Faculty of Science

Connected Science

2015
Year in Review

Ryerson University

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2015
Year in Review

Ryerson University
Faculty of Science

Departments

Chemistry and Biology

Computer Science

Mathematics

Physics

At a Glance

2014-2015 in Numbers

Undergraduate Programs
Biology
Biomedical Sciences
Chemistry
Computer Science
Financial Mathematics
Mathematics and its Applications
Medical Physics

Graduate Programs
Applied Mathematics (MSc)
Biomedical Physics (MSc, PhD)
Computer Science (MSc, PhD)
Mathematical Modelling and Methods (PhD)
Molecular Science (MSc, PhD)
Environmental Applied Science and Management (MASc, PhD)*

Canada Research Chair

Roberto Botelho
Canada Research Chair
(Tier 2) in Biomedical Sciences and Technologies

Research Centres Housed in Faculty of Science
Ryerson Urban Water Centre
Privacy and Big Data Institute

* Interdisciplinary program administered by the Yeates School of Graduate Studies.

Innovation and Entrepreneurship Statistics for 2010-2015

34 Number of disclosures filed

13 Number of licenses executed

14 Number of patents filed

Growth in 5 Years

60% Undergraduate Student Enrolment

21% Graduate Student Enrolment

17% FOS Publications

23% Tri-Council Funds*

* Ryerson's Fiscal Year Is May 1 To April 30.

2,371 Undergraduate Students

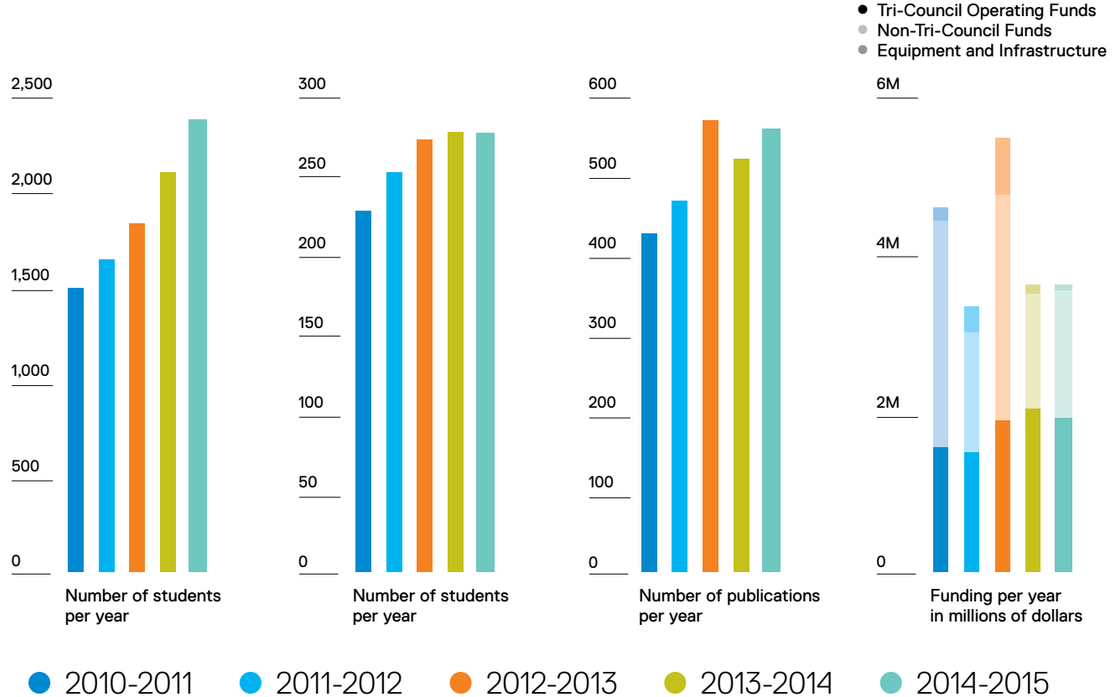
275 Graduate Students

91 International Students

93 Faculty Members

22 Postdoctoral Fellows

52 Staff



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Connected Science

Ryerson University's Faculty of Science exists at the intersection of mind and action. Together with many diverse partners outside our walls, we're applying ground-breaking research to real-world problems. Given our focus on relevance, our creative and multidisciplinary faculty members are continuously connecting with the community, maximizing the impact of our research and partnerships.

Our vision is to inspire and empower our faculty and students to become leaders in researching and solving global challenges.

Faculty-level activities — outreach and communication

As part of its strategic planning, the Faculty of Science identified science communication and community outreach as priorities over the next five years. Dr. Emily Agard, our new director of Science Communication, Outreach and Public Engagement (SCOPE), is developing a strategic plan to achieve those goals. Activities connected to the priorities we've established include:

- Participating as the educational partner in the MythBusters exhibition at the Ontario Science Centre.
- Participating as the only Canadian post-secondary institution with student research proposals for experiments to be carried out aboard the International Space Station.

Program offerings

Undergraduate studies

Our foundational science programs continue to thrive and attract strong enrolment, increasing by 45 per cent since 2012.

The Faculty of Science is developing its own version of zone learning with the Science Innovation Zone (SIZ) pilot. Twenty-three science students presented their ideas for new processes, products or technologies. This pilot project will evolve and continue as we identify barriers and opportunities.

The Faculty also boasts a lively range of worthy organizations and activities among the student community, including new societies such as the Ryerson Science Society, and support for engagement in various conferences. For example, a Computer Science student group placed 26th out of 130 teams at an International Collegiate Programming Contest (ICPC), and a Financial Mathematics student team competed in the Rotman International Trading Competition (RITC).

Graduate studies

Our graduate studies within the Faculty continue to grow and mature. Highlights this year included:

- Our first master's graduate from the Biomedical Physics program with the CAMPEP accreditation option.
- The first PhD graduates from the Computer Science graduate program.
- The approval of the new PhD in Mathematics, Mathematical Modelling and Methods (2016). The approval of the Math PhD program now makes the Faculty of Science the first completely comprehensive Ryerson Faculty in which all departments are research-intensive and offer both MSc and PhD programs.
- Biomedical Physics PhD student Eno Hysi received the Vanier Canada Graduate Scholarship, one of the most prestigious in Canada.

Research, collaborations, community involvement

- The Institute for Biomedical Engineering, Science and Technology (iBEST), a partnership between Ryerson University and St. Michael's Hospital, became a physical reality, and the Faculty of Science is also completing and outfitting a new laboratory research space at MaRS.
- The Faculty of Science continues to provide a home base for two research centres: Ryerson Urban Water (RUW), and the Privacy and Big Data Institute (PBD). Both RUW and the PBD Institute are multidisciplinary, pan-university centres aiming to bring together thought leaders, researchers and other partners to develop solutions to current societal problems.

@RySciDean

While the world around us is beset by change, complex needs and new threats, Ryerson's Faculty of Science is well-positioned to respond. Our creative and collaborative approach, our diversity and uniquely urban setting all serve to enhance our ability to make an impact – both locally and in a global sense.

Imogen R. Coe
Dean, Faculty of Science

Select Awards and Accolades

2014 – 2015 faculty awards and recognition

Dr. Costin Antonescu received the YSGS Outstanding Contribution to Graduate Education Award.

Dr. Alexandre (Sasha) Douplik received the Deans' Scholarly, Research and Creative Activity Award.

Dr. Marcos Escobar-Anel received the Deans' Scholarly, Research and Creative Activity Award.

Dr. Chul Kim received the Deans' Teaching Award.

Dr. Andrew Laursen received the Deans' Teaching Award.

Dr. Andrew Laursen received the Provost's Innovative Teaching Award.

Dr. Isaac Woungang received the Deans' Service Award.

Dr. Isaac Woungang received the NSERC Japan Society for the Promotion of Science (JSPS) Short-term Award in 2015.

2013 – 2014 faculty awards and recognition

Dr. Emily Agard received the Dean's Teaching Award.

Dr. Catherine Beauchemin received the Early Researcher Award.

Dr. Roberto Botelho received the Early Researcher Award.

Dr. Roberto Botelho was awarded a Canada Research Chair Tier 2.

Dr. Andrea Burgess received the Deans' Scholarly, Research and Creative Activity Award.

Dr. Alexander Ferworn received the Partners in Research Technology Ambassador Award.

Dr. Debora Foster received the YSGS Outstanding Contribution to Graduate Education Award.

Dr. Kimberley Gilbride received the Deans' Teaching Award.

Dr. Ali Miri received the Deans' Service Award.

Dr. Derick Rousseau received the Deans' Scholarly, Research and Creative Activity Award.

Dr. Derick Rousseau received the AOCS Timothy L. Mounts Award.

Postdoctoral fellows and staff awards

Postdoctoral fellow Dr. Natalia Grañé Boladeras received the St. Michael's Hospital Postdoctoral Award in 2015.

Postdoctoral fellow Dr. Tommaso Traetta received the n. 10 Post-doc INdAM-COFUND-2012 Fellowships in Mathematics and/or Applications for experienced researchers, co-funded by Marie Curie actions in 2015.

Postdoctoral fellow Dr. Lauren Wirtzfeld received the Canadian Cancer Society Travel Award.

Staff member Graham Pearson received the Make Your Mark Award in 2014.

2014 – 2015 student competition winners (external)

Chemical Institute of Canada Book Prize

Chemistry student Koushan Farshad received this award.

Chemical Institute of Canada Medal

Chemistry student Bahar Ameri received this award.

CIHR Canada Graduate Scholarship – Doctoral Award

Molecular Science PhD student Monica Dayam received this award.

CIHR Canada Graduate Scholarship – Master's Program Award

Molecular Science MSc student Victoria Hipolito received this award.

iBEST Angels' Den Trainee Competition

Physics MSc students Shabad Momin, Muhannad Fadhel, and Physics PhD student Pooya Sobhe Bidari received first, second, and third place, respectively, at this competition.

IEEE International Conference on Advanced Information Networking and Applications

Computer Science MSc student Ssowjanya HariShankar won the Best Paper Award.

International Symposium on Purine and Pyrimidine Metabolism in Man

Molecular Science MSc student Maliha Zafar won the best poster prize.

NSERC Canada Graduate Scholarship – Doctoral Award

Molecular Science PhD student Ryan West received this award.

NSERC Vanier Canada Graduate Scholarship

Biomedical Physics PhD student Eno Hysi received this award.

Next Generation Solar – Photovoltaics Canada National Scientific Conference

Molecular Science PhD student Muhammad Yousaf won first place in the HQP Research Poster Competition.

2014 – 2015 student competition winners (internal)

Bill Cott Award

Chemistry student Omar Abdi and Biology student Stephen Bautista received this award.

C. Roy Horney Scholarship Award

Mathematics and its Applications student Sophia Park received this award.

Computer Science Alumni Award

Computer Science students Mark Bouchkevitch, Tammmy Ngo and Matthew Ruten received this award.

Connections in Science Award

Contemporary Science student Michelle Defilippis received this award.

Department of Chemistry and Biology Excellence Award

Biology student Anastasiya Boutko received this award.

Department of Chemistry and Biology Faculty Award

Biomedical Science student Ryan Shilliday, Chemistry student Kyle Vollett, and Biomedical Science students Syed Mohammad Ibrahim and Cristina Thuppa Mudalige received this award.

Select Awards and Accolades

2014 – 2015 student competition winners (internal) continued

Department of Chemistry and Biology Research Award

Chemistry student Mohammad Talha Chaudhry, Biology student Alex Somerville, and Biomedical Science student Gemma Mancuso received this award.

Dennis Mock Award

Chemistry student Kaushiga Pirabaharan, Chemistry cooperative student Shaheen Yacoub, Computer Science student Shahnawaz Syed, Computer Science student Yomna Aly, Environmental Biology student Sujeev Sithamparanathan, and Mathematics student Christopher Heggerud received this award.

Dr. Philip H Byrne Memorial Award

Computer Science student Alessandro Profenna received this award.

Eugene Wertyporoch Memorial Prize

Biomedical Science student Mercedes Ing received this award.

Faculty of Science Gold Medal

Computer Science student Yomna Ally was the winner of this medal.

Federation of Chinese Canadian Professionals Education Award

Computer Science student David Tenty received this award.

Frank G. Roughton Award

Contemporary Science student Veronika Januszko received this award.

Fred N. Hainsworth Award

Medical Physics student Michael George Dervenis received this award.

Howard H. Kerr Memorial Scholarship

Financial Mathematics student Harjas Singh received this scholarship.

Jack Roy Longstaffe Memorial Scholarship

Computer Science student Steniel Sy received this scholarship.

James H. Rattray Memorial Award

Computer Science student Victoria Hellinga and biology student Tanya Bittles received this award.

Mathematics Faculty Scholarship

Financial Mathematics student Ghazaleh Asrderakhshan received this scholarship.

Noel Award

Medical Physics student Ana Sofia Vargas Garza received this award.

Paul and Anna Maria Bonato Mathematics Scholarship

Mathematics and its Applications student Andrew de Mesa received this scholarship.

Physics Faculty Scholarship

Medical Physics students Caryn Geady and Daniel Molenhuis received this scholarship.

Robert A. Guerriere Scholarship

Contemporary Science student Ben Fischer received this scholarship.

Ryerson 3MT (Three Minute Thesis) Competition

Computer Science MSc student Zainab Al-Zanbouri won second place.

Sarwan S. Sahota Award

Biomedical Science student Kazeera Aliar received this award.

School of Computer Science Award

Computer Science students Shahab Deljooye Shahir, Paul Tan, David Zhang, Jason Hsiung, Matthew Ruten and Wayne Tong received this award.

Sony Canada Charitable Foundation Scholarship

Computer Science student Navid Khan received this scholarship.

Stalin Boctor Undergraduate Award

Biology student Ryan Shilliday received this award.

Sudharakan Aerath Memorial Award

Computer Science student Jason Hsiung received this award.

Women in Computer Science Award

Computer Science students Elizabeth Chan and Azra Jessa received this award.

Women in Mathematics Undergraduate Award

Mathematics and its Applications student Sophia Park received this award.

Chemistry and Biology Research Symposium

The poster competition prize winners and runners-up in each category were as follows:

Winner, Paloma Prieto; runner-up, Jeff Pau (undergraduate, chemistry)

Winner, Kayla Fischer; runner-up, Kamlesh Mistry (graduate, chemistry)

Winner, Victor Lu; (undergraduate, environmental biology)

Winner, Amir Tehrani; runner-up, Kruti Shukla (graduate, environmental biology)

Winner, Tanveer Singh; runner-up, Alyson Burtch (undergraduate, molecular/cell biology)

Winner, Victoria Hipolito; runners-up, Tracy Lackraj and Diana Schwendender-Forkel (graduate, molecular/cell biology)

2013 – 2014 student competition winners (external)

Chemical Institute of Canada Book Prize

Chemistry student Calvin Morier received this prize.

Chemical Institute of Canada Medal

Chemistry student Jasjit Singh received this medal.

Canadian Chemistry Conference and Exhibition

Molecular Science MSc student Omar Abdi won this award for best presentation in Materials Chemistry.

CIHR ICS Travel Award

Molecular Science PhD student Donald Fernandes received this award.

Experimental Biology Conference

Molecular Science MSc student Eden Ross won the best poster award.

International Conference & Research Support Fund (ICRSF) Award

Molecular Science MSc student Monica Dayam received this award.

International Society of Trace Element Research in Humans

Biomedical Physics PhD student Eric Da Silva received the Best Young Researcher Award.

Select Awards and Accolades

2013 – 2014 student competition winners (internal)

Bill Cott Award

Chemistry student Maryam Abdinejad and Biology student Leslie Bone received this award.

Biology Faculty Award

Biology student Nishara Muthuarachchige received this award.

Biomedical Science Faculty Award

Biomedical Science student Ryan Park received this award.

C. Roy Horney Scholarship Award

Mathematics and its Applications student Christopher Heggerud received this award.

Computer Science Alumni Award

Computer Science students Brian Chiu, Stenial Sy and David Tenty received this award.

Dennis Mock Award

Biology student Karen Quinto received this award.

Departmental of Chemistry and Biology Research Award

Chemistry student Sara Abuadas and Biology student Emma Brun-Hayne received this award.

Dr. Philip H. Byrne Memorial Award

Computer Science student Wayne Tong received this award.

Dr. Robert A. Guerriere Scholarship

Biology student Farnaz Fekri received this scholarship.

Errol Aspevig Undergraduate Award

Biology student Tanveer Singh received this award.

Eugene Wertyporoch Memorial Prize

Chemistry student Mohammed Chaudhry received this prize.

Federation of Chinese Canadian Professionals Education Award

Computer Science student Denis Bezverbnyy received this award.

Frank G. Roughton Award

Chemistry student Koushan Farshad received this award.

Fred N. Hainsworth Award

Medical Physics student Julia Pearse received this award.

Howard H. Kerr Memorial Scholarship

Mathematics and its Applications student Andrew de Mesa received this scholarship.

Jack Roy Longstaffe Memorial Scholarship

Computer Science student Seth Nagelberg received this scholarship.

James H. Rattray Memorial Award

Chemistry student Jasjit Singh and Computer Science student Jared Gottinger received this award.

Learning & Teaching Office (LTO) TA/GA Award

Molecular Science MSc student Zach Teitel received this award.

Mako Ryerson Student Invention Award Competition

Physics students Hazra Sokoli and Rawan Ibrahem won second place in this competition.

Mathematics Faculty Scholarship

Financial Mathematics student Harjas Singh received this scholarship.

Office of Science Outreach and Enrichment (OSOE) Award of Excellence

Chemistry student Sara Abuadas received this award.

Outstanding Student Professional Award

Biology student Tanveer Singh received this award.

Paul and Anna Maria Bonato Mathematics Scholarship

Mathematics and its Applications student Christopher Heggerud received this scholarship.

Physics Faculty Award

Medical Physics student Mithunan Modchalingam received this award.

Physics Faculty Scholarship

Medical Physics students Caryn Geady and Armand Samaroo received this scholarship.

President's National Entrance Scholarship

Computer Science students Azra Jessa and Sadia Mehmood received this scholarship.

Ryerson Physics Undergraduate Research Symposium

Medical Physics student Robert Earl won first place, Medical Physics student Gabriella Tesfay won second place, and Medical Physics student Patryk Wohlert won third place.

Sarwan Sahota Award

Biomedical Science student Mercedes Ing received this award.

School of Computer Science Alumni Award

Alumni Brian Chiu, Stenial Sy and David Tenty received this award.

School of Computer Science Award

First-year computer science students Mark Bouchkevitch, Jason Hsiung and Wayne Tong, and second-year computer science students Navid Khan, Jake Nicolaidis and Steniel Sy, received this award.

Sony Canada Charitable Foundation Scholarship

Computer Science student Matthew Tesfaldet received this scholarship.

Stalin Boctor Undergraduate Award

Biology student Bryan Hsu received this award.

Sudharakan Aerath Memorial Award

Computer Science student Navid Khan received this award.

Ryerson 3MT (Three Minute Thesis) Competition

Molecular Science PhD student Muhammad Ali Naqvi won first place.

Toronto Agile Community Award

Computer Science student Peter Campeau received this award.

Women in Computer Science Award

Computer Science students Yomna Aly and Elizabeth Chan received this award.

Chemistry and Biology Research Symposium

The poster competition prize winners and runners-up in each category were as follows:

Winner, Burhan Hussein; runners-up, Andrew Harris, Kiron Gonidis, Charles Wilson and Dean Simonsky (undergraduate, chemistry)

Winner, Nande Wright; runners-up, Devin Machin and Vassilios Kanellis (graduate, chemistry)

Winner, Anna Maria Lulek; (undergraduate, environmental biology)

Winner, Wendy Stone; runner-up, Nick Dimas (graduate, environmental biology)

Winner, Emma Brun-Hayne; runner-up, Tanveer Singh (undergraduate, molecular/cell biology)

Winner, Leslie Bone; runners-up, Amra Saric and Tracy Lackraj (graduate, molecular/cell biology)

Chemistry and Biology

Unravelling the natural world to better understand life's machinery

Ryerson's intentional combining of chemistry and biology into one department (chemistry and biology are not typically housed together) reflects our unique interdisciplinary and collaborative approach. Together, our researchers in biomedical sciences, environmental science and chemistry are addressing critical issues affecting human health and the world we inhabit.

Genetics, the effects of toxic chemicals on biological organisms, the functionality of materials, and interactions between molecules. At Ryerson, the Department of Chemistry and Biology offers a dynamic program that combines core education with unique opportunities to explore the critical interface between chemistry and biology.

Each subdivision of our teaching program has laboratories devoted to undergraduate instruction – chemical instrumentation, chromatography, and analytical, inorganic, physical and organic chemistry. We also have labs specifically designed for biochemistry and microbiology experiments, including gel electrophoresis and DNA sequencing. Facilities for air pollution control and wastewater treatment are also available to students working on their undergraduate theses. Finally, the mission and strength of this department includes a student-focused academic plan, plus accomplished and approachable instructors focused on student success.

By the Numbers
Ryerson's Chemistry and Biology department has:

33 tenured and tenure-track faculty members

3 limited-term faculty members

1,135 undergraduate students (approximately)

9 postdoctoral fellows

33 students pursuing master's degrees

18 students pursuing doctoral degrees

Photo: Dr. Bryan Koivisto, Associate Professor in the Department of Chemistry and Biology

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Chemistry and Biology

High-quality research is a priority for our department. Each year, we continue to experience significant research funding, a steady rate of growth, and an increasing number of PhD students. In addition to **Dr. Roberto Botelho**, our Canada Research Chair (Tier 2) in Biomedical Sciences and Technologies, faculty members have external funding from agencies such as NSERC and CIHR and are active in multiple industrial and corporate interactions as well as many innovative projects.

We are also major contributors to Ryerson Urban Water, a multi-disciplinary collective of experts with research and educational interests in water in urban environments.

Looking ahead, as we continue to implement the Biomedical Sciences undergraduate program, now in its third year, our department will hire more faculty members, and develop additional research capacity and collaborative projects. **Dr. Stephen Wylie**, our department chair, says, "Ryerson is carving out a reputation for relevant, collaborative research, and our department is a strong part of that."

Highlights

Dr. Warren Wakarchuk received $213,000 per year for two years through the Canadian Glycomics Network (GlycoNet). Glycomics is the comprehensive study of all sugars and sugar derivatives present in organisms – and GlycoNet is a national research network working with industry, government and academic partners to drive solutions to important health issues through the study of glycomics.

Another of Wakarchuk's projects, a collaboration with Canadian biotechnology company Plantform Corporation, yielded key progress in a venture using plants to make an enzyme that has promise as a pharmaceutical protein. Awarded a contract by the Canadian government, Wakarchuk and Plantform are developing a plant-made BuChE drug candidate as a less costly alternative to the plasma-derived BuChE enzyme.

Every month, the Victoria Street Cell Biology Club gathers up to 60 students, faculty and medical researchers from St. Michael's Hospital and Ryerson to talk about science in a collaborative environment. The club was started two years ago by **Dr. Costin Antonescu.**

In August, Science at the Interface, the department's fourth-annual interdisciplinary symposium had its biggest event ever, with 80 student posters, nine student talks and 150 attendees. This student-organized conference provides graduate and undergraduate students with a friendly inclusive introduction to presenting at scientific conferences, plus the opportunity to connect with peers.

In April, the department held its third-annual Alumni/Student Mentoring Event in downtown Toronto. This event provides networking opportunities and inspiration to students, recent graduates and alumni alike.

Research areas

Biomedicine and biomolecular interactions

Synthetic and medicinal chemistry

Surfaces and interfaces

Pathogens and infection

Cells, genes and molecules

Water, energy and environmental change

Materials and food chemistry

Pedagogy, science education and outreach

Research facilities

Advanced Microscopy Facility consisting of a two-photon confocal laser scanning microscope (CLSM); a Raman confocal microscope (RCM); an atomic force microscope (AFM); and an inverted laser confocal microscope suitable for live-cell imaging

Deconvolution Epifluorescence Microscopy Facility for live-cell imaging

400-MHz Bruker multi-probe nuclear magnetic resonance instrument

Tritium Labelling Facility

Level 2 Biohazard Facility licensed for work with eukaryotes and prokaryotes

A suite of analytical equipment, including high-performance liquid chromatography (HPLC) with UV, refractive index, conductance and fluorescence detection; gas chromatography-mass spectrometry (GC-MS) with autosampler; gas chromatography with headspace and purge-and-trap autosamplers; molecular luminescence, UV-visible spectroscopy; and Fourier Transform Infrared spectroscopy

An array of dedicated research laboratories in direct support of Chemistry and Biology faculty members' research programs

Photo: Dr. Sarah Sabatinos, Assistant Professor in the Department of Chemistry and Biology

Case Study: Cell Checkpoints, Genome Instability and Survival

Understanding how some cells escape chemotherapy during cancer treatment

Human cells have built-in machinery that allows them to respond to toxic stresses – such as harmful drugs and temperature changes – by stopping cell growth, repairing damage, and then restarting the process of growth and metabolism. The machinery and paths within cells that bring about these stops are called "checkpoints."

In her NSERC-supported research work, "Measuring the Effect of Environmental Stress on Checkpoint, Genome Instability and Survival," Ryerson's **Dr. Sarah Sabatinos**, an assistant professor in the Department of Chemistry and Biology, explores environmental impact on cells. Her work examines how checkpoints work, why they can fail, and whether the everyday stresses a cell encounters before and during drug exposure can change the checkpoint program. Sabatinos also wants to determine if surviving cells have undergone changes, what issues that might pose, and whether certain environmental stress factors could improve cell health during or after toxic-drug exposure.

"In the real world, these questions have implications in cancer," says Sabatinos. "First, because many cancers alter checkpoints. Cancer cells effectively become checkpoint mutants. Second, because chemotherapy uses drugs to target and kill proliferating cancer cells. Third, because we are increasingly aware that cells are affected by their 'micro environment' in the body, and this might impact cancer therapy."

Essentially, says Sabatinos, "I want to understand how some cells escape chemotherapy during cancer treatment. I call these cells the 'escapees.'" She adds that escapees are potentially dangerous because they have survived drug treatment and could mutate into a more problematic cell type – yet they're difficult to monitor. Currently, Sabatinos tests genetic contributions to escape in the fission yeast, *Schizosaccharomyces pombe*, which is a powerful micro-organism with human-like characteristics in checkpoint/chromosomes/cell cycle. Calling escapee cells an overlooked factor in cancer relapse, Sabatinos says by understanding how they survive and how environmental stress contributes to escape, we learn more about how cancer is established.

In 2015, Sabatinos published a study, "Replication stress in early S phase generates apparent micronuclei and chromosome rearrangement in fission yeast," in the journal *Molecular Biology of the Cell*. A former research associate at the University of Southern California, her teaching interests include molecular biology, cell biology, biochemistry, cancer and experimental design.

Chemistry and Biology

Case Study: Adherent-Invasive E. Coli and Crohn's Disease

Photo: Dr. Joseph McPhee, Assistant Professor in the Department of Chemistry and Biology

How one bacteria induces and adapts to inflammatory conditions associated with Crohn's

Canada has one of the world's highest rates of inflammatory bowel disease. In fact, diagnoses of Crohn's disease have doubled since 1995. This places a tremendous burden on patients, their families and the health-care system.

Ryerson's **Dr. Joseph McPhee**, an assistant professor in the Department of Chemistry and Biology, is working to define the molecular determinants of bacterial resistance to host-defence peptides and determine the means of combating them. In particular, McPhee wants to further study adherent-invasive *Escherichia coli* (AIEC) associated with Crohn's disease. These bacteria are able to adhere to the intestinal epithelium and survive inside host macrophages (something most E. coli cannot do). McPhee says, "We want to understand how this group of bacteria induces and adapts to the inflammatory conditions associated with Crohn's diseases."

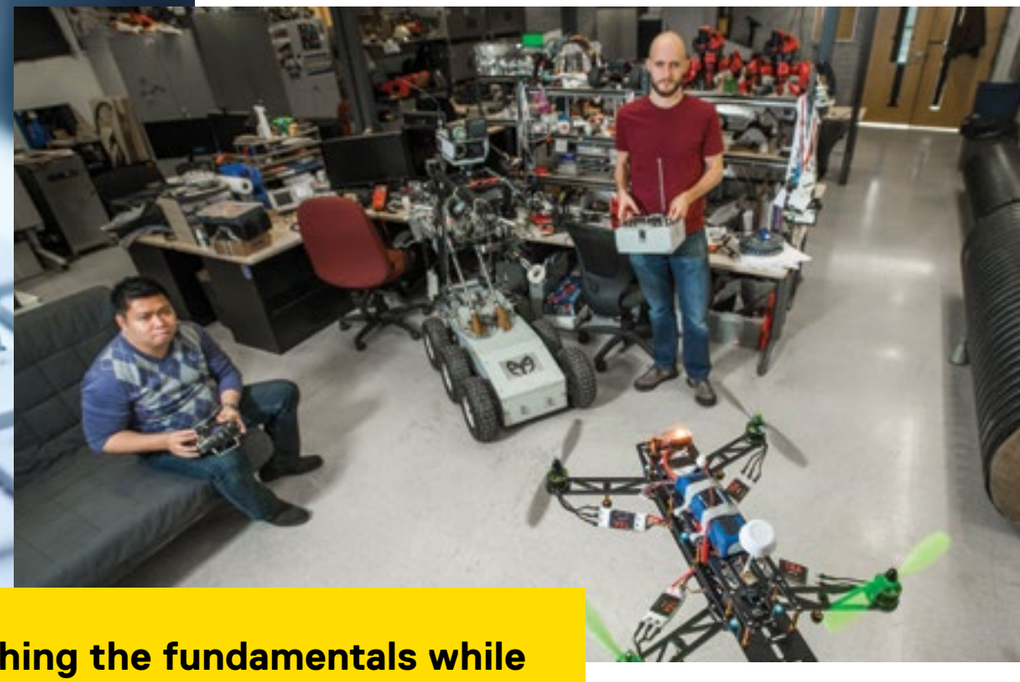
More particularly, McPhee is interested in how enteric pathogens adapt to the intestinal environment, and induce and respond to intestinal inflammation. He's investigating specific questions such as, "How do these bacteria survive exposure to the natural antibiotics found in our GI tract?" and "How does inflammation change the way these bacteria metabolize nutrients in the gut?" By utilizing comparative genomic, molecular biological, microbiological, biochemical and immunological techniques, McPhee and his team seek to define the molecular determinants of bacterial fitness under pro-inflammatory conditions.

McPhee's team has found, in at least one strain of Crohn's-associated E. coli, that specific genes are associated with increased resistance to host antimicrobial peptides. "We are trying to figure out what these proteins do and how they contribute to host-resistance. We've got a good handle on one of them; we don't understand what the other two do." says McPhee.

Related to this research, McPhee attended the 2015 American Society for Microbiology meeting in New Orleans and made a presentation on the role of a propanediol utilization system in the fitness of adherent-invasive E. coli. As well, Youn Hee Cho, a fourth-year undergraduate in McPhee's lab, received a Ryerson University Faculty of Science Undergraduate Research Opportunity Award for her project on how adherent-invasive E. coli are able to resist human host-defense peptides.

McPhee's research is supported by an NSERC Discovery Grant, and his teaching interests include medical microbiology, host-pathogen interactions, and microbiome in health and disease.

Computer Science



Teaching the fundamentals while exploring new frontiers

In today's hyperconnected age, the need for relevant innovation from computer scientists keeps growing. Consequently, there's a huge demand for computer science graduates. And Ryerson's Department of Computer Science is ready. We're forming innovative partnerships and research initiatives including big data ventures to equip our students to answer digital questions of today and tomorrow.

In Ryerson's Department of Computer Science, we recognize that traditional models like lecture-based instruction aren't enough. In a climate of continual innovation, we need to train graduates who are enterprising, collaborative and think outside the box. Our department – one of the largest in Ontario – balances solid teaching of the fundamentals with opportunities for practical learning and hands-on exploration through co-op placements, in-class projects and work with external partners.

We offer traditional instruction modes complemented with in-house access to the best equipment, online testing and tutorial facilities, plus highly accomplished and engaged instructors. And crucially, we've also forged a variety of external partnerships with government, business and the non-profit sector – our students gain real-world experience and connections throughout their academic training.

By the Numbers
Ryerson's Computer Science department has:

20 tenured and tenure-track faculty members

2 postdoctoral fellows

750 undergraduate students (approximately)

42 students pursuing master's degrees

30 students pursuing doctoral degrees

Photo: Jimmy Tran and Alex Ufkes, Computer Science PhD students in the Network-Centric Applied Research Team (N-CART)

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Computer Science

A lively extracurricular component completes the picture. The department actively supports a diverse range of student-organized activities. This includes everything from workshops on game development by the Game Maker's Union, to the Women in Computer Science (WiCS) group which offers support, networking and professional development events to female students, an important function as women are still underrepresented in the computer science field. Other departmental involvements include participation in International Collegiate Programming Contests (ICPCs), "hackathon" events and Code Camp 2015, a programming clinic designed for incoming students who lack a background in computer science.

Over the past year, Ryerson researchers worked in cutting-edge research areas including: cloud computing, robotics, software engineering, security, visualization, computer vision and artificial intelligence.

Highlights

Our program offerings continue to expand towards our goal of equipping our students with relevant skills, knowledge and experiences:

- We had our first cohort of PhD graduates during the fall convocation of 2015, signalling the maturation of our graduate program, which began in 2011. Dr. Fatema Rashid was our first PhD graduate and Dr. Mubarak Alrashoud was the first international student to complete our PhD program.
- For undergraduate students, a new concentration in Software Engineering has been approved by the Departmental Council and Senate.
- **Dr. Alexander Ferworn** co-applicant, received funds from the NSERC Collaborative Research and Training Experience (CREATE) program. The team received funding for six years to train future disaster and emergency-response professionals.
- In July, **Dr. Ali Miri** was technical program chair and a keynote speaker at the 13th International Conference on Privacy, Security and Trust (PST2015).
- The department also participated in a number of community projects through the Office of Science Communication, Outreach and Public Engagement (SCOPE). We hosted high school students in our classes and involved them in department-organized workshops on robotics and mobile app development. Recognizing the need to boost computer literacy across our campus, faculty members also designed accessible computer courses and workshops for students in other departments.

Research areas

Computational intelligence

Network-centric applied research

Information and computer security

Wireless and sensor networks

Ubiquitous and pervasive computing

Research Areas (continued)

Artificial intelligence: knowledge representation and reasoning

Interactive visual exploration, manipulation, and analysis of 2D and 3D data

Computer vision

Cloud computing

Social computing, data analytics, and behavior informatics

Research facilities

Network-Centric Applied Research Team (N-CART)

Information and Computer Security Laboratory (iCaSL)

Computational Intelligence Initiative (CI2)

Distributed Applications and Broadband NEtworks Laboratory (DABNEL)

Distributed Systems and Multimedia Processing (DSMP) Lab

Ubiquitous and Pervasive Computing Lab (UPCL)

Ryerson Vision Lab (RVL)

Photo: Dr. Jelena Mišić, Professor in the Department of Computer Science

Case Study: Machine-to-Machine Communications

Designing efficient and scalable communications for the Internet of Things

Forecasts predict that by 2020, some 50 billion things will be connected to the internet – everything from our coffeemakers, HVAC systems, cars and the family pet. Potential useful applications are virtually endless. For example, our home appliances, fitted with tiny devices, could report energy consumption to a power meter, and turn themselves on and off, depending on the time of day and load on the local power utility network.

Further scientific study of machine-to-machine (M2M) communications is the current research focus of Ryerson's **Dr. Jelena Mišić**, a professor of computer science and expert in wireless networks. Mišić and her husband and collaborator **Dr. Vojislav Mišić**, also a computer science professor at Ryerson, recently co-authored a well-received book on M2M communications called *Machine-to-Machine Communications: Architectures, Technology, Standards, and Applications* (CRC Press, 2014).

Mišić and her students are developing novel ways to modify the existing technology standard to allow machine-to-machine traffic to coexist and share spectrum bands – plus a large portion of the existing cellular network infrastructure – with traditional users and their smartphones, tablets and similar devices.

Intrigued by the benefits and potential applications of what's sometimes referred to as the Internet of Things, Mišić is equally clear on the technical challenges. Mišić says that traditional wireless networks – typically involving smart devices such as phones, tablets and computers operated by humans and a limited number of such devices in a given area – are transferring ever-increasing chunks of data (via web page and video downloads). Yet this traffic explosion is nothing compared to machine-to-machine communications where thousands or even millions of smart electronic devices communicate with tiny messages all the time. Consequently, designing efficient and scalable machine-to-machine communications poses a rather different set of challenges compared to that of traditional wireless networks. And that is particularly true since existing technologies – including modern 4G networks such as LTE – cannot be used directly.

This research is supported by Ericsson Canada and a number of NSERC grants.

Computer Science

Case Study: Wireless Sensor Networks with Wireless Recharging

Photo: Dr. Vojislav Mišić, Professor in the Department of Computer Science

Extending network lifetime while maintaining throughput

Wireless sensor networks (WSNs) are required to perform for prolonged periods of time without human intervention. Currently though, battery lifetime is a major constraint and limits the usability of wireless sensor networks. This is because batteries, every so often, have to be manually replaced.

Yet if device batteries could be recharged, either from environmental energy or via radio energy pulses from the base station or access point, the network lifetime could be greatly extended, and operational costs reduced. Drs. **Jelena Mišić** and **Vojislav Mišić**, professors of computer science in Ryerson's Department of Computer Science, are investigating means of significantly extending the lifetime of WSNs. Their research focuses on wireless radio-frequency recharging, which they believe is a very promising approach. The benefits of this approach (versus recharging from environmental energy) is that it offers greater reliability and controllability, since radio frequency recharging does not depend on the availability of sufficient energy in the environment to replenish the nodes' power source. The Mišićs and their students, notably PhD student Mohammad Shahnoor Islam Khan, are collaborating on the design of WSN with wireless recharging on node batteries.

Algorithms and protocols developed by the Mišićs and their team try to interleave communication and recharging periods with the goal of extending the network lifetime while maintaining the desired communication throughput of the network. To this end, individual nodes are instructed to request a recharge whenever they detect that their battery level falls below a predefined threshold; other nodes in the vicinity can repeat recharge requests if the access point fails to properly receive it due to noise.

In a recent paper for the *Journal of Communications* (Vol. 10, No. 9, September, 2015), Khan and the Mišićs present a simple MAC protocol based on polling that includes provisions for on-demand recharging using the same radio frequency band as normal data communications. And they developed a probabilistic performance model to evaluate the impact of the recharging process on data communications under a range of values.

The Mišićs, who are frequent collaborators, have published several books and numerous publications in peer-reviewed journals, supervised many graduate students and postdoctoral students and are also both senior members of the Institute of Electrical and Electronics Engineers (IEEE). Their research interests include cognitive networks, cloud computing, machine-to-machine communications and network security.

Mathematics

Pure mathematics meets real-world applications

What does a mathematics program for the 21st century look like? At Ryerson, we think it's one that offers an applied and interdisciplinary education to match today's hungry demand for advanced mathematics graduates

Whether it's analyzing risk in the stock market, simulating the spread of a disease through a population, or modelling online social media networks like Facebook, sophisticated mathematical tools are continually called upon in our digital age. Given the robust real-world demand, and the fact that it is the only applied mathematics program offered in the GTA, Ryerson's Department of Mathematics continues to attract attention and grow.

Since 2008, with our first undergraduate program in Mathematics and Its Applications, the department has been developing highly focused and rigorous programs. We added a master's program in Applied Mathematics in 2009 and another undergraduate degree in Financial Mathematics in 2013.

By the Numbers
Ryerson's Mathematics department has:

20 tenured and tenure-track faculty members

1 limited-term faculty member

200 undergraduate students (approximately)

7 postdoctoral fellows

20 students pursuing master's degrees

Photo: Dr. Sebastian Ferrando, Professor in the Department of Mathematics

Continued from previous page

Mathematics

The planning for the Mathematical Modelling and Methods PhD program passed another hurdle in 2015 with the completion of an external review. Pending approval, our doctoral program is on track for the 2016-17 academic year.

At Ryerson, the key to success is our approach. We combine "pure" and publishable mathematics with opportunities for relevant, hands-on experimentation via co-op placements and collaborative research. The overarching emphasis is on applied research and innovative solutions, particularly in Canada's telecommunications, financial, engineering, health, environmental and government sectors.

Then, after graduating ceremonies, Ryerson's applied focus means our graduates have greatly expanded professional opportunities ranging well beyond traditional avenues such as academic research and teaching.

Features of our program include:

- An interdisciplinary format where students are trained in one of three areas of research (Biomathematics and Fluids, Financial Mathematics, Graphs at Ryerson) – but also exposed to tools from other streams.
- Proximity to leading-edge resources like research institutes, centres for biomedical research, university hospitals and financial institutions.
- Multiple collaborations with industry partners, governmental agencies, incubators at Ryerson and the larger scientific community.

Highlights

The Graphs at Ryerson (G@R group), under **Dr. Pawel Pralat**, started a new collaboration with the Tutte Institute for Mathematics and Computing. This is an Ottawa-based government organization conducting classified research to improve the security of Canada and its allies.

Pralat also holds the title of mathematics researcher with the most NSERC Engage Grants (he has seven). His most recent NSERC Engage-supported partnerships include "Relationship-mapping analytics for fundraising and sales prospect research" with Charter Press, and "Utilizing Big Data for business-to-business (B2B) matching and recommendation system" with ComLinked Corp.

Dr. Anthony Bonato, also with G@R, was appointed to the NSERC Discovery Grant Evaluation Group for Mathematics and Statistics.

In February, for the first time ever, students from the Financial Mathematics group competed in the Rotman International Trading Competition (RITC), the world's largest such competition.

Department faculty arranged knowledge-exchange activities internationally and closer to home. This included a symposium on random graphs at the 5th biennial Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM) held in Saskatoon in June, the workshop Cargese Fall School on Random Graphs held in Corsica, France, the 11th Workshop on Algorithms and Models for the Web Graph held in Beijing, and the Faculty of Science's annual Pi Day in March at Ryerson, which attracted many researchers and students.

The department created two new awards, including the Women in Mathematics Undergraduate Award for outstanding undergraduate contributions to women in mathematics.

Research areas

Biomathematics and fluids

Financial mathematics

Graph theory

Research facilities

Ryerson Applied Mathematics Laboratory (RAMLab)

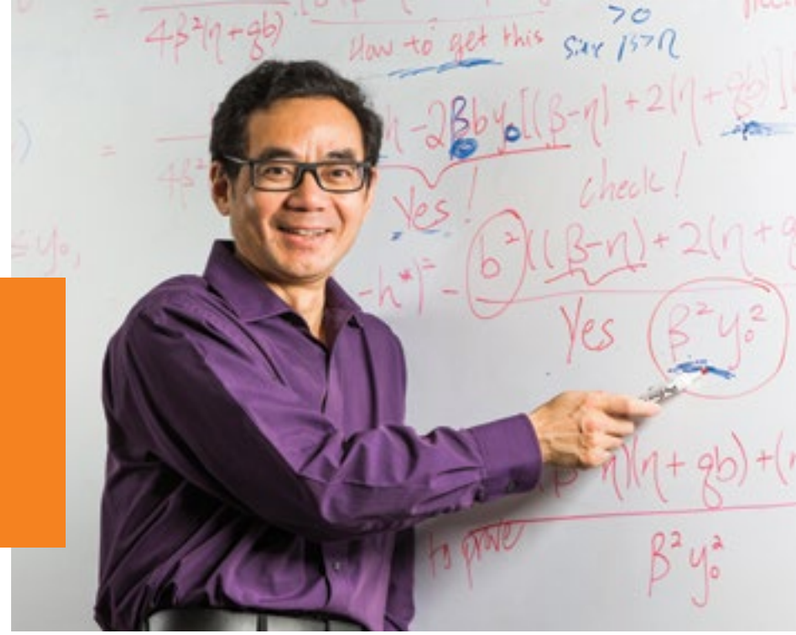


Photo: Dr. Kunquan Lan, Professor in the Department of Mathematics

Case Study: Predator-Prey Systems

Modelling dynamics between predator and prey

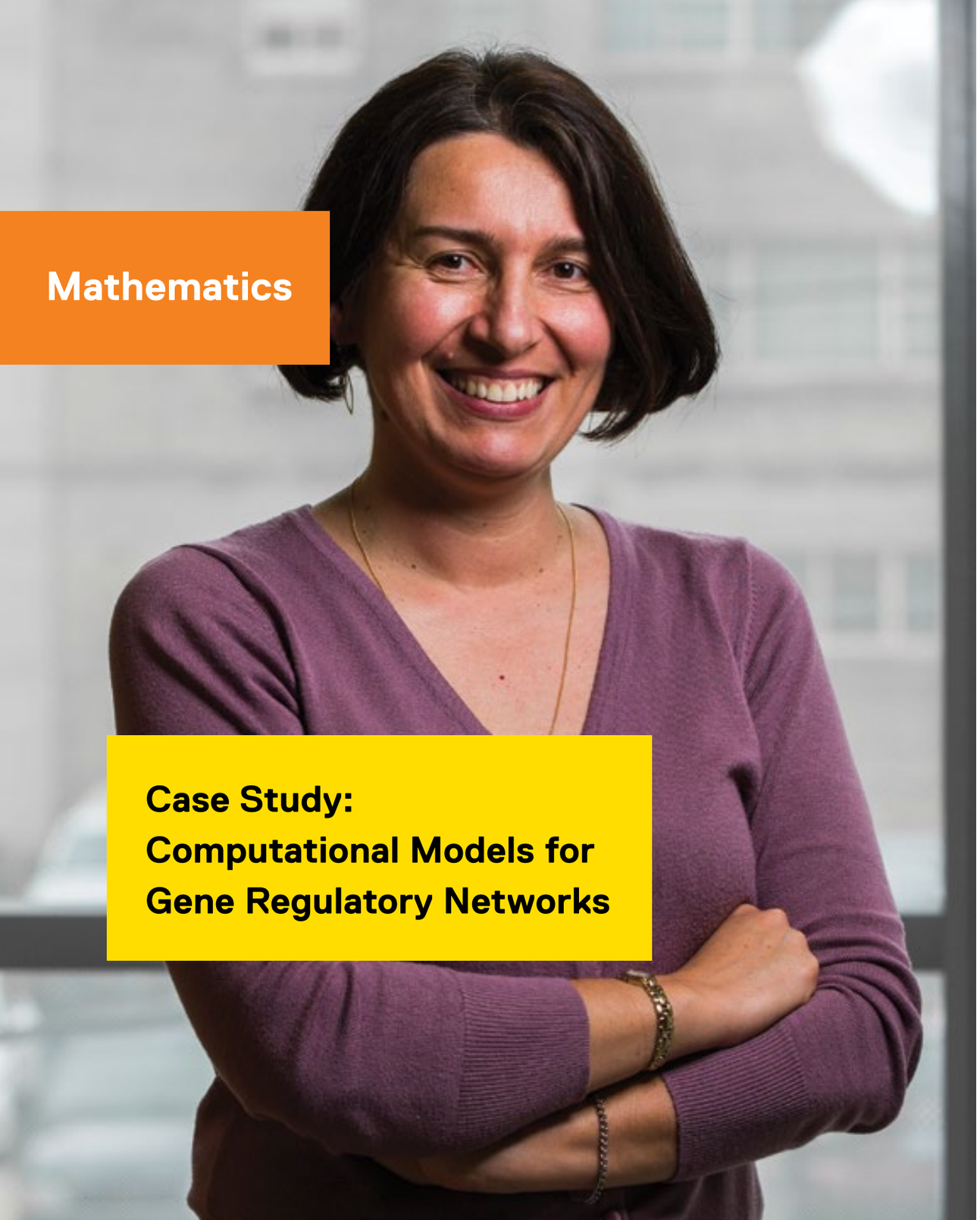
Ants and spiders. A yellow field of alfalfa and sap-sucking aphids. The dynamic relationship between predators and their prey is one of the most important themes in ecology. And predator-prey systems continue to fascinate **Dr. Kunquan Lan**, a professor in Ryerson's Department of Mathematics' Biomathematics and Fluids group. Lan's work fully embodies the Biomathematics and Fluids group's agenda, which is to explore the application of mathematics to biology.

In their predator-prey modelling, Lan and his team created several mathematical models, described by differential equations, and used them to learn more about the relationship between predators and prey. Lan explains, "the qualitative theories of dynamical systems are used and the dynamical behaviours of such predator-prey systems with initial states near equilibria can be predicted for appropriate ranges of parameters involved."

Together with student Christopher Heggerud, Lan published findings from his research in a joint research paper entitled "Local stability analysis of ratio-dependent predator prey models with predator harvesting rates" in the *Applied Mathematics and Computation* journal. Summarizing their research, Lan and Heggerud wrote, "Our results generalize and improve some known results and show that the models have more rich dynamics than those ratio-dependent predator-prey models without any harvesting rates."

Typical of the department's research initiatives, Lan's work is aimed at deriving innovative solutions to real-world problems. Ultimately, this mathematical modelling could help determine the circumstances in which species will survive or become extinct, and assist in species protection and optimal management of renewable resources like fishery and forestry.

An NSERC Discovery Grant recipient, Lan's areas of specialization include differential equations and partial differential inequalities, nonlinear analysis, mathematical biology, ecology and fluid dynamics. Besides predator-prey modelling, his current research activities include a focus on infectious disease models and boundary value problems. Lan also supervises two undergraduate mathematics students, a master's student and a postdoctoral fellow.



Mathematics

Case Study: Computational Models for Gene Regulatory Networks

Developing computational models to help scientists understand and treat genetic diseases

Advancing the field of personalized medicine is one of the ultimate goals of computational and systems biology. **Dr. Silvana Ilie**, an associate professor in Ryerson's Department of Mathematics says, "The computational models I develop will help scientists understand and design treatment for diseases with a genetic component."

Ilie, whose expertise lies in the fields of computational biology and scientific computing, says that in post-genomic biology, describing and analyzing the complex dynamical interactions at the cellular level is a fundamental challenge.

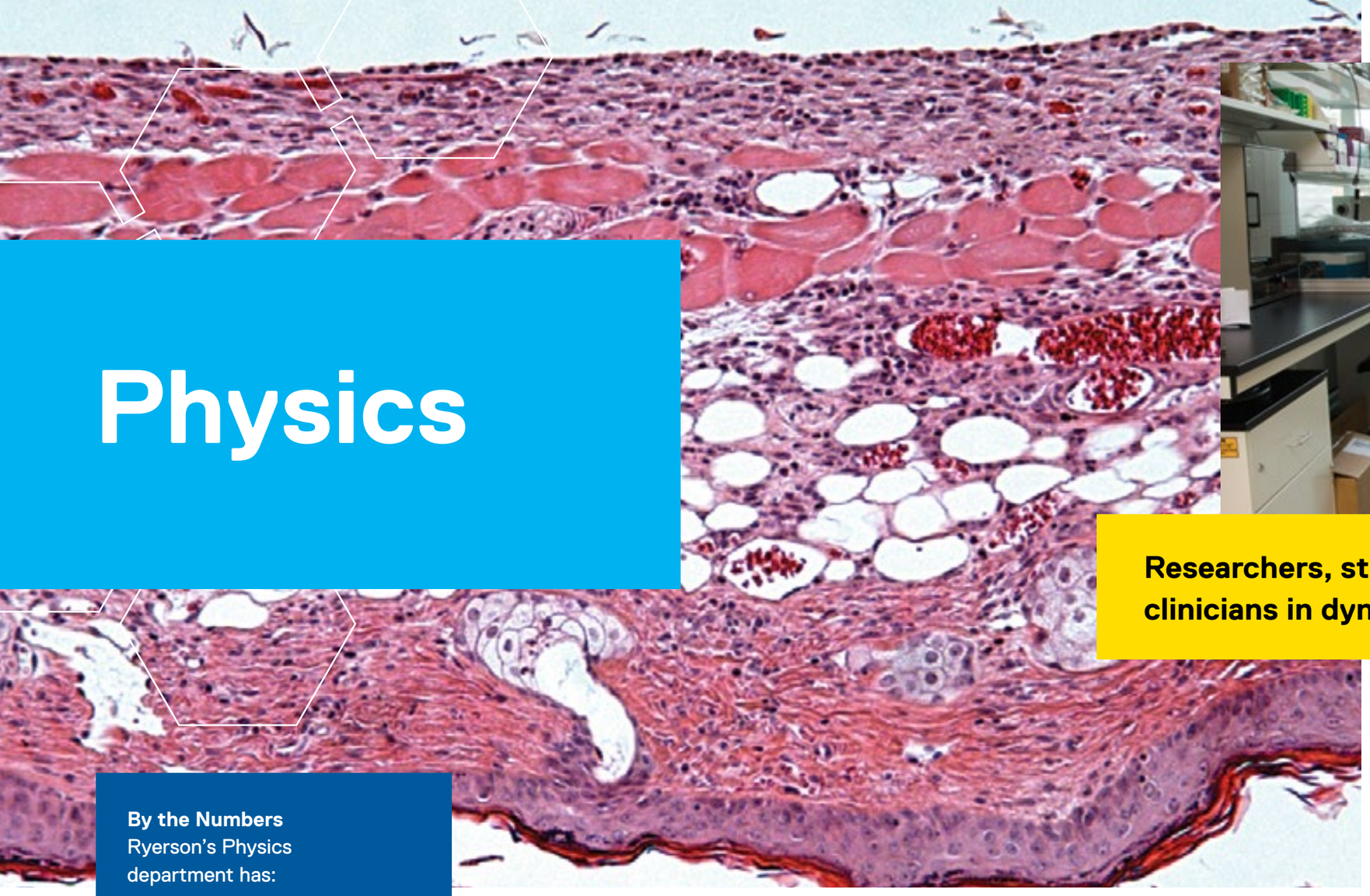
Currently there are several levels of refinement used for modelling cellular processes. As Ilie explains, often chemical kinetic models represent such processes as systems of chemical reactions, which were traditionally modelled as continuous deterministic systems. And the small number of some molecular species within a cell invalidate the hypothesis of continuity and the stochastic fluctuations which are captured by the experiments are neglected by such models. A study of the stochastic behaviour of the biochemical systems at the cellular is an important and difficult task. Accurate models of such systems are discrete, stochastic and non-linear – whereas most biochemical networks of interest involve many components interconnected in a complex manner and evolving on multiple scales in time. "As a consequence," Ilie says, "development of innovative theoretical methods and computer tools to deal with the complexity of large-scale simulations are becoming of outmost importance."

Ilie's research is concerned with the development of powerful new numerical methods for solving mathematical models of homogeneous and heterogeneous biochemical networks in a cell. Such methods will enable accurate simulation of the proposed models, helping to validate the model, make predictions of its behaviour, and study its robustness with respect to perturbations.

At Ryerson, Ilie has supervised several outstanding graduate students and postdoctoral fellows. Awards received by her students include a 2015 Ryerson University Gold Medal given to recent master's graduate Jill Padgett. Ilie has also supervised and co-supervises master's and doctoral students at Western University and University of Waterloo. Her students were also involved in MITACS-sponsored internships with industrial partners in biotechnology, an important training opportunity.

Ilie's research has appeared in some of the top journals and conferences in her field. As well, her work has received numerous grants, including, an NSERC Discovery Grant in 2015 which was renewed for five years, and a Ryerson Faculty of Science Discovery Accelerator Grant for two years.

Photo: Dr. Silvana Ilie, Associate Professor in the Department of Mathematics



Physics

By the Numbers
Ryerson's Physics department has:

16 tenured and tenure-track faculty members

6 postdoctoral fellows

190 undergraduate students (approximately)

18 graduate students have chosen the CAMPEP accreditation option

34 students pursuing master's degrees

23 students pursuing doctoral degrees

Photo: Eno Hysi, Biomedical Physics PhD student

Researchers, students and medical clinicians in dynamic collaborations

Ryerson physicists are applying physics principles to some of today's most critical health-care concerns. An emerging force, the Department of Physics offers a powerful combination – an open and supportive academic environment, plus burgeoning opportunities for hands-on clinical work at world-renowned hospitals and research centres.

Using acoustic shock waves to better understand traumatic brain injury. Developing novel cancer radiation treatment technology. Modelling influenza dynamics to help manage disease spread. Ryerson's Department of Physics specializes in Medical and Biomedical Physics, and our overall focus is towards applying physics to improve medical diagnosis and treatment, in Canada and beyond.

By all accounts, 2015 has been a year marked by growth and tremendous accomplishment for the physics department. In the 2016 Maclean's Magazine University Rankings, Ryerson's undergraduate Medical Physics program was highlighted as one of Ryerson's "Standout Programs." Department Chair **Dr. Ana Pejović-Milić** says, "I am proud and grateful that our hard work and dedication to Medical Physics education has been recognized by Maclean's in the same year as our program enters its tenth year of existence. I am looking forward to the next ten years and many more new, and exciting achievements."

Today, we are able to offer unprecedented opportunities to our researchers and students.

Continued from previous page

Physics

As researchers, we've worked to develop dynamic interdisciplinary collaborations with industry partners across the health-care spectrum. In keeping with the Ryerson approach, we've sought continually to bridge gaps between clinical practitioners and researchers, and drive innovation with a patient-centric and problem-centric approach. We've partnered with institutions like Sunnybrook Health Sciences Centre, Sunnybrook Research Institute, St. Michael's Hospital, Princess Margaret Cancer Centre/University Health Network, Hamilton Health Sciences and Carleton University. Industry partners include Novadaq Technologies Inc. and Seno Medical Instruments Inc.

On the student side, we offer a first-class physics education that draws directly on our faculty members' research, features innovative teaching methods, and emphasizes both conceptual understanding and practical learning. Then with our co-op option, students have the chance to get their feet wet in real-life hospital settings.

Our department offers an undergraduate program in Medical Physics, a master's program in Biomedical Physics and a doctoral program in Biomedical Physics. We also offer a CAMPEP accredited Biomedical Physics MSc and PhD option in Medical Physics. In addition, undergraduate students in Chemistry have the option to specialize in Applied Physics and in Biology to specialize in Biophysics.

Highlights

Our department formed a landmark joint partnership with the Sunnybrook Research Institute at Sunnybrook Health Sciences Centre with mutual goals of advancing clinical radiation therapy technology and providing high-quality educational experiences to students.

The Sunnybrook partnership also brought new faculty members to the department:

- **Dr. William Song**, the head of the Department of Medical Physics at the Odette Cancer Centre at the Sunnybrook Health Sciences Centre, as an adjunct professor
- **Dr. James Gräfe**, a certified clinical physicist with a joint clinical role at the Odette Cancer Centre, as an assistant professor
- **Eric Da Silva** as assistant professor
- Seven clinical medical physicists from the Odette Cancer Centre

2015 also marked the opening of the 22,000-square-ft. Institute for Biomedical Engineering, Science and Technology (iBEST). The research institute is a culmination of a successful collaboration between Ryerson and St. Michael's Hospital researchers. Drs. **Michael Kolios**, **Devika Chithrani**, **Alexandre Douplik**, **Raffi Karshafian**, and **Jahan Tavakkoli** from Ryerson's Department of Physics are the core researchers of iBEST, and will conduct cutting-edge research in this new facility alongside St. Michael's researchers and clinician-scientists. Planned iBest research team projects include innovative approaches to image blood flow, treatment of disease using ultrasonically stimulated microbubbles or gold nanoparticles, and novel applications of high-intensity focused ultrasound (HIFU) to treat certain neurological disorders.

In July, Ryerson and St. Michael's Hospital also highlighted their collaborative activities at Symposium 2015, their fourth annual research and innovation event.

In September, our growing department got a much-needed new space, the 4M Physics Lab – or Modern, Mobile, Multipurpose and Modular Lab. Designed for space optimization, this lab accommodates lab work, tutorial classes, and conference and meeting space.

Two years after launching, our CAMPEP-accredited Biomedical Physics Option in Medical Physics – the only one of its kind in the GTA – saw our first CAMPEP option graduate, Charmainne Cruje. The CAMPEP accreditation option in Medical Physics is for graduate students interested in pursuing opportunities as professional medical physicists.

Photo: Biomedical Physics graduate students

Research areas

Medical Imaging and Treatment Modalities

Optoacoustic imaging

Ultrasound biomicroscopy

Advanced biomedical ultrasound imaging and therapy

Ultrasound and microbubble therapeutics and imaging in cancer

Ultrasound mediated imaging

Magnetic resonance imaging and near infrared spectroscopy

Nanoparticles for improved therapeutics and imaging in cancer therapy

Minimally invasive thermal therapy

Robust treatment planning

Clinical feedback for laser surgery

Treatment optimization for radiation therapy and image reconstruction

Image Guided Radiation Therapy

Computational and Mathematical Physics

Physical modelling in biology, immunology and ecology (phymbie)

Computational biomedical physics

Simulated treatment courses using Monte Carlo techniques

Trace Element Detection in Human and Biological Samples

Human trace element detection

X-ray fluorescence

Physics Education

Technologies include interactive peer response systems (or clickers) and computer-based laboratory equipment such as Logger Pro

Research facilities

Advanced Biomedical Ultrasound Imaging and Therapy Laboratory

Clinical Feedback for Laser Surgery Laboratory

Computational Biomedical Physics Laboratory

Institute for Biomedical Engineering, Science and Technology (iBEST)

Near Infrared Spectroscopy Laboratory

Minimally Invasive Thermal Therapy Laboratory

Nanoparticles for Improved Therapeutics and Imaging in Cancer Therapy Laboratory

Optoacoustic Imaging Laboratory

Physical Modelling in Biology, Immunology, and Ecology (phymbie) Laboratory

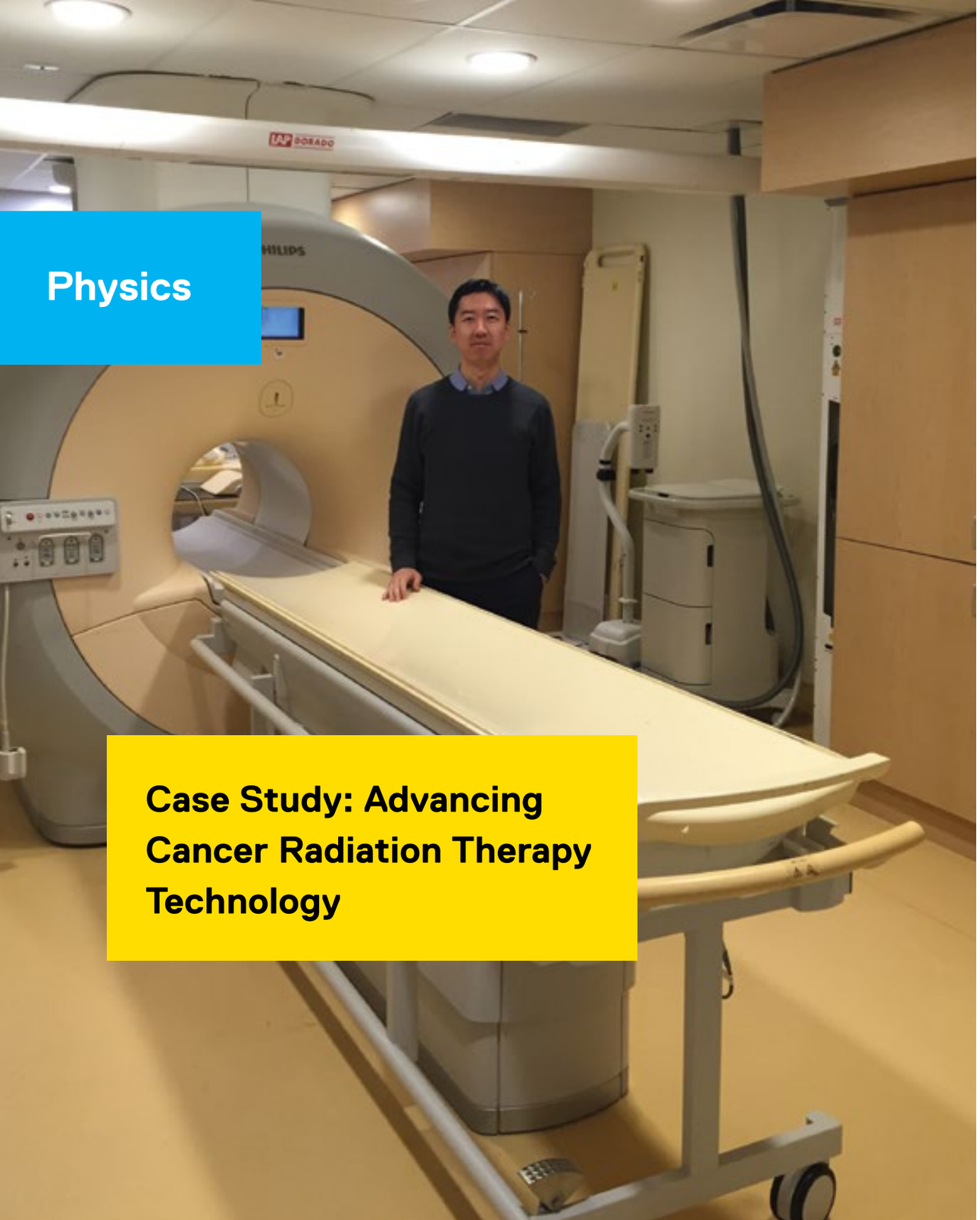
Simulation of Radiation Therapy Delivery Using Monte Carlo Techniques Laboratory

Labs at Sunnybrook Research Institute/ Odette Cancer Centre

Trace Element Detection in Human and Biological Samples Laboratory

Ultrasound Biomicroscopy Laboratory

Ultrasound and Microbubble Mediated Therapeutic Applications Laboratory



Ryerson graduate students get unique clinical training opportunity at Sunnybrook Hospital

As part of Ryerson's ground-breaking three-way partnership with Sunnybrook Health Sciences Centre and Sunnybrook Research Institute, **Dr. William Song**, who heads the Department of Medical Physics at Sunnybrook's Odette Cancer Centre and is a scientist at the Sunnybrook Research Institute, has joined our Department of Physics as an adjunct professor.

This collaboration focuses on advancing radiation therapy related technologies and sharing clinical experiences with academia. As a result, Ryerson's biomedical physics graduate students now have a great new opportunity for a hands-on role in this valuable field, by participating in research and clinical work at Sunnybrook's Odette Cancer Centre. Of the ramifications for Ryerson students, Song says, "To become a medical physicist, they need to do thesis work in the field of medical physics, and also do clinical residency training in a hospital setting before they can become certified to practice." This new official co-teaching and co-training program with Sunnybrook allows Ryerson students to complete studies at Ryerson – and gain a competitive edge. As Song explains, students get the chance to work with world-renowned faculty on interdisciplinary research and at the same time get their feet wet in a clinical working environment. "In order to do research in the field, a collaboration with a hospital setting is a must," says Song.

Song, who specializes in brachytherapy and image reconstruction and processing, explains that radiation treatment for cancer can basically be broken into two types of deliveries: brachytherapy and external beam radiation therapy. Song's research is concerned with both. More particularly, his goals include developing technologies that will produce high-quality images for external beam radiation treatment guidance, particularly using Cone Beam CT and MRI, and to develop the next applicator technology for delivery of effective brachytherapy to maximize tumour control while minimizing damage to healthy tissues in sites such as cervical, breast, prostate and rectal cancers.

To further capitalize on the opportunity, Ryerson established two tenure-track positions at the assistant professor level in radiation therapy physics that will act as a bridge between Ryerson and Sunnybrook Medical Physics faculties. The two appointed faculties will hold offices in both institutions. Song says, "I am beginning a collaboration with Ryerson faculty members **Drs. James Gräfe**, **Ana Pejović-Milić**, and **Carl Kumaradas** on different projects involving medical imaging and brachytherapy." Song will begin supervising two MSc and two PhD students in co-supervision with Gräfe, Pejović-Milić, and Kumaradas. Additional supervisory and research opportunities are being provided by many of the Medical Physics faculty at the cancer centre, Lee Chin, Geordi Pang, Arman Sarfehnia, Mark Ruschin, Claire McCann and Ananth Ravi, as well as a senior scientist and physician at Sunnybrook Research Institute, **Dr. Gregory Czarnota.**

This new venture has great potential to benefit both institutions in terms of educational and research opportunities. But, ultimately, the partnership and resultant research will serve a wide range of cancer patients.

Photo: Dr. William Song, Adjunct Professor in the Department of Physics

Physics

Case Study: Photoacoustic Imaging and Cancer Treatment

Photo: From left: Eno Hysi, Biomedical Physics PhD student and his supervisor, Dr. Michael Kolios, Professor in the Department of Physics

Using photoacoustic imaging to examine changes in tumours hours after cancer treatment

For his doctoral research, **Eno Hysi**, a Biomedical Physics PhD student at Ryerson, supervised by **Dr. Michael Kolios**, is using photoacoustics to examine cancerous tumours hours after radiation treatment and investigate early changes in their vasculature. "Through ongoing collaborations with the Ontario Institute for Cancer Research, The University of British Columbia and Sunnybrook Hospital," Hysi says, "we are currently testing the response of various cancer drugs and treatments through the in vivo photoacoustic imaging of different tumour types."

Why photoacoustics? Hysi says photoacoustic imaging is a relatively new technology capable of making images of vasculature and its oxygenation by recording sound waves generated from the optical illumination of blood cells. "One of the most significant achievements of photoacoustic imaging," he says, "is its ability to provide simultaneous structural and functional information on the same imaging plane."

More compellingly, unlike conventional imaging modalities such as MRI or CT, photoacoustic imaging is significantly cheaper. Currently, the assessment of treatment progression is limited by the cost of standard diagnostic modalities. Hysi hopes that imaging at multiple early time-points could yield valuable information to clinicians on the efficacy of treatments – and be used to predict long-term treatment outcomes.

A long-time Ryerson student, Hysi has received numerous awards and scholarships, including the Ontario Graduate Scholarship and NSERC's Alexander Graham Bell Canada Graduate Scholarship, and this year, the prestigious Vanier Canada Graduate Scholarship. Hysi says, "A significant source of my success comes from the support that I have constantly received from the world-class researchers and teachers in the Department of Physics and the Faculty of Science."

Photo: Laura Liao, Biomedical Physics PhD student

Case Study: Quantifying Defective Interfering Particles Produced by Influenza A

A timely review and revision of traditional counting methods for defective interfering particles (DIPs)

Influenza (or flu) is a growing concern for global health authorities. The threat of virulent strains – not to mention annual costs of managing flu-related illness – make understanding the mechanisms that drive this disease all the more pressing.

Laura Liao, a Biomedical Physics PhD student at Ryerson, supervised by **Dr. Catherine Beauchemin**, conducts research focused on methods for counting defective interfering particles (DIPs). How do DIPs relate to the flu virus? DIPs are incorrectly formed viruses which get spontaneously generated and amplified in influenza infections. DIPs interfere with virus replication and production – so potential applications aren't difficult to envision. Management of these virus-suppressing particles would be a boon to vaccine production, where high viral yields are desirable and DIPs are a hindrance. DIPs might also have positive applications as an antiviral measure to suppress infection.

Quantification of DIPs is complicated, since they are indistinguishable from virus in a virus sample. Back in 1959, Bellett and Cooper proposed an experiment which could, in theory, count DIPs. Deviations of the experimental data from the theoretically predicted trend were not fully explained. Liao's research uses a mathematical model to simulate influenza A virus infection with virus and DIPs to evaluate the assumptions made by Bellett and Cooper in developing their experiment. "We revisit the DIP counting method to show the conditions under which it should be used, otherwise it will wrongly count DIPs. This has never been shown before and our findings explain why some data from previous DIP counting experiments did not match expectations. Our contribution is timely since there has been renewed interest in DIPs after two decades of relative silence."

Liao's research is supported by NSERC. She has recently presented her research at the 2015 International Symposium on Respiratory Viral Infections and the 2nd Workshop on Virus Dynamics at the Fields Institute with a paper to follow shortly. She currently holds a Doctoral Canada Graduate Scholarship awarded by NSERC.

Profiles

Chemistry and Biology

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Research Areas: Cell biology, in particular molecular mechanisms that control membrane traffic and hormone signaling related to human health and disease

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Research Areas: Quantifying the effects of climate change, genetically-engineered crops, invasive species, contaminants etc. on the local and global production and distribution, and ensuing fitness consequences, of essential fatty acids

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Research Areas: Phosphorus transfer from watersheds to freshwater systems; the impact of specific particulate phosphorus fractions on the phytoplankton community; ecotoxicological aspects of nanoparticles as vectors for hydrophobic contamination

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Research Areas: Cell biology, biochemistry, organelle identity, phosphoinositides, membrane trafficking, phagosome, endolysosomes

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Research Areas: Agro-evolutionary biology, conservation, evolution, global climate change consequences, invasive species

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Research Areas: Protein structure and function, protein-protein interactions, new methods in science education, inquiry-based learning

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Research Areas: Development of novel HIV/AIDS therapeutics exploiting the MCEF protein, structure/function analysis of MCEF, HIV-1 transcription, protein transduction

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Research Areas: The nature and uses of host-guest complexes, binding models for cyclodextrins, applications of polymer-immobilized cyclodextrins, development of molecular imprinted hydrogel polymers

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Profiles

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Research Areas:
Pathogenesis of diarrheagenic E. coli, impact of stress on virulence of pathogenic E. coli

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Research Areas:
Novel inorganic and organometallic polymers

Noel George, PhD
Associate Professor and Academic Coordinator, First Year and Common Science Office

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Research Areas:
Chemical education

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Research Areas:
Molecular microbiology, bacterial diversity, surface waters, wastewater treatment process, bacterial pathogens

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Research Areas:
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Research Areas:
Chemical education, online learning in chemistry, using new teaching tools in the chemistry curriculum

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Research Areas:
Environmental microbiology, molecular microbial ecology, biofilms, environmental biotechnology

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Research Areas:
Physical/analytical chemistry, surfaces and interfaces, photochemistry, raman microscopy, thin films

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Associate Professor and Undergraduate Program Director (Chemistry)

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Research Areas:
Chemical education research, case studies, bioorganic chemistry, spatial ability

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Research Areas:
Sustainable energy, advanced solar design, next-generation photovoltaics

Profiles

Chemistry and Biology

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Associate Professor

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Research Areas:
Ecology and evolution of infectious diseases

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Associate Professor

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Research Areas:
Aquatic ecology, nitrogen carbon and sulfur biogeochemistry, ecosystem science

Julia Lu, PhD
Professor

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Research Areas:
Analytical chemistry, biogeochemistry of persistent toxic pollutants, chemical speciation, air and water quality

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John G. Marshall, PhD
Associate Professor

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Research Areas:
Mass spectrometry of receptors complexed with their circulating ligands, innate immune response, phagocytosis, free radicals from NAPDH oxidase, protein biochemistry, analytical biochemistry, analytical cell biology

Lynda H. McCarthy, PhD
Professor

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Research Areas: Great Lakes pollution, industrial and municipal wastewater ecotoxicology, land-application of biosolids

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Assistant Professor

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Research Areas: Two-component signal transduction, host-pathogen interactions, inflammatory bowel disease, host-defense peptide resistance

Andrew McWilliams, PhD
Associate Professor

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Research Areas:
Inorganic chemistry, polymer synthesis, main group chemistry, organometallic chemistry, inverse crowns

Stephanie Melles, PhD
Assistant Professor

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Research Areas:
Spatial ecology, cross-scale drivers of diversity, network theory, aquatic ecosystem classification, optimizing sampling design

David Naranjit, PhD
Professor

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Areas of interest:
Analytical chemistry, spectroscopy, chromatography

Dérick Rousseau, PhD
Professor

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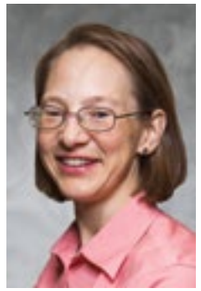
Research Areas:
Food science and technology, lipid crystallization, controlled release, emulsions, microemulsions, chocolate

Profiles

Chemistry and Biology



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Assistant Professor

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Research Areas: environmental stress effects on cell cycle checkpoint; high-resolution live-cell imaging to assess chemotherapy escape; prognostic biomarkers for cancer relapse

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Associate Professor

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Research Areas: Synthetic organic chemistry, medicinal chemistry (especially with Cystic Fibrosis), stereochemistry, bioorganic chemistry

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Professor

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Research Areas: Glycobiology, glycosyltransferase and glycosylhydrolase structure and function, application of glycosyltransferases for glycan synthesis

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Professor

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Research Areas: Environmental microbiology, biofilm ecology, biofilm control, bioprocessing

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Research Areas: Methods in science education, inquiry-based learning

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Research Areas: Inorganic chemistry, reaction thermodynamics, kinetics and mechanisms, supramolecular self-assembly

Computer Science

Abdolreza Abhari, PhD
Professor

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Research Areas: Web 2.0 social networking, web mining and information retrieval, data mining and database systems, big data analysis, sensor networks and distributed systems, soft computing and fuzzy logic, modelling and simulation

Konstantinos Derpanis, PhD
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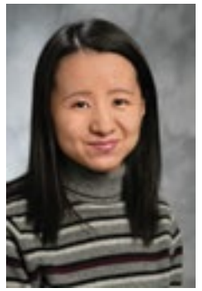
Research Areas: Computer vision



Chen (Cherie) Ding, PhD
Professor

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Research Areas: Cloud computing, software service selection and ranking, recommender systems, data analytics, social network, behaviour informatics, information retrieval

Profiles

Computer Science

Alexander Ferworn, PhD
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Research Areas:
Computational public safety: Urban Search and Rescue (USAR) and Chemical, Biological, Radiological and Nuclear explosives (CBRNe) applications; mobile, autonomous and teleoperated robotics; artificial intelligence and network applications

Denis Hamelin, PhD
Associate Professor

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Research Areas:
Computer science education, multimedia, web design, quantitative research

Eric Harley, PhD
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Research Areas:
E-learning, bioinformatics, natural language processing

David Mason, PhD
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Research Areas:
Citizen programmers, programming languages, program analysis, software reliability, code optimization

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Research Areas:
Software engineering, OS, DBMSs, distributed systems (OS and DBS), repositories (reuse), multidimensional files (tables)

Tim McInerney, PhD
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Research Areas:
3D interactive visualization, medical image analysis, 3D human-computer interaction

Andriy Miranskyy, PhD
Assistant Professor

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Research Areas:
Quantifying and mitigating risks (in the broadest sense) associated with the software engineering process in three different areas: quality assurance, green (energy efficient) software, requirements engineering

Ali Miri, PhD, PEng
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Research Areas:
Security and privacy, computer networks, digital communication

Jelena Mišić, PhD
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Research Areas:
Cloud computing and networking, M2M communications, body area networks, cognitive and green networking, network security, performance evaluation

Vojislav Mišić, PhD
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Research Areas:
Wireless networks, software engineering

Profiles

Computer Science

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Research Areas:
Teaching faculty, specifically in object-oriented and mainframe education; first and second year Science and Engineering computer education

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Research Areas:
Human-computer interaction, user interface design, usability testing

Alireza Sadeghian, PhD
Professor

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Research Areas:
Computational intelligence, neural networks, fuzzy sets of higher order, knowledge-based systems, and nonlinear modeling

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Associate Professor and Associate Dean, Undergraduate Programs and Student Affairs

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Research Areas:
Genetic and evolutionary computation, knowledge representation and automatic reasoning

Mikhail Soutchanski, PhD
Associate Professor

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Research Areas:
Artificial intelligence knowledge representation and reasoning, computationally tractable reasoning about actions and events

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Research Areas:
Software engineering, software testing, agile software development, software reliability composition

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Research Areas: Network security, mobile communication systems, mobile wireless networks

Mathematics

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Research Areas:
Financial mathematics, dependence modelling, pricing, arbitrage, stochastic processes

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Research Areas:
Networks, graph theory, web graph, social networks

Profiles

Mathematics

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Research Areas:
Discrete mathematics, design theory, graph decompositions and factorizations, covering arrays

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Research Areas:
Computational complexity, model theory of relational structures, algebraic method in graph theory

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Research Areas:
Multidimensional stochastic processes, dependence structures, financial mathematics, biostatistics

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Graduate Studies

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Research Areas:
Mathematical finance, computational harmonic analysis and applications, ergodic theory

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Research Areas:
Combinatorial optimization, convex optimization, distributed algorithms, game theory

Chris Grandison, MSc
Professor

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Research Areas:
Approximation theory and its software implementation

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Research Areas:
Ergodic and operator theory

Silvana Ilie, PhD
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Research Areas:
Computational biology; development and analysis of simulation methods for biochemical systems; stochastic computation with applications to systems biology; numerical methods, analysis and computation; applications to gene regulatory networks

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Research Areas:
Cryptography, cryptanalysis, information security management, computation algebra

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Research Areas:
Harmonic analysis, signal and image processing

Profiles

Mathematics

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Research Areas:
Differential equations, partial differential inequalities, nonlinear analysis and applications to mathematical biology, ecology

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Research Areas:
Computational, commutative and topological algebra

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Research Areas:
Mathematical finance, asymptotic inference of stochastic processes, levy models, stochastic differential equations

Garnet Ord, PhD
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Research Areas:
Exactly solvable models in statistical mechanics, foundations of quantum mechanics

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Professor

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Research Areas:
Fluid mechanics, hydrodynamic instability, gravity-driven flows, numerical methods

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Associate Professor and Associate Chair for Research

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Research Areas:
Modelling and searching complex networks in the big data era

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Research Areas:
Non-Newtonian fluid dynamics, reaction diffusion equations, stochastic processes, numerical methods, particle aggregation

Bozena Todorow, PhD
Associate Professor

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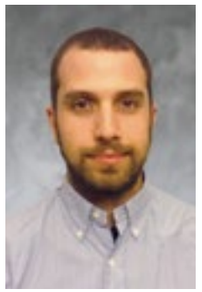
Research Areas:
Mechanical and electrical properties of raw and annealed metallic glasses (thin magnetic layers); statistics applied to engineering problems



Foivos Xanthos, PhD
Assistant Professor

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Research Areas:
Mathematical economics and finance, functional analysis

Profiles

Physics

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Research Areas:
Physics education research, curriculum development, educational technologies, science education and outreach, condensed matter physics, physical chemistry

Catherine Beauchemin, PhD
Associate Professor and Co-op Program Faculty Advisor

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phymbie.physics.ryerson.ca/~cbeau

Research Areas:
Virophysics, or utilizing physical models to resolve the temporal dynamics of viral infections; specifically, the development of realistic mathematical and computer models to capture and explain the kinetics of viral infection spread within a cell culture (in vitro) or a host (in vivo)

NO PHOTO AVAILABLE

Margaret Buckby, PhD
Professor

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Research Areas:
Nuclear astrophysics, supernovae, extraterrestrial life

Juliana Carvalho, PhD
Professor

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Research Areas:
Collective motion in nuclear physics, algebraic models, Schur function formalism; MAPLE as a tool for teaching physics

Basnagge Devika Chithrani, PhD
Assistant Professor

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Research Areas:
Medical physics, synthesis and characterization of nanoparticles, development of nanoparticle based systems for multimodal imaging and therapeutics, nanoparticle-based radiosensitizers, drug delivery, intracellular fate of nanoparticles

Eric Da Silva, MSc
Assistant Professor

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Research Areas:
Applied radiation physics, atomic and molecular spectroscopy, radiation dosimetry, radiation metrology, analytical and materials chemistry

Alexandre Douplik, PhD
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Research Areas:
Clinical photonics

Pedro Goldman, PhD
Professor

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Research Areas:
Radiation therapy of tumours, fast inverse dose optimizations for intensity modulated radiation therapy (IMRT) and tomotherapy, alternative methods for efficient CT image reconstruction, physics education

James Gräfe, PhD, MCCPM
Assistant Professor

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Research Areas:
Medical physics, radiation therapy, image guided radiation therapy, in vivo trace and toxic metal analysis, in vivo neutron activation analysis, in vivo X-ray fluorescence, rare earth metal toxicity

Raffi Karshafian, PhD
Associate Professor

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Research Areas:
Ultrasound and microbubble therapy, sonoporation, chemotherapy, radiotherapy, ultrasound imaging, biophysics

Profiles

Physics

Michael Kolios, PhD
Professor, Associate Dean of Research and Graduate Studies

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Research Areas: Ultrasound imaging and therapy, optoacoustic imaging, optical imaging and therapy, thermal therapies

Carl Kumaradas, PhD
Associate Professor and Graduate Program Director

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Research Areas: Medical physics, thermal therapy, electromagnetism, heat transfer, numerical analysis

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Research Areas: Medical physics, trace elements analysis in humans, bone strontium, aluminum, manganese, and magnesium, nuclear analytical methods for medical applications, X-ray fluorescence (XRF), in vivo neutron activation analysis (IVNAA)

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Research Areas: Biomedical ultrasound, image-guided ultrasound therapy, nonlinear ultrasound simulation, ultrasound signal and image processing, medical devices

Vladislav Toronov, PhD
Associate Professor

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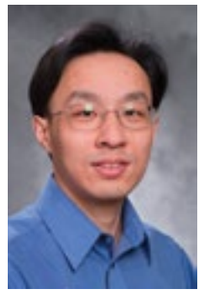
Research Areas: Optical and magnetic resonance biomedical imaging, non-linear dynamics of the brain



Yuan Xu, PhD
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Research Areas: Ultrasound imaging, novel imaging reconstruction algorithms, multi-wave imaging methods, medical imaging

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