have harmonious passion for what they do, they train hard, but most of them have actually a long career and they're also passionate about other stuff in their life.

"Just like for me, for instance, I've been doing research for over 40 years, but I also have passion for basketball and playing guitar," he says. "What you try to do is have little pockets of passion here and there and everywhere, in different areas of your life."

Those who don't have that balance in the passion in their lives, who have only one area of passion, tend "to be more obsessive in nature," he says. "That obsessive passion will allow you to reach high level of performance because you spend a lot of time on it. The problem is that you'll get anxious as you think about it, ruminate about it. And at some point, you may have a downside to your psychological wellbeing." This is not the case with harmonious passion because it allows you to reach high levels of performance while enjoying the rest of your life as well.

Dr. Vallerand holds a Canada Research Chair in Motivational Processes and Optimal Functioning.

SLOAN FELLOWSHIP

Anastassia Voronova

Brain repair research holds promise for multiple sclerosis, other neurological diseases

Neural stem cell biologist Anastassia Voronova and her research team at the University of Alberta are trying to teach new tricks to older brains.

"We study how neural stem cells build and repair the brain," she says. "Stem cells build the brain during fetal development, so my idea is that if we can understand how they built the brain in the first place, then maybe we can understand how to wake up or mobilize stem cells in our adult brain."

Unfortunately, these stem cells in adult brains are rather lazy, she says, when it comes to making repairs. "They just don't want to do what they need to do, which is to replace damaged or lost cells."

Her promising work has garnered Dr. Voronova the **2023 Sloan Fellowship**.

"By understanding how stem cells build and maintain the brain, we can figure out how to hijack those molecular pathways that were once important in development and use this information to encourage adult neural stem cells to replace cells that are lost in neurological disorders." Specifically, the team studies how neural stem cells can be harnessed in multiple sclerosis and neurodevelopmental disorders such as autism spectrum disorder.

Dr. Voronova, holder of a Canada Research Chair in Neural Stem Cell Biology, has shown how the molecules naturally present in the brain activate neural stem cells to potentially halt and even reverse the effects of multiple sclerosis and other

neurological diseases for which there is currently no cure. She also studies how aberrant neural stem cells contribute to the development and progression of neurodevelopmental and neurodegenerative disorders.

"In my lab we try to translate developmental discoveries to real pharmacological treatments," she says. "We use preclinical mouse models of multiple sclerosis and neurodevelopmental disorders. We aim to fill the gap between basic discovery and clinical research, but we draw all of our inspiration from basic research, which I think is really important to highlight."

"The Sloan Fellowship is specifically for fundamental basic research. That's significant because without fundamental discoveries in basic research, it's really hard to translate anything into clinical applications."

The recognition of the Sloan Fellowship is "really reassuring," she says. "It affirms that what you're doing is high quality, innovative, creative and has a lot of potential. The Sloan Fellowship really underscores how important it is to have that curiosity. What we try to do is to translate the discoveries coming out of our curiosity into tangible outcomes for patients down the road."

Awards descriptions

BBVA Frontiers of Knowledge Award

The BBVA Foundation Frontiers of Knowledge Awards seek to recognize and encourage world-class research and artistic creation, prizing contributions of lasting impact for their originality and theoretical significance. These international awards honour fundamental disciplinary or interdisciplinary advances across eight categories: basic sciences (physics, chemistry, mathematics); biology and biomedicine; information and communication technologies; ecology and conservation biology; climate change; economics, finance and management; humanities and social sciences; and music and opera.

Crafoord Prize

The Crafoord Prize is one of the world's most prestigious science prizes awarded in mathematics and astronomy, geosciences, biosciences and polyarthritis since 1982.

Dan David Prize

The Dan David Prize recognizes the work of historians, art historians, archaeologists, digital humanists, curators, documentary filmmakers and all those who deepen our knowledge and understanding of the past.

The Eduard Rhein Foundation Award

The goal of the foundation is to promote scientific research, learning, arts, and culture. This is done by granting awards for outstanding achievements in research and/or development in radio, television and information technology.

Guggenheim Fellowship

Guggenheim Fellowships are intended for mid-career individuals who have demonstrated exceptional capacity for productive scholarship or exceptional creative ability in the arts and exhibit great promise for their future endeavors. Fellowships are awarded through an annual competition open to citizens and permanent residents of the United States and Canada.

The Harvey Prize

The Harvey Prize, the most prestigious award bestowed by the Technion – Israel Institute of Technology, is awarded annually in a variety of disciplines within the categories of science & technology and human health. The Harvey Prize has also been awarded for contribution to peace in the Middle East.

New Horizons Prize in Mathematics

The New Horizons in Mathematics Prize of $100,000 is awarded to promising early-career researchers who have already produced important work. The prize is funded by a grant from the Milner Foundation. Each year, up to three New Horizons in Mathematics Prizes are awarded.

Sloan Research Fellow

The Sloan Research Fellowships seek to stimulate fundamental research by early-career scientists and scholars of outstanding promise who hold a PhD or equivalent in chemistry, computer science, economics, mathematics, molecular biology, neuroscience, ocean sciences, physics or a related field. These two-year

fellowships are awarded yearly to 126 researchers in recognition of distinguished performance and a unique potential to make substantial contributions to their field. Fellows are selected on the basis of their independent research accomplishments, creativity and potential to become leaders in the scientific community through their contributions to their field.

The Tang Prize

The objective of the Tang Prize Award for Achievement in Psychology is to honour a living internationally-recognized scholar with a PhD in psychology who has made an exceptional contribution to psychological health anywhere in the world.

Tyler Prize for Environmental Achievement

Established in 1973 by the late John and Alice Tyler, the Tyler Prize for Environmental Achievement is one of the first international premier awards for environmental science, environmental health and energy. Recipients encompass the spectrum of environmental concerns, including environmental policy, health, air and water pollution, ecosystem disruption and loss of biodiversity and energy resources. Individuals and organizations chosen have conferred great benefits upon mankind.

VinFuture Special Prize

The vision of the VinFuture Prize is to catalyze meaningful change in people's everyday lives through tangible and highly scalable improvements in areas such as productivity, prosperity, connectivity, health, safety, environment, sustainability and people's overall happiness regardless of their socioeconomic status.

Wolf Prize

The acclaimed Wolf Prize is awarded to outstanding scientists and artists from around the world for achievements in the interest of humanity and friendly relations among people.

The scientific categories of the prize include medicine, agriculture, mathematics, chemistry and physics. The Prize's art categories include painting and sculpting, music and architecture. The prize laureates are selected by international jury committees which comprise world-renowned professionals from all over the world.

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