science contours
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IMPACT FACTOR

The ripple effect of the actions and reactions of science

UNIVERSITY OF ALBERTA

science contours

Vol. 36, No. 1, Spring/Summer 2019

The University of Alberta Faculty of Science is a research and teaching powerhouse dedicated to shaping the future by pushing the boundaries of knowledge in the classroom, laboratory, and field. Through exceptional teaching, learning, and research experiences, we competitively position our students, staff, and faculty for current and future success.

Science Contours is a semi-annual publication dedicated to highlighting the collective achievements of the Faculty of Science community. It is distributed to alumni and friends of the faculty.

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UNIVERSITY OF ALBERTA
FACULTY OF SCIENCE

Minimum notes, maximum knowledge

Little notes make a big difference for undergraduate students in Ratmir Derda's chemistry classes. Students can bring in these Post-it-size sheets for their exams—which are then hung in an unofficial gallery outside of Derda's office.

contents

A representative sample:

FACULTY OF SCIENCE DIVERSITY REPORT 2.0

BY JULIE NAYLOR / PHOTOS JOHN ULAN

On the status of equity, diversity, and inclusion in science

FOR THE LAST DECADE, WOMEN HAVE MADE UP JUST OVER HALF OF THE UNDERGRADUATE STUDENT POPULATION IN THE FACULTY OF SCIENCE—AN IMPRESSIVE AND INSPIRING STATISTIC. BUT WHILE UNDERGRADUATE STUDENTS BOAST GENDER PARITY, THE REPRESENTATION OF MALES AND FEMALES CHANGES SIGNIFICANTLY AMONG GRADUATE STUDENTS, AND EVEN MORE DRASTICALLY AMONG FACULTY MEMBERS.

IT'S A QUESTION OF ATTRITION, EXPLAINS LISA WILLIS, NEW ASSISTANT PROFESSOR (BIOLOGICAL SCIENCES). AND AS A FEMALE WITH A DISABILITY, SHE SEES AND EXPERIENCES THINGS THAT SOME UNDERREPRESENTED GROUPS ENCOUNTER.

"There is higher attrition for women than men at every single level in STEM post-secondary," Willis explains. "I think part of it is when they realize they have a harder and longer race to run, and with more obstacles, they get discouraged and disheartened. I certainly know that happened to me, and I realized I needed to do something about it."

Willis started to explore whether there was a scientific basis for this discrimination. What does it look like, according to science?

She attended any talks she could on equity, diversity, and inclusion—or EDI—many of which focused on anecdotal examples, and while she realized that may work for people experiencing discrimination or those who are already engaged, she noted anecdotes don't always work well for scientists.

"I did a full literature review and found that despite the perception that things are getting better, they aren't for gender equity in STEM," Willis explains. "It has plateaued."

As part of her action plan, Willis set forward to educate her colleagues on the topic, focusing on offering workshops that highlighted the science of EDI, using data and research to reinforce her message.

EDI tips to get you started

1. **Question yourself about your biases.**

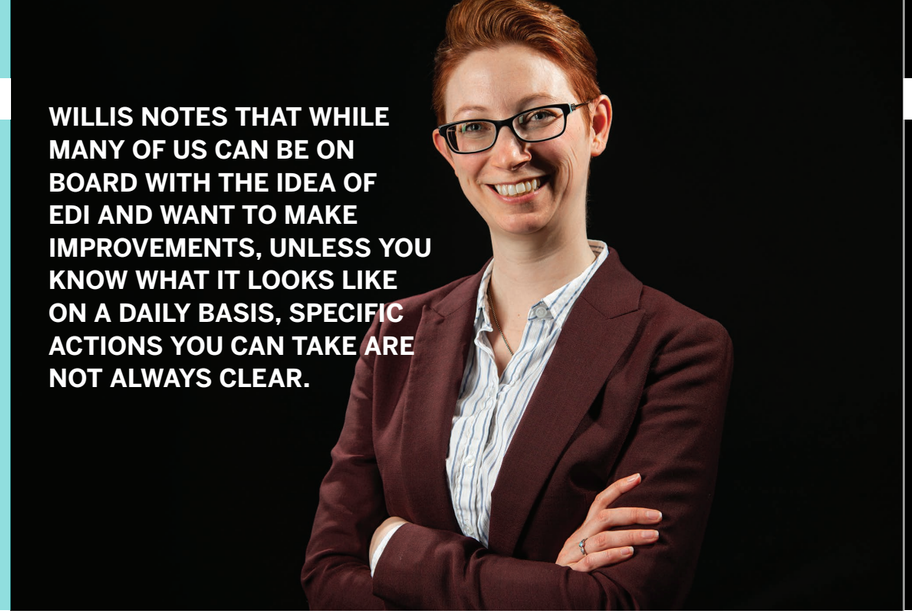
   Try the online Harvard Implicit Bias test to find out more about which biases you have.

2. **Actively promote individuals from underrepresented groups.**

   Inviting a speaker? Recommending people for a new job? Ensure your short list contains equal numbers of men and women as well as ethnic and cultural diversity.

3. **Be inclusive!**

   Planning an event or hosting a visitor? Ensure the location is accessible for people with physical disabilities. Working in a group? Seek input from all individuals and provide multiple ways for people to participate, from speaking up in a meeting to sending ideas through email to having short one-on-one conversations.



WILLIS NOTES THAT WHILE MANY OF US CAN BE ON BOARD WITH THE IDEA OF EDI AND WANT TO MAKE IMPROVEMENTS, UNLESS YOU KNOW WHAT IT LOOKS LIKE ON A DAILY BASIS, SPECIFIC ACTIONS YOU CAN TAKE ARE NOT ALWAYS CLEAR.

Diversity in research

WILLIS IS PASSIONATE not only about building diversity awareness with her colleagues, but about applying the diversity lens to her research, noting that her experience has played a role in her glycoimmunology and microbial glycobiology research.

"I am exploring the human immune system and working to understand the differences between men and women," she says. "Specifically, I'm looking at autoimmune disease to better understand why 60 to 80 per cent of those affected are female. We know glycobiology plays an important role in the immune system, but we don't know why exactly, and I think it may hold the key to some of the questions."

Willis also brings her expertise to GlycoNet, a pan-Canadian Network of Centres of Excellence of more than 140 researchers, centred at UAlberta.

By the numbers

GENDER REPRESENTATION IN THE FACULTY OF SCIENCE THEN AND NOW.

Female Male

	2009–10	2018–19
Undergraduate	52%	51%
Master's	39%	36%
PhD	32%	36%
Faculty members	18%	22%

CATCHING THEM YOUNG

THE YOUNGER GENERATION needs role models, she notes. "We need to change the culture for these young women and to show what a path to success looks like in order to keep them in science" .

Cue WISEST. For more than 35 years, WISEST (Women in Scholarship, Engineering, Science & Technology) has been working hard to empower women in the fields of science, engineering, and technology through hands-on experiences, mentorship, networking, outreach, and education. At the recent CHOICES conference in Edmonton, more than 600 Grade 6 girls were introduced to various STEM activities, with the overall theme that science is something they can excel at, challenging their ideas about scientists and engineers.

Grade 6 student Reese Kennedy (L) and her classmates are encouraged by the choices in science, illustrated by their participation in WISEST's CHOICES conference.

And the message seems to be getting through. "Everyone has an equal opportunity to learn what they are passionate about," says Grade 6 participant Reese Kennedy. "The conference gives girls the opportunity to look at all the different options in science and shows that you don't have to decide on one right away, and that there's lots of time to think about it. You can go from one area to another, or you can do more than one. It's all about learning, making mistakes, moving on, and getting better."

SOLUTION-BASED STRATEGIES

EFFORTS TOWARD IMPROVING EDI are also making waves at the institutional level. In 2018, UAlberta became the first university in the world to make intersectional gender research and teaching a strategic priority. Less than a year later, UAlberta announced its first EDI strategic plan, which takes a comprehensive approach to understanding and addressing issues of equity, diversity, and inclusion on campus.

Earlier this year, the federal government announced the creation of a fund to foster EDI in research, specifically in the scientific and engineering communities. In addition, $10 million in funding was directed to targeted EDI capacity-building grants to help post-secondary schools embrace and increase diversity.

For Willis, this is one step in the right direction.

"With the Natural Science and Engineering Research Council (NSERC) now requiring EDI statements in grants, more faculty are becoming aware of it," comments Willis. "Requiring EDI statements brings awareness to the issue. I wish more people were offering information to scientists about diversity to get them engaged from the science aspect."

Willis notes that while many of us can be on board with the idea of EDI and want to make improvements, unless you know what it looks like on a daily basis, specific actions you can take are not always clear. While she notes much of the information and presentations focus on being generally aware of our biases, they don't go that critical step further to illustrate how to address—and change—those biases. Her workshops, therefore, focus on practical experience and suggestions to address bias on a daily basis.

"Everyone is part of the problem," she says. "We need everyone to participate to be part of the solution."

To learn more about diversity in the Faculty of Science, visit ualberta.ca/science/diversity

UAlberta focus

IN FEBRUARY 2019, the University of Alberta launched its first Equity, Diversity, and Inclusion (EDI) Strategic Plan. The plan sets out institutional priorities and goals over the next four years, with special emphasis in the first year on establishing improved systems for data collection (both quantitative and qualitative) to support target setting and identify specific barriers. It also emphasizes developing resources to integrate EDI considerations into research and teaching, and sustaining and enhancing training and development across the university.

It is with deep sadness that the Faculty of Science announces the recent passing of **Margaret-Ann Armour** ('70 PhD, '13 DSc). As associate dean (diversity), Armour focused unwaveringly on increasing the diversity in our faculty. Under her tenure and tireless efforts since 2005 until shortly before her passing in May 2019, the representation of women in our faculty ranks rose from 14 to 22 per cent. We will honour her legacy by continuing to champion the cause of diversity in STEM. Margaret-Ann, you are deeply missed.

Mathematics Professor Dragos Hrimiuc
on **calculus, community,**
and **creating connections**

Pi in the sky

The art of teaching mathematics

Today, you'll get one dollar. Tomorrow, you'll get 50 cents. The next day, a quarter of a dollar, then an eighth, a sixteenth, and so on. If this goes on forever, will you be rich, or will you be poor?

"Well, you'll only ever be two dollars richer than you are now, so the answer really depends on you," said Dragos Hrimiuc (mathematical and statistical sciences). "This is the concept of series. When I teach about series, I start class with this example. That way, students have a concrete understanding from the outset."

Hrimiuc has been teaching concepts like these for more than 23 years. And over the last quarter century, he has been the recipient of numerous teaching and leadership awards, including the Rutherford Award for Excellence in Undergraduate Teaching, the Pacific Institute for the Mathematical Sciences (PIMS) Education Prize, and various student-selected accolades.

"It is these that mean the most to me—the ones that are selected by students," Hrimiuc explained. "It is not set up or selected by faculty committees. Instead, it is selected by students. Each year, different students select the winner." Hrimiuc has won an impressive six times.

Hrimiuc, who teaches all levels of mathematics courses—from introductory undergraduate classes all the way to advanced graduate courses—is much beloved by his pupils. The secret to his success? Being passionate and knowledgeable.

"I love my students. To be a teacher is one of the best jobs you could have. I'm surrounded by young people. They keep me feeling energetic and excited about learning."

—Dragos Hrimiuc, professor in the Department of Mathematical and Statistical Sciences.

By **Katie Willis** *Photos* **John Ulan**

Not just the numbers

"What I'm doing, I'm doing with passion," Hrimiuc explained. "This is easy because I like what I teach. I see teaching as the art of conveying hard scientific knowledge in the simplest way while connecting to our audience emotionally to drive more engagement."

As for the second element, being knowledgeable seems like a given for any teacher. But, Hrimiuc explains, teaching is much more than presenting knowledge. "It requires enthusiasm, dedication, enjoyment of the work, and a lot of creativity to stimulate learning," he said. "Most of the time, my lectures between different sections are completely different because I am creating as I teach and try to transform a monotonous routine into an exciting challenge. Of course, you cannot be creative if you are not knowledgeable. It is very important to know a lot about the subject to keep the motion of presentation, the flow through the material.

"You have to understand how the brain of the student works in order to transmit knowledge. When I look in the eyes of my students, I can see if I maintain their interest or if they understand my explanations. I catch the moment when the idea clicks. You have to look at your class and understand what that moment looks like to be a good teacher."

Amazing alumni

IN HIS 23 YEARS at the University of Alberta, Dragos Hrimiuc has taught more than 9,000 students in 120 classes. He's met many of his students after they've left the classroom—even once while on vacation in Paris. Many times, he says, former students will just stop by his office to talk.

Have a favourite moment you'd like to share? Email us at science.contours@ualberta.ca

"When I look in the eyes of my students, I can see if I maintain their interest or if they understand my explanations. I catch the moment when the idea clicks."

Calculus and community

But Hrimiuc's passion for inspiring a love of mathematics in his students doesn't stop there. He's also committed to bringing this inspiration to a younger generation, namely Albertan high school students through the Alberta High School Mathematics Competition. The annual competition engages approximately 800 students from across the province, who compete for cash prizes in two competition phases.

"We want to encourage high school students to work on challenging problems, which could inspire them to become good mathematicians," explained Hrimiuc. "Solving complex math problems improves the ability to think clearly and creatively. We have to educate students to participate in math competitions, which can provide a challenging, engaging math experience. Competitions teach students that effective performance requires a lot of practice."

Back on the University of Alberta campus, Hrimiuc is also famous for his open review sessions, held twice each semester—once for the midterm and once for the final. The sessions, held in the 500-person lecture theatres in the Centennial Centre for Interdisciplinary Science, are standing room only for two hours. Attendees are invited to make an optional donation, about the value of a cup of coffee.

"Maybe one dollar, maybe five dollars," he said with a laugh. "After each session, I count up the change. It usually takes me a couple of hours." The funds are then donated to a charity, usually the Stollery Children's Hospital or the Alberta Cancer Foundation. Since 2006, Hrimiuc has raised more than $22,000.

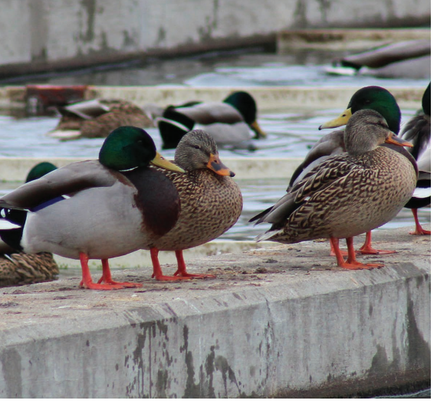
"I love my students. I want to see them succeed. To be a teacher is one of the best jobs you could have. I'm surrounded by young people. They keep me feeling energetic and excited about learning."

Dragos Hrimiuc's passion for teaching is palpable.

By Sarah Nason ('15 BSc) / Photos supplied by Patrick Welsh

Ducking the costs of migration

A monolithic factory churning through human waste might not seem like a paradise for wildlife, but every winter this is exactly where a motley crew of mallards make their home in Edmonton.



ESCHEWING the traditional migratory habits of their species, this renegade group elects instead to dwell in and around ponds of partially treated wastewater produced by the local wastewater treatment plant. Luckily for the ducks, the water here, called secondary clarified effluent water (SCEW), has already had certain undesirables filtered out. But what convinces a duck to overwinter here?

"Ducks only go however far south, or east, or west, or wherever their normal overwintering grounds are to reach appropriate conditions for them to overwinter," explains Cynthia Paszkowski, professor emeritus (biological sciences). "One thing that often creates an attractant, which was true at the water treatment plant, is open water. Not only do they feed or drink from the open water, but that's also where they often like to sleep because they're relatively safe from predators on the water."

Another factor for the birds is finding a warm spot to escape the winter cold. As a result of the treatment process, the pond water remains at a hospitable temperature (more than 10 C) all year round, even when the ambient temperature drops to a chilly -30 C during the infamous Alberta winter. The mallards seem happy to skip the cross-continental flight, but onlooking scientists are not so sure.

Hungry birds

"THERE WAS an earlier study done in the '90s where they looked at overwintering birds, and a lot of the birds were not in good condition. They were pretty skinny. It's not the best place for them, clearly," says Paszkowski.

The truth is, wintering up north is probably not so much a cunning choice as a necessary evil for ducks that are unprepared to migrate. Most winter residents on the local North Saskatchewan River are juveniles, suggesting that they hatched too late in the season to build up the strength for migration. On top of that, the birds lose up to 30 per cent of their body weight over the winter. In effect, the birds find themselves in a vicious cycle: they need more food to build up the strength to make a migration, but the SCEW ponds don't have enough food for them to make it over the hurdle.

"You've got all of our drugs—recreational or pharmaceutical—and you've got all of our personal care products."

What's in the water?

WITH THE DUCKS likely to stay on these ponds long-term, there remains an elephant in the room: what's in the water at the wastewater treatment plant?

"Everything," says Keith Tierney (biological sciences), an expert in toxicology and fish. "You've got all of our drugs—recreational or pharmaceutical—and you've got all of our personal care products."

Tierney and his team have also been investigating the potential toxic effects the mallards may suffer due to their prolonged exposure to the partially treated water. The researchers were mainly concerned with the potential feminizing effects of synthetic compounds in the water, such as the active ingredient in birth control—ethinyl estradiol—which has been demonstrated to affect sexual development in fish.

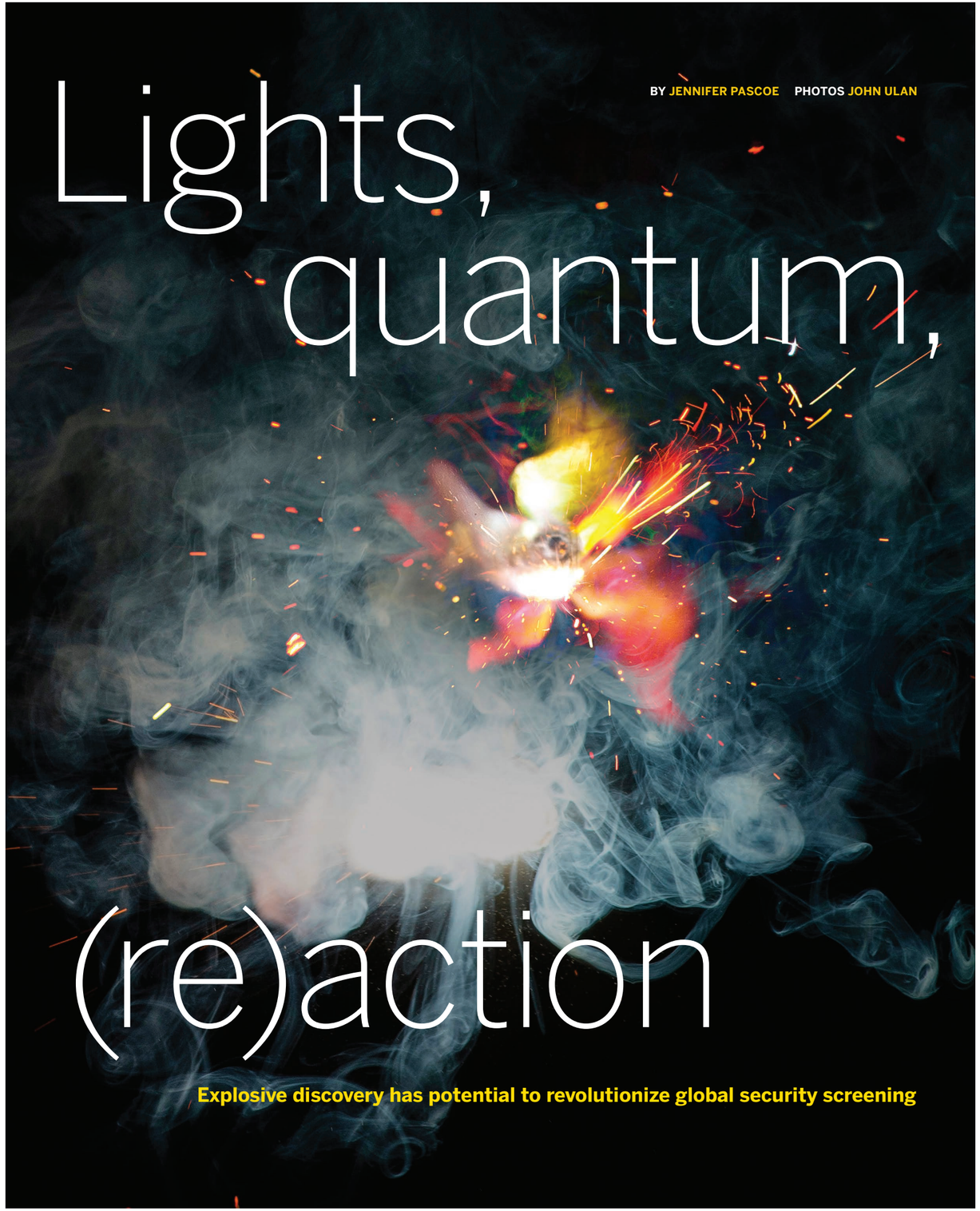
Luckily for the ducks, research by Tierney and his students showed that the SCEW appears to be safe. "It's full of pollutants, but they're at a very low concentration. We answered the question about toxicity, but the ecology of it, we don't know. There's going to be a relationship between mortality, starvation, and fitness benefit of overwintering, and we'd like to know what that is. But we haven't figured it out; we've only said that it exists."

Overall, the mallards might sound like quite the success story: they have found a stable niche in the urban environment, which is not the case for a lot of wildlife out there. Humans often struggle to share space with animals, resulting in animal populations being displaced, reduced, or eliminated.

But the question remains open of whether birds are truly better or worse off for wintering at the ponds, and with climate change likely to increase the number of ducks opting to stay put, this question may become more urgent in the future. The issue does not only affect Edmonton mallards: ducks and geese across the world are increasingly falling into what may be considered "ecological traps:" human-made micro-habitats that only work in the short term.

If the SCEW ponds are indeed a trap, how do you stop a mallard from landing there in the first place? Paszkowski suggests solutions borrowed from the fishery industry, such as wiring or netting off the ponds. Such a system might be a way to stop the cycle. To be sure what steps need to be taken, more research will be needed on the costs and benefits of an earthbound lifestyle for these urban ducks.

Sarah Nason graduated from the Faculty of Science in 2015 with a bachelor of science. Nason now works as a science communicator at Fuse Consulting Ltd.



Everything's bigger in Texas, or so the saying goes. But for one Texan who now calls Edmonton home, it's the little things that count. Really little. To the nanoscale, in fact. And her explosive discovery of something super small is adding up to really big possibilities that could soon revolutionize global security screening.

Christina Gonzalez ('17 PhD) followed a pretty typical graduate student journey. Get curious. Ask questions. Explore all possible answers. Present a poster or two. Publish the results. Build citations and scientific impact. And pursue employment. But for Gonzalez, that last step was anything but typical.

Around the time of her graduation, her former PhD supervisor, Jon Veinot (chemistry), happened to be starting a spinoff company, Applied Quantum Materials (AQM). AQM focused on heavy-metal-free, biocompatible silicon quantum dots and semiconductor nanoparticles for a broad range of applications in sensing, energy, displays, security, and bio-imaging. And Veinot's co-founder and AQM CEO, David Antoniuk ('83 PhD, Eng), was looking for innovative ideas to commercialize.

A fortuitous wander down the hallway and a glance at one of those aforementioned research posters out of Veinot's group piqued Antoniuk's curiosity. So much so that he contacted Gonzalez to offer her employment with AQM to commercialize her findings.

"During my PhD studies, we tested our silicon quantum dots for their response towards different explosive compounds, like RDX, PETN, and the more commonly known TNT," Gonzalez says of her research.

While their technology is still a few steps away from commercialization, the publicity generated earlier this year for her work stimulated interest from multiple partners across North America, which is allowing Gonzalez and AQM to optimize parameters to negate false positives caused by temperature and other environmental factors.

While the science behind it is anything but, the application is simple, only requiring a handheld UV light held up to a strip of paper. If it glows, you're good to go. If not, that simple chemical reaction indicates traces of an explosive material.

Christina Gonzalez ('17 PhD) in AQM laboratories


At the swipe of a hand, Gonzalez's discovery demonstrates the presence—or absence—of explosive compounds.


If it glows, you're good to go. The discovery could revolutionize global security.

Glow and go

"What we found is if we introduced one of those explosive compounds at the start, we would see that the glowing luminescence characteristic of silicon nanocrystals would quench, or turn off, in the presence of the explosive substances. The silicon nanocrystals glow a red orange in UV light, but when you add the explosive, they don't glow anymore. It causes them to dim or turn off."

While her undergraduate and master's work focused on analytical chemistry and using nanoparticles for water remediation, Gonzalez said it was the nanoparticles themselves that sparked her interest in pursuing PhD studies. She was drawn from her home in El Paso, Texas, to the University of Alberta, known for its strong nanocharacterization facilities and multiple faculty members within the chemistry department renowned for their work in nanomaterials.

While she had her sights set on becoming a research scientist after graduation, Gonzalez had no idea that she could continue pursuing her research passion while also working with a burgeoning startup, one so promising that it recently received a nearly half-million-dollar stamp of approval from Alberta Innovates. (That grant was for solar windows, demonstrative of the depths and breadth of potential application for AQM's innovations.) With that announcement in February, followed by an explosion of mainstream media interest in Gonzalez's project, the future is glowing for AQM.

In addition to Veinot and Antoniuk, AQM employs four scientists, all former students of Veinot's.

"Commercialization ventures like AQM reach far beyond making money from innovation," says Veinot. "They simultaneously increase the visibility and impact of U of A research while offering U of A graduates the invaluable opportunity to witness technologies they developed during their academic studies move from idea to reality. This experience puts everything into context and fosters an enthusiasm that cannot be realized through any other way."

Inner workings

"It's exciting to know I'm the co-inventor of this technology that could be implemented in so many different avenues," says Gonzalez. "It was unexpected. I didn't foresee myself in a spinoff. A lot of students don't have the opportunity to commercialize their research."

Back in the lab, Gonzalez is using the opportunity to redefine detection of explosives. In addition to obvious applications for use in airport screening to replace the cumbersome and time-consuming technology currently in use, the AQM team have their eye on mobile applications including inspections of vehicles used to transport dignitaries or of podiums used by orators, scenarios that might benefit from a portable, more efficient technology.

"We are taking advantage of the fact that silicon nanocrystals still glow, even if they're on paper. If you look under UV light after swiping materials such as hands, backpacks, laptops, or other surfaces that may have come into contact with explosives, if there's regions of the paper that aren't glowing anymore, it indicates there is an explosive present. AQM's quantum dot sensor can detect trace amounts of explosives in the nanogram range. To put that into perspective, a fingerprint can pick up 100 micrograms. So we are detecting explosive compounds more than 1,000 times less."

By **MEGAN ENGEL ('10 BSc, '11 MSc)** / Photos JOHN ULAN

Impact of interdisciplinary interactions

Theoretical physicist Carlo Rovelli said, "Quantum physics does not describe how things are, but how things interact with one another. Even we human beings [are] a net of interactions with the world." I can think of no better way to describe who I am than with this concept. "I am a network of interactions that underlie all I do, just as microcosmically, synapse connections between neurons comprise the basis for all higher learning and creative advancement."

I AM A NETWORK of interactions between scientific disciplines. My academic path might at first appear disconnected; I hopped from computational quantum mechanics to laser microscopy to observational astrophysics during the summers of my undergraduate studies. But my interest really lies in what links these disciplines together: the universality of fundamental physical and mathematical laws, which can be applied to yield insights in diverse contexts, from X-ray binaries to lasers.

As my research career advances, I am particularly drawn to how biological systems have harnessed physics to remarkable ends. Human learning; the efficiency of photosynthesis; evolution; the miracle of the self-assembly of proteins and nucleic acids … like distinct concertos written for the same orchestra, each of these phenomena connects the same beautiful principles that make stars burn, and I want to find the musical scores.

My interdisciplinary curiosity was nurtured by the deeply formative mentorship of several professors. I would never have considered research if I hadn't been encouraged by my first summer project supervisor, Kevin Beach, after class one day. And I would not have applied for graduate school if my final summer research supervisor, Professor Craig Heinke (physics)—who went above and beyond by coaching me to publish as an undergraduate—hadn't pointed me to a master's scholarship he thought I could get.

Megan Engel ('10 BSc, '11 MSc)

I was shaped by the belief and support my cross-disciplinary mentors offered, and because of them, I went on to obtain a doctorate degree from Oxford and am now pursuing biophysical research as a Schmidt Science Fellow.

I am also a network of interactions between sciences and humanities. The first scientists were also philosophers, and remaining philosophically and ethically literate is vital for scientists. Among UAlberta's great strengths is its provision of freedom to have robust philosophical debates (particularly with those who disagree with you), and its requirement for scientists to engage with the arts. I vividly recall escaping to the Education building's music practice rooms—which were once open to all—to play piano, sing, and write music between quantum mechanics and electrodynamics lectures. Maintaining my artistic pursuits during a highly technical degree was vital for spurring new ways of thinking and contextualizing my research.

I will continue to strengthen and expand my network of interactions—scientific, artistic, personal, and spiritual—as my life continues, and will always reflect with gratitude on the latitude I was given to do so by the University of Alberta.