vision
To be a world leader in research and education in pure and applied quantum science and technology.

mission
To advance quantum science and technology through interdisciplinary research, teaching, and outreach.

key facts

15 postdoctoral fellows
73 graduate students
21 undergraduate students
59 publications in refereed journal and conference proceedings including Nature (2), Nature Communications (2), Physical Review Letters (3), Physical Review X (1), Nano Letters (1) and Proceedings of the National Academy of Sciences of the United States of America (1)
38 invited talks at national & international conference/workshops including two keynote talks & one plenary talk
1.8M dollars research funding
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The Institute for Quantum Science and Technology hosts 14 research groups and a total of around 123 academic members including professors, research staff and students. The Institute has four research themes—molecular modelling, nanotechnology, quantum information and computing, and quantum optics—across the four departments of Chemistry, Computer Science, Mathematics and Statistics, and Physics and Astronomy. In recent years, the Institute has effectively expanded to the provincial level through the growth of the Quantum Alberta initiative, which has three sites: the Universities of Alberta, Calgary and Lethbridge. The Institute for Quantum Science and Technology maintains a strong identity in Calgary but also exists as one of three Quantum Alberta branches.

Two new members were welcomed in the past year. Daniel Oblak joined the faculty to lead the quantum communication program. After having been a long-term member of Wolfgang Tittel’s group, Daniel was an excellent choice to build on the strengths left by Wolfgang Tittel when he chose to accept an offer to join Delft University of Technology in the Netherlands and leave Calgary. Alex Lvovsky accepted an offer to join the University of Oxford in the United Kingdom, and the University of Calgary moved swiftly to create a replacement position. Shabir Barzanjeh accepted the offer and will move from the Institute of Science and Technology in Austria to commence a faculty position at the University of Calgary in January 2020.

The Institute for Quantum Science and Technology has enjoyed a successful year of research and training during the 2018/2019 year. Members of the Institute had 59 papers published in refereed journals and proceedings including 10 papers appearing in the top-tier journals of Nature (2), Physical Review Letters (3), Nature Communications (2), Physical Review X (1), Nano Letters (1) and Proceedings of the National Academy of Sciences of the United States of America (1). The Institute attracted thirteen new students into quantum graduate studies programs in 2018/2019. Seven masters students graduated and four doctoral students completed their degrees. The Institute hosted fifteen postdoctoral researchers with six being recipients of national and provincial postdoctoral fellowship including the NSERC Postdoctoral Fellowship (2), the PIMS Postdoctoral Fellowship (1), the Alberta Innovates Eyes High Postdoctoral Fellowship (2) and the T. Cheng Fong Postdoctoral Fellowship in Medical Imaging Science (1).

Success of the Institute is underpinned by support for training and infrastructure with especially notable support from the Natural Sciences and Engineering Research Council (NSERC) Collaborative Research and Training Experience (CREATE) Program called Quanta, which is headquartered at the University of Alberta. This program supports seven University of Calgary graduate students. Furthermore, quantum activity is advanced significantly by a Canada Foundation for Innovation (CFI) grant for quantum technology, led by the University of Calgary.

In 2019, the Alberta government’s Economic Development and Trade Ministry chose to invest in three areas of major innovation under the Alberta Research and Innovation Framework. These three areas are $6.3M for antimicrobial resistance led by the University of Calgary, $7.1M for autonomous systems led by the University of Alberta, and $5.8M for quantum technologies.
Science is the foundation of sustainability, diversity, and economic prosperity; it’s where discovery ignites innovation. As technological advances disrupt our core industries, we are leveraging our passion for science to adapt to, and lead this change—and the Institute for Quantum Science and Technology is a shining example. Researchers in IQST are catalysts for advancing the exciting multidisciplinary area of quantum science and growing the province’s research and innovation ecosystem. The team brings a deep commitment for how quantum science applications can improve human existence.

In addition to the research strength of the Institute, the team is also educating the next generation of students and enable them to develop the curiosity, communication and critical thought, perspective and disciplinary excellence necessary to solve the challenges of the future. As a result, our students and alumni are engaged citizens and life-long learners who positively impact and change society.

My congratulations to IQST director Dr. Barry Sanders, PhD, on receiving significant support from the Alberta government’s Major Innovation Fund, which invests in research and innovation to attract and retain top talent to support industries and local businesses. I am excited to see how the team will contribute to establishing Alberta as a hub for quantum technologies.

BARRY SANDERS
Director, IQST

LESLEY RIGG
Dean
Chair, IQST Board of Directors
Research Achievements

The Institute for Quantum Science and Technology (IQST) has significant research achievements over the past year. The following exposition of achievements provides a sample of the kinds of activities and breakthroughs seen within IQST.

Gilad Gour had an excellent year of research achievements including publications in Physical Review Letters and in Physical Review X, which are the two American Physical Society flagship journals and regarded as the top society-published physics journals, and in Nature Communications. Gour’s Physical Review Letters article connects memory capacity to quantum thermodynamics resources, and this emphasis on quantum thermodynamics is germane to Gour’s Nature Communications article on entropic conditions for quantum thermodynamics. Rounding out this impressive set of achievements is Gour’s Physical Review X article showing that transformations among pure multipartite entangled states via local operations are almost never possible.

Robert Thompson’s work with the ALPHA collaborative team at the particle-physics research institute CERN has resulted in major experimental discoveries in antimatter research. Their characterization of the 1S-2S transition in antihydrogen and their observation of the 1S–2P Lyman-α transition in antihydrogen resulted in two Nature papers in 2018.

Christoph Simon and his group report in a Physical Review B article how to produce indistinguishable single photons in the solid-state setting by exploiting ultrasmall cavity-mode volumes. They suggest that a nanodiamond’s negatively charged silicon-vacancy centre combined with a plasmonic Fabry-Perot hybrid cavity would serve as an excellent candidate system.

Alex Lvovsky collaborated on a project that shows two-level masers can operate as heat-to-work converters, which was published in the Proceedings of the National Academy of Sciences of the United States of America. In beautiful experimental work, Lvovsky and his research group demonstrated entanglement and teleportation between polarization and wave-like encodings of an optical qubit, which appeared in Nature Communications.

Paul Barclay’s group realized hexagonal boron-nitride cavity optomechanics, explained in their Nano Letters article, establishing a key step toward realizing integrated optomechanical circuits employing hexagonal boron-nitride.

Nasser Moazzen-Ahmadi’s collaborative 2018 result on performing a detailed infrared spectrum of a weakly bound molecular complex has garnered significant attention. They obtain the infrared spectrum and potential energy surface for a dimer comprising a carbon-monoxide molecule weakly bound to an oxygen molecule. This report was designated a hot article in Physical Chemistry Chemical Physics.

Barry Sanders and collaborators performed ab initio characterization of coupling strength for all types of dangling-bond pairs on a “hydrogen-terminated silicon surface”, which was published as an Editor’s Pick in the Journal of Chemical Physics. Additionally, Sanders leads theoretical work for experimental quantum groups, with three especially notable results published as three separate Physical Review Letters articles. One result reports the observation of topologically protected edge states in a photonic two-dimensional quantum walk and establishes a well-controlled platform for exploring other types of nontrivial topological phases using light. A second result uncovers topology via quantum-quench spin dynamics on a two-dimensional Chern band, realized in an ultracold Rubidium-87 gas. The third result is on experimental quantum switching for exponentially superior quantum communication complexity by realizing a superposition of communication directions for a two-party distributed computation in up to 216 dimensions and demonstrates a communication complexity advantage over any causally ordered protocol.
Awards

INTERNATIONAL AWARDS

China Scholarship Council Award
Zhengcai Zhang

Feodor Lynen Research Fellowship
Martin Schon

NATIONAL AWARDS

MITACS Scholarship
Rishabh Shukla

MITACS Globalink
Katelynn Daly
Jianing Geng
Zhe Liu

MITACS-Accelerate Graduate Research Internship Program
Seyed Shakib Vedaie

NSERC Alexander Graham Bell Canada Graduate Scholarship - Doctoral
David Lake
Stephen Wein

NSERC Postdoctoral Fellowship
Ghazal Haji Salem
Maryam Taheri

NSERC USRA
Alicia Anderson
Dante Bencivenga
Nathan Fischer
Alex Hickey

NSERC Vanier Scholarship
Carlos Enriquez-Victorero

Nova Chemicals Graduate Scholarship
Rishabh Shukla

PIMS Postdoctoral Fellowship
Yunlong Xiao

PROVINCIAL AWARDS

Alberta Innovates Graduate Students Scholarship
Dante Bencivenga
Sumit Goswami
Faezeh Kimiaee Asadi
Stephen Wein

UNIVERSITY OF CALGARY AWARDS

Alberta Innovates Eyes High Postdoctoral Fellowship
Nikolai Lauk
Namrata Shukla

Canadian Queen Elizabeth II Diamond Jubilee Graduate Scholarship
Nehad AttaElmanan AbdElrahim Mabrouk
Joan Ngure

Curriculum Development Teaching Award (team award)
Simon Trudel

Entangled Hypothesis Graduate Scholarship in Mathematics & Physics
Archismita Dalal

Eyes High Doctoral Recruitment Scholarship
Andrew Evans

Faculty of Graduate Studies’ Transformative Talent Internship Program
Hamza Qureshi

Izaak Walton Killam Doctoral Scholarship
Sumit Goswami

PURE Award
Zhan Yu
Rana Zibakhshshabgahi

Queen Elizabeth II Graduate Scholarship
Aaron Barclay
Stephanie Bovincini
Katelynn Daly

Scholar of Scholars Academy
Dante Bencivenga
Zhan Yu

T. Cheng Fong Postdoctoral Fellowship in Medical Imaging Science
Ronnie Banerjee
Key Performance Indicators

GRADUATE STUDENT ENROLMENT AND QUALITY OF ENTRANTS

- Number of PhD Entrants
- PhD Median Entrance Score
- Number of MSc Entrants
- MSc Median Entrance Score

PUBLICATIONS AND PRESENTATIONS

- Invited Talks
- Refereed Papers

- Total
- Student
AWARDS (CHAIRS, FELLOWSHIPS AND SCHOLARSHIPS)

- Faculty Members
- Postdoctoral Fellows
- Graduate Students
- Undergraduate Students

TRAINEE DESTINATIONS AFTER IQST

- Fellows
- Industry
- Academia
- Industry
- Other
NANOSCALE OPTICS
Explores interactions between light and nanoscale systems such as single atoms, electron spins and nanomechanical structures. Employs nanofabrication methods to engineer optical properties of these systems in order to enhance light-matter coupling. The current focus couples single quantum emitters, or “artificial atoms”, to optical nanocavities. The labs are at the University of Calgary and at the NRC National Institute for Nanotechnology in Edmonton, which has advanced nanofabrication tools plus leading quantum optics and nanotechnology researchers.

PRACTICAL QUANTUM COMPUTATION
Focuses on understanding intrinsic properties of physical systems, such as ultracold atomic gases or spin lattices, can be employed to construct larger devices able to perform quantum computation. In addition, the group explores alternative models for the implementation of quantum logic, such as one-way quantum computation, quantum walks, and topological quantum computation.
QUANTUM INFORMATION THEORY
Employs sophisticated mathematical methods, such as algebraic geometry, matrix analysis, group theory and C*-algebras, to solve core problems in quantum information science.

QUANTUM COMPUTING
Explores the potential powers of quantum systems to develop quantum algorithms, quantum communication protocols, quantum cryptographic protocols, and quantum computer simulations of quantum mechanical systems. Characterizes the powers and their limitations by studying quantum complexity theory, non-locality, entanglement, and quantum information theory.
MOLECULAR SIMULATIONS OF LIQUIDS & SOLUTIONS, INTERFACES AND CRYSTALLIZATION

Molecular simulations to examine collections of molecules representing solid or liquid systems. Probes the molecular behaviour to understand properties of liquids and solids and their transformations including nucleation and crystallization. Explores behaviour of the hydroxyl radical in various aqueous environments. Applications range from atmospheric and materials sciences to molecular biology and water treatment.

QUANTUM INFORMATION TECHNOLOGY WITH LIGHT AND EXPERIMENTAL QUANTUM OPTICS

Concentrates on implementing light for the purposes of quantum information technology — that is, learning to synthesize, control, characterize, and store arbitrary quantum states of the electromagnetic field, as well as causing photons to interact with each other. We work on achieving sub-Rayleigh resolution of optical imaging using passive imaging devices.
SPECTROSCOPY OF HYDROCARBONS AND MOLECULAR CLUSTERS AND COMPLEXES
Measures forces responsible for formation of atomic and molecular clusters. Investigates the intermolecular potential in the region of the potential minimum. Explores non-additive effects on the interaction energy and to determine possible condensation pathways. Relevant to a range of applications from atmospheric chemistry to molecular biology.

QUANTUM CLOUD LAB
In the Quantum Cloud Lab we aim to develop experimental capabilities that will lead to practical implementations of quantum links forming the basis of quantum networks that connect distant quantum devices. The goal involves research into quantum-key distribution over fibre and free-space channels, non-classical light sources, and quantum memory based on solid-state materials such as rare-earth ion doped crystals.
MULTISCALE MODELING OF (BIO)CHEMICAL REACTIONS IN COMPLEX ENVIRONMENTS

Investigates mechanisms and rates of chemical reactions occurring in complex environments. Models enzymatic catalysis, electron transfer between proteins and/or heavy oil upgrading. Employs multiple techniques, from quantum chemistry, to molecular dynamics, to stochastic network analysis, are brought to bear on the problem in a context of High Performance Computing.

QUANTUM INFORMATION SCIENCE

Develops quantum information technologies that have transformative applications and will be feasible within a decade. The research program is divided into five strands: (i) long-distance secure communication, (ii) simulations of complex systems, (iii) implementations of quantum information tasks, (iv) empirical characterization of quantum states and processes, and (v) determining and quantifying all resources for quantum information processing.
CHEMICAL VAPOR DEPOSITION CHEMISTRY

Focuses on chemical and physical processes underpinning the formation of silicon-containing semiconductor thin film materials using hot-wire chemical vapour deposition. Applies technically demanding laser ionization mass spectrometric and laser spectroscopic techniques to investigate this process at the molecular level. Explores gas-phase reaction chemistry in the formation of silicon carbide and silicon nitride and laser spectroscopy of silicon carbide clusters generated using pulsed discharge and laser ablation methods. Applications include superior-quality films for industrial applications.

THEORETICAL QUANTUM OPTICS

We use quantum optical approaches to study potential applications of unique quantum phenomena such as superposition and entanglement (e.g. a future “quantum internet”), to probe whether these phenomena are universal, and to investigate whether they could play a role in biology (e.g. in neuroscience). Our theoretical research is often done in close collaboration with leading experimental groups.
TRAPPED ION PHYSICS WITH ATOMS, MOLECULES, AND EXOTIC SPECIES

Develops and measures low-density trapped atoms, molecules and exotic species, especially anti-matter Hydrogen. Collaboration with the Antihydrogen Laser Physics Apparatus (ALPHA) project at CERN involving 40 scientists across 16 institutions. Collaborates with TRIUMF’s Ion Trap for Atomic and Nuclear (TITAN) Science, particularly on sympathetic and evaporative cooling.

NANOSCALE MATERIAL

Investigates the synthesis, characterization, and structure-property relationships in inorganic solid-state nanomaterial, such as metal-oxide thin films and multimetallic nanoparticles. Develops high-performance materials in technologically and commercially relevant focus areas such as clean-energy conversion and spin-based electronics. Characterizes materials using state-of-the-art methods, such as electrochemical testing, electron microscopy, x-ray diffraction, and magnetometry based on superconducting quantum interference devices. Properties are analyzed to provide feedback for synthetic approaches for improvement.
Institute Structure

The Institute is managed on a day-to-day level by the Institute Director and the Institute Administrator. The Director reports to the Board of Directors and is ex officio a member of this Board. The Board reports to the Dean of Faculty of Science who chairs the Board.

The Director and the Administrator of the Institute work on day-to-day matters of the Institute. The Institute Executive comprises the Director, Administrator and three faculty members other than the Director. The Executive meets monthly to discuss and make decisions on executive matters. The Executive receives advice and guidance from the IQST Council, which comprises all full and affiliate faculty members of the Institute and meets three times annually.

All of the Institute’s research, teaching, service and outreach activities are conducted by faculty members and their research groups.
Governance

BOARD OF DIRECTORS
Lesley Rigg
Dean, Faculty of Science, University of Calgary
Marie D'Iorio
Senior Strategy Advisor, University of Ottawa
Chip Elliott
Chief Technology Officer, Raytheon BBN Technology
John Kendall
Sir Peter Knight
Principal, The Kavli Royal Society International Centre
Barry C. Sanders
Professor, Department of Physics and Astronomy, University of Calgary
Carl Williams
Acting Director, Physical Measurement Laboratory (PML), National Institute of Standards and Technology (NIST)

EXECUTIVE COMMITTEE
Gilad Gour
Professor, Department of Mathematics and Statistics, University of Calgary
Barry C. Sanders
Professor, Department of Physics and Astronomy, University of Calgary
Yujun Shi
Professor, Department of Chemistry, University of Calgary

COUNCIL

FACULTY MEMBERS
Paul Barclay
Associate Professor, Department of Physics and Astronomy, University of Calgary
David Feder
Associate Professor, Department of Physics and Astronomy, University of Calgary
Gilad Gour
Professor, Department of Mathematics and Statistics, University of Calgary
Peter Høyer
Associate Professor, Department of Computer Science, University of Calgary
Peter Kusalik
Professor, Department of Chemistry, University of Calgary
Alex Lvovsky
(resigned November 2018)
Professor, Department of Physics and Astronomy, University of Calgary
Nasser Moazzen-Ahmadi
Professor, Department of Physics and Astronomy, University of Calgary
Daniel Oblak
Assistant Professor, Department of Physics and Astronomy, University of Calgary
Dennis Salahub
Professor, Department of Chemistry, University of Calgary
Barry C. Sanders
Professor, Department of Physics and Astronomy, University of Calgary
FACULTY MEMBERS (CONT’D)

Yujun Shi
Professor, Department of Chemistry, University of Calgary

Christoph Simon
Professor, Department of Physics and Astronomy, University of Calgary

Robert I. Thompson
Professor, Department of Physics and Astronomy, University of Calgary

Simon Trudel
Associate Professor, Department of Chemistry, University of Calgary

AFFILIATE MEMBERS

Robin Cockett
Professor, Department of Computer Science, University of Calgary

David Hobill
Associate Professor, Department of Physics and Astronomy, University of Calgary

Sergei Noskov
Professor, Department of Biological Sciences, University of Calgary

Reginald Paul
Professor, Department of Chemistry, University of Calgary

Rei Safavi-Naini
Professor, Department of Computer Science, University of Calgary

Renate Scheidler
Professor, Department of Mathematics and Statistics, University of Calgary

Peter Tieleman
Professor, Department of Biological Sciences, University of Calgary

Richard Zach
Professor, Department of Philosophy, University of Calgary

POSTDOCTORAL FELLOWS

Abhijeet Alase
Gustavo Amaral (resigned July 2018 → Postdoc, Delft University of Technology)
Ronnie Banerjee (completed December 2018 → Postdoc, University of Toronto)
Roohollah Ghobadi (completed June 2018 → Researcher, 1QBit)
Nikolai Lauk (completed September 2018 → Postdoc, California Institute of Technology)
Gustavo de Oliveira Luiz
Ghazal Haji Salem
Carlo Maria Scandolo
Martin Schon
Namrata Shukla (completed February 2019 → Postdoc, Max Planck Institute for the Science of Light)
Maryam Taheri
Yunlong Xiao
Jun Zhang
Wei Zhang
Zhengcai Zhang

RESEARCH ASSOCIATES/COORDINATORS/ENGINEERS

Burke Brockelbank (Research Assistant)

GRADUATE STUDENTS (PHD PROGRAM)

Pramodh Senarath Yapa Archchige
Mohsen Bagherimehrab
Aaron Barclay
Bishnupada Behera
Stephanie Bovincini
Oliver Calderon
Jesus Alejandro Marin Calzada
Archismita Dalal
Katelynn Daly
Carlos Enriquez-Victorero
Koorosh Esteki
Andrew Evans
Mohsen Falamarzi Askarani (transferred April 2018 → PhD, Delft University of Technology)
Jose da Costa Filho (transferred August 2018 → PhD, University of Oxford)
Alison Fulton
Sumit Goswami
Chris Healey
Jiawei Ji
Salini Karuvade
Hamidreza Kaviani
Abdullah Khalid (graduated September 2018 → Lecturer, Habib University)
Faezeh Kimiaee Asadi
Sourabh Kumar  
David Lake  
Pascal Lefebvre  
Nehad AttaElmanan AbdElrahim Mabrouk  
Adam Mayer  
Matthew Mitchell  
Eugene Moiseev  
James Moncreiff  
Mahmood Noweir  
Eduardo Páez  
Pantita Palittapongarnpim (graduated February 2019 → Postdoc, University of Warwick)  
Gaurav Saxena  
Janakan Sivasubramanium  
Anastasia Pushkina (transferred August 2018 → PhD, University of Oxford)  
Priyaa Varshinee Srinivasan  
Arina Tashchilina  
Raju Valivarthi (graduated April 2018 → Postdoc, Institute of Photonic Sciences Barcelona)  
Seyed Shakib Vedae  
Elena Vialych (graduated March 2019 → Postdoc, University of Colorado, Boulder)  
Lei Wang  
Yadong Wu  
Parisa Zarkeshian

GRADUATE STUDENTS  
(MSC PROGRAM)

Eric Ampong  
Paul Anderson (graduated April 2018 → PhD, University of Waterloo)  
Behnam Ashrafkhani  
Alex Cameron  
Jacob Davidson (graduated May 2018 → PhD, Delft University of Technology)  
Nuiok Dicaire (graduated September 2018 → PhD, University of Edinburgh)  
Jake Flowerdew  
Masoud Habibi Davijani  
Shreyas Jalnapurkar (graduated April 2018 → Specialist, SB Technology)  
Jiawei Ji (graduated January 2019 → PhD, University of Calgary)  
Mojtaba Komeili  
Murali Krishna  
Prasoon Kumar Shandilya  
Tamiko Masuda (graduated August 2018 → PhD, Business Development Specialist, Universal Quantum Devices Inc.)  
Blaine Jeffrey McLaughlin  
Mahdi Mousaei  
Yasser Novo-Fernández  
Kimberley Ann Owen  
Hamza Qureshi  
Mohammad Rahmati (graduated January 2019)  
Dante Renato Bencivenga  
Kuntal Sengupta  
Prasoon Shandilya  
Rishabh Shukla  
Prathviraj Umesh  
Stephen Wein  
Taoche Wu  
Yufeng Wu  
Yanjian Xiong

UNDERGRADUATE STUDENTS

Alicia Anderson (NSERC USRA)  
Thomas Agnew (UofC PHYS598)  
John Burniston (UofC PHYS598)  
Nathan Fischer (NSERC USRA)  
Sebastian Garcia (UofC PHYS599)  
Rysa Greenwood (UofC PHYS598)  
Paul Harringer (UofC PHYS598)  
Alex Hickey (NSERC USRA & PHYS598)  
Janet Leahy (UofC CPSC502)  
Zhe Liu (MITACS Globalink)  
Nolan McMahon (UofC PHYS598)  
Thanh Nguyen (Canada-ASEAN Scholarship and Educational Exchange for Development–SEED)  
Austin Nhung (UofC PHYS598)  
Kyle Ostrander (research assistant)  
Maria Pettyjohn (UofC PHYS598)  
Arta Seify (undergraduate research)  
Sarvin Sepassi (UofC PHYS599)  
Amanda Torres (UofC PHYS599)  
Zhan Yu (UofC CPSC502 & PURE award)  
Rana Zibakhshshabgahi (UofC PURE Award & PHYS598)

ADMINISTRATION

Xining Chen (Part-time Webmaster)  
Jing (Nancy) Lu (Administrator)


M. J. Mitchell, D. Lake and P. E. Barclay, “Realizing Q > 300 000 in diamond microdisks for..."


### REFBEREDE CONFERENCE PROCEEDINGS


### BOOKS AND CHAPTERS


### STUDENT THESIS


T. Masuda, “Fibre-taper collected photoluminescence characterization of diamond microdisks” (MSc Thesis), May 2018.


INTELLECTUAL PROPERTY


INVITED PRESENTATIONS AT WORKSHOPS/CONFERENCES

(Speaker name is underlined for presentations with multiple authors)


10 May 2018, S. Trudel, “Amorphous mixed-metal oxy(hydroxides) catalysts for the oxygen evolution reaction” (keynote), 2th Canadian Catalysis Symposium, Saskatoon, Canada, 8—11 May 2018.


Workshop (LPHYS’18), Nottingham, United Kingdom, 16—20 July 2018.


14 December 2018, B. C. Sanders, “Topology of a quantum walk on a lattice with a SU(3) coin” (plenary), 8th Workshop on Quantum Simulation and Quantum Walks (QSQW2018), Perth, Australia, 14—16 December 2018.


Collaborations

INTERNATIONAL INSTITUTIONS

Aarhus University, Denmark
Al-Nahrain University, Iraq
Beijing Computational Science Research Centre,
People’s Republic of China
Ben-Gurion University of the Negev, Israel
CAS-Alibaba Lab for Quantum Computation,
People’s Republic of China
Cardiff University, United Kingdom
California Institute of Technology, United States of
America
Centro de Investigación y de Estudios Avanzados
(CINVESTAV), Mexico
Chinese Academy of Science’s College of Earth
Science, People’s Republic of China
Chinese Academy of Science’s Institute of
Geology and Geophysics, People’s Republic of
China
Chinese Academy of Science’s Shanghai Institute
of Microsystem and Information Technology, People’s Repulic of China
Cockcroft Institute, United Kingdom
Complutense University of Madrid, Spain
Duke University, United States of America
East China Normal University, People’s Republic of
China
Eastern Illinois University, United States of
America
Griffith University, Australia
Henan University of Technology, People’s
Republic of China
Hokkaido University, Japan
Imperial College London, United Kingdom
International School for Advanced Studies, Italy
Isfahan University of Technology, Iran
Macquarie University, Australia
Missouri University of Science and Technology,
United States of America
Montana State University, United States of
America
Nagoya University, Japan
Nanjing University of Posts and
Telecommunications, People’s Republic of China
Nanyang Technological University, Singapore
National Research Council (CNR) Italy–Institute for
Photonics and Nanotechnologies (IFN) Milano
National Research Council (CNR) Italy–Institute for
Photonics and Nanotechnologies (IFN) Como
National Research Council (CNR) Italy–Istituto Officina dei Materiali (IOM)
National Institute for Standards and Technology
(Boulder), United States of America
National University of Singapore, Singapore
Peking University, People’s Republic of China  
Purdue University, United States of America  
Politecnico di Milano, Italy  
Polish Academy of Science’s Institute of Nuclear Physics, Poland  
Radboud University, The Netherlands  
Raman Research Institute, India  
Shandong University, People’s Republic of China  
Shanxi Datong University, People’s Republic of China  
Sharif University of Technology, Iran  
Soreq Nuclear Research Center, Israel  
Southeast University, People’s Republic of China  
Stockholm University, Sweden  
Swansea University, United Kingdom  
Texas Technology University, United States of America  
Technische Universität München, Germany  
The Russian Quantum Center, Russia  
Tsinghua University, People’s Republic of China  
Università Ca’ Foscari Venezia, Italy  
Universität of Münster, Germany  
Universidade Federal do Rio de Janeiro, Brazil  
Universidad de la República, Uruguay  
University College Dublin, Ireland  
Université catholique de Louvain, Belgium  
Université Paris-Sud, France  
University of California at Berkeley, United States of America  
University of California at San Diego, United States of America  
University of Electronic Science and Technology, People’s Republic of China  
University of Innsbruck, Austria  
University of Illinois, Urbana-Champaign, United States of America  
University of Liverpool, United Kingdom  
University of Manchester, United Kingdom  
University of New Mexico, United States of America  
University of Oxford, United Kingdom  
University of Pavia, Italy  
University of Manchester, United Kingdom  
University of Science and Technology of China, People’s Republic of China  
University of Sydney, Australia  
University of Technology Sydney, Australia  
University of Tehran, Iran  
University of Wisconsin, Madison, United States of America  
Vienna University of Technology, Austria  
Zhejiang University, People’s Republic of China

NATIONAL INSTITUTIONS

Brock University  
Canadian Institute for Advanced Research  
Lakehead University  
National Institute for Nanotechnology  
National Research Council of Canada Ottawa  
Queen’s University  
Simon Fraser University  
TRIUMF  
University of Alberta  
University of British Columbia  
University of Ottawa  
University of Victoria  
University of Waterloo  
University of Saskatchewan  
York University

INDUSTRIAL & GOVERNMENT

1QBit  
City of Calgary  
Hewlett-Packard  
Lumerical  
Natural Resources Canada (CanmetENERGY)  
Norcada  
Xanadu
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abhijeet Alase</td>
<td>Dartmouth College</td>
</tr>
<tr>
<td>Saeid Asgarnezhad</td>
<td>Sharif University of Technology</td>
</tr>
<tr>
<td>Boris Braverman</td>
<td>University of Ottawa</td>
</tr>
<tr>
<td>Aashish Clerk</td>
<td>University of Chicago</td>
</tr>
<tr>
<td>Jacob Davidson</td>
<td>Delft University of Technology</td>
</tr>
<tr>
<td>Ish Dhand</td>
<td>Universität Ulm</td>
</tr>
<tr>
<td>Shane Eaton</td>
<td>Politecnico di Milano</td>
</tr>
<tr>
<td>TC Fraser</td>
<td>Perimeter Institute for Theoretical Physics</td>
</tr>
<tr>
<td>Mark Freeman</td>
<td>University of Alberta</td>
</tr>
<tr>
<td>Jianing Geng</td>
<td>Shandong University</td>
</tr>
<tr>
<td>Thomas Grégoire</td>
<td>Carleton University</td>
</tr>
<tr>
<td>Xianxin Guo</td>
<td>Hong Kong University of Science and Technology</td>
</tr>
<tr>
<td>Khabat Heshami</td>
<td>National Research Council Ottawa</td>
</tr>
<tr>
<td>Carmen Hsieh</td>
<td>University of Toronto</td>
</tr>
<tr>
<td>Can-Ming Hu</td>
<td>University of Manitoba</td>
</tr>
<tr>
<td>Mahnaz Jafarzadeh</td>
<td>Urmia University</td>
</tr>
<tr>
<td>Richard Lieu</td>
<td>University of Alabama at Huntsville</td>
</tr>
<tr>
<td>Na Lin</td>
<td>Shandong University</td>
</tr>
<tr>
<td>Jianlong Liu</td>
<td>University of Science and Technology of China</td>
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<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
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</thead>
<tbody>
<tr>
<td>Zhe Liu</td>
<td>Dalian University of Technology</td>
</tr>
<tr>
<td>Laleh Memarzadeh</td>
<td>Sharif University of Technology</td>
</tr>
<tr>
<td>William Murphy</td>
<td>Hicks &amp; Associates Intellectual Property</td>
</tr>
<tr>
<td>Riley Nerem</td>
<td>Montana State University</td>
</tr>
<tr>
<td>Joan Ngure</td>
<td>African Institute for Mathematical Sciences Rwanda</td>
</tr>
<tr>
<td>Simanraj Sadana</td>
<td>Raman Research Institute</td>
</tr>
<tr>
<td>Joe Salfi</td>
<td>University of British Columbia</td>
</tr>
<tr>
<td>Hridya Meppully Sasidharan</td>
<td>S. V. National Institute of Technology</td>
</tr>
<tr>
<td>Urbasi Sinha</td>
<td>Raman Research Institute</td>
</tr>
<tr>
<td>Kartik Srinivasan</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>Ming-Ming Wang</td>
<td>Xi’an Polytechnic University</td>
</tr>
<tr>
<td>Jianwei Xu</td>
<td>Northwest A&amp;F University</td>
</tr>
<tr>
<td>Charles Zhaoxi Xiong</td>
<td>Harvard University</td>
</tr>
<tr>
<td>Siren Yang</td>
<td>Dalian University of Technology</td>
</tr>
<tr>
<td>Jeff Young</td>
<td>University of British Columbia</td>
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</tbody>
</table>

Institute for Quantum Science and Technology
### graduate courses

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Instructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC619 Quantum Computation</td>
<td>P. Høyer</td>
<td>Introduction to quantum computing. Quantum algorithms, quantum search, quantum fourier transforms, quantum error correcting codes, quantum cryptography, nonlocality and quantum communication complexity, and quantum computational complexity.</td>
</tr>
<tr>
<td>PHYS615 Non-relativistic Quantum Mechanics</td>
<td>D. Feder</td>
<td>Mathematical formalism of quantum mechanics. Topics may include addition of angular momenta, Clebsch-Gordan coefficients, Wigner-Eckart theorem; charged particles in electric and magnetic fields; quantum operators; approximation methods; scattering; quantum nonlocality, Einstein-Podolsky-Rosen paradox, Bell's theorem.</td>
</tr>
<tr>
<td>PHYS677 Implementations of Quantum Information</td>
<td>B. C. Sanders</td>
<td>Proposals and realizations of quantum information tasks including quantum computation, quantum communication, and quantum cryptography in optical, atomic, molecular, and solid state systems.</td>
</tr>
</tbody>
</table>
## Conferences/Workshops

<table>
<thead>
<tr>
<th>Members</th>
<th>Committee</th>
<th>Conference/Workshop</th>
<th>Location</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. E. Barclay</td>
<td>Co-Chair</td>
<td>Spin Canada 2018</td>
<td>Calgary, Canada</td>
<td>19–20 Jul 2018</td>
</tr>
<tr>
<td>P. E. Barclay</td>
<td>Chair/Photonics Program (FiO4b)</td>
<td>Frontiers in Optics</td>
<td>Washington DC, United States of America</td>
<td>16–20 Sep 2018</td>
</tr>
<tr>
<td>B. C. Sanders</td>
<td>Organizer</td>
<td>BIRS Workshop on New Developments in Quantum Machine Learning</td>
<td>Banff, Canada</td>
<td>12–17 Jul 2020</td>
</tr>
<tr>
<td>S. Trudel</td>
<td>Symposium Organizer</td>
<td>25th Canadian Symposium on Catalysis</td>
<td>Saskatoon, Canada</td>
<td>8–11 May 2018</td>
</tr>
</tbody>
</table>
# Professional Services

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Journal/Society/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. E. Barclay</td>
<td>Associate Editor</td>
<td>Optics Express</td>
</tr>
<tr>
<td>P. G. Kusalik</td>
<td>Member, Advisory Board, US Department of Energy Frontier Research Centre “Fluid Interface Reactions, Structures and Transport (FIRST)”</td>
<td>Oakridge National Laboratory</td>
</tr>
<tr>
<td>A. I. Lvovsky</td>
<td>Deputy Editor</td>
<td>Optics Express</td>
</tr>
<tr>
<td>N. Moazzen-Ahmadi</td>
<td>Member, Editorial Board &amp; Guest Editor</td>
<td>Journal of Molecular Spectroscopy</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Editorial Board</td>
<td>Advances in Quantum Chemistry</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>College of Reviewers</td>
<td>Canadian Institutes of Health Research</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Editorial Board</td>
<td>Computation</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Resource Allocation Committee</td>
<td>Compute Canada</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Review Panel</td>
<td>German Federal Government (for Universities of Excellence Competition)</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Vice Chair, Editorial Board</td>
<td>Interdisciplinary Science: Computational Life Sciences</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Editorial Board</td>
<td>Journal of Computational Chemistry</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Academic Editorial Board</td>
<td>PLOS One</td>
</tr>
<tr>
<td>D. R. Salahub</td>
<td>Member, Grant Review Panel (CTMC Quantum Chemistry)</td>
<td>United States National Science Foundation</td>
</tr>
<tr>
<td>B. C. Sanders</td>
<td>Member, Editorial Board</td>
<td>IOP ebook™</td>
</tr>
<tr>
<td>B. C. Sanders</td>
<td>Chair, Steering Committee</td>
<td>Quantum Africa Conference Series</td>
</tr>
<tr>
<td>B. C. Sanders</td>
<td>Editor-in-Chief</td>
<td>New Journal of Physics</td>
</tr>
<tr>
<td>Y. J. Shi</td>
<td>Associate Editor</td>
<td>Canadian Journal of Chemistry</td>
</tr>
<tr>
<td>C. Simon</td>
<td>Guest Editor, Special Issue “Quantum Transduction”</td>
<td>Quantum Science and Technology</td>
</tr>
<tr>
<td>C. Simon</td>
<td>Guest Editor, Special Issue “Quantum Networks”</td>
<td>Entropy</td>
</tr>
<tr>
<td>S. Trudel</td>
<td>Chair, Materials Division</td>
<td>Chemical Institute of Canada</td>
</tr>
</tbody>
</table>
Outreach Lectures


9 November 2018, A. I. Lvovsky, “Quantum as an online technology trend”, Canadian Business Frontiers, Toronto, Canada.


Media Coverage

<table>
<thead>
<tr>
<th>Source</th>
<th>Title of Article</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global and Mail</td>
<td>Really want to end “manels”? Some conference organizers are offering childcare: S. Trudel</td>
<td>25 Jun 2018</td>
</tr>
<tr>
<td>Physicsworld.com</td>
<td>Magnetic model simulated in 3D by D-Wave quantum processor: B. C. Sanders</td>
<td>16 Jul 2018</td>
</tr>
<tr>
<td>Explore.ucalgary.ca</td>
<td>Can we be public and private at the same time? The coded thrill of cyberconnectivity: B. C. Sanders</td>
<td>1 Aug 2018</td>
</tr>
<tr>
<td>UToday</td>
<td>Industry, government and academia collaborate to advance cyber security, big data, and oil and gas water treatment: C. Simon</td>
<td>13 Aug 2018</td>
</tr>
<tr>
<td>CQNews</td>
<td>Quantum telecommunication conference held in Changshou: B. C. Sanders</td>
<td>17 Sep 2018</td>
</tr>
<tr>
<td>Chinanews</td>
<td>Chongqing starts a quantum project: B. C. Sanders</td>
<td>17 Sep 2018</td>
</tr>
<tr>
<td>Physicsworld.com</td>
<td>Superconducting and diamond qubits get a boost: B. C. Sanders</td>
<td>25 Sep 2018</td>
</tr>
<tr>
<td>Physicsworld.com</td>
<td>Journal editors share their views on the future of open-access publishing: B. C. Sanders</td>
<td>26 Oct 2018</td>
</tr>
<tr>
<td>Inside Science</td>
<td>Journal editors share their views on the future of open-access publishing: B. C. Sanders</td>
<td>30 Oct 2018</td>
</tr>
<tr>
<td>PLOS Blogs</td>
<td>Supercomputing 18: Pioneer spirit at the “Quantum Communication Networks and Technologies” panel: C. Simon</td>
<td>27 Nov 2018</td>
</tr>
<tr>
<td>TU Wien News</td>
<td>Quantum tricks to unveil the secrets of topological materials: B. C. Sanders</td>
<td>19 Dec 2018</td>
</tr>
<tr>
<td>Eureka Alert</td>
<td>Quantum tricks to unveil the secrets of topological materials: B. C. Sanders</td>
<td>21 Dec 2018</td>
</tr>
<tr>
<td>Stony Brook University News</td>
<td>Quantum immersion workshop to showcase research: B. C. Sanders</td>
<td>14 Feb 2019</td>
</tr>
<tr>
<td>UToday</td>
<td>Antimicrobial resistance and quantum technology dream teams receive $12M in research funding: B. C. Sanders and MIF Quantum Technologies Team</td>
<td>8 Mar 2019</td>
</tr>
</tbody>
</table>
Research Grants (unaudited)

**BY FUNDING AGENCY**

- Natural Sciences and Engineering Research Council of Canada (62.3%)
- University of Calgary (1.9%)
- PIMS (0.5%)
- Alberta Innovates (9.8%)
- Canadian Institute for Advanced Research (2.7%)
- Compute Canada (7.1%)
- Industry (0.7%)
- MITACS (4.1%)
- National Research Council Canada (3.2%)
- Other Grants (7.7%)

**TOTAL REVENUE**

$1.8M

**BY ORIGIN**

- National Funding (80.7%)
- Provincial Funding (11.7%)
- International Funding (7.6%)

**TOTAL REVENUE**

$1.8M
objectives for next year

PAUL E. BARCLAY
- Demonstrate optomechanical switching for interfacing different wavelengths of light
- Develop optical memory for in-situ processing of stored information
- Create optomechanical devices for high frequency magnetometry

DAVID FEDER
- Determine the kinds of symmetry-protected topological states in quantum many-body systems that serve as resources for universal measurement-based quantum computation
- Explore topological phases of two-dimensional spin-orbit coupled quantum gases in the presence of interactions
- Uncover quantum phases of the extended Bose-Hubbard model in the presence of spin-orbit interactions in one dimension

GILAD GOUR
- Determine necessary and sufficient conditions for converting one state to another under symmetric operations
- Derive necessary and sufficient conditions for converting an incoherent athermal state to an athermal state with coherence in the energy basis
- Find an explicit example for non-additivity of the Holevo capacity of a quantum channel
- Generalize the uncertainty principle from a lone system to a system entangled with quantum memory

PETER HØYER
- Develop a quantum algorithm for sampling using quantum walks

PETER KUSALIK
- Further develop and validate effective interaction potentials for the hydroxyl radical in water that faithfully reproduces structural features observed from ab initio simulations
- Determine stability and reactivity of hemi-bonded complexes of the hydroxyl radical with chloride or bromide anions
- Develop and test empirical and coarse-grain potential models appropriate for simulations of self-assembling processes in zinc/carboxylate metal-organic frameworks
- Use machine learning to identify appropriate measures for tracking formation of order during metal-organic framework self-assembly
- Determine key structural features in nucleation of ice and gas clathrate hydrates
- Examine the factors in the nucleation of gas hydrates from water-in-oil emulsions
- Develop novel approaches for molecular simulations of nucleation

NASSER MOAZZEN-AHMADI
- Develop sensitive, compact, potable, and low-cost sensors for monitoring green-house gas emission
- Develop accurate global potential energy surfaces for molecular complexes
- Perform spectroscopic studies of microsolvation of carbon monoxide and carbon dioxide in water
DANIEL OBLAK
- Demonstrate quantum memory with above 50% efficiency and greater than 100 MHz compatible with quantum repeaters
- Demonstrate quantum memory with more than 1 us storage time in thulium doped yttrium-gallium-garnet
- Commence construction of a quantum-satellite ground station
- Demonstrate spectrally multiplexed entangled pairs from a non-linear crystal
- Design components for a measurement-device-independent quantum-key-distribution prototype
- Identify rare-earth ion doped materials for quantum transduction from microwave to optical
- Develop verification and validation protocols for quantum-communication tasks

YUJUN SHI
- Further understand the chemical vapor deposition of silicon nitride using N-containing organosilicon precursors
- Apply chemical vapor deposition for the growth of Si-based nanostructures
- Develop pulse-laser dewetting method for formation of bimetallic nanoparticles

DENNIS SALAHUB
- Implement density functional theory with the Hubbard U-correction method in deMon2k for strongly correlated systems
- Extend oil-sands upgrading simulations to molybdenum sulfide as the nanocatalyst
- Initiate density functional theory with Hubbard U-correction calculations for the water gas shift reaction on nickel-ceria nanocatalysts
- Explore the use of machine learning to identify reaction coordinates (collective variables) for free-energy calculations

BARRY C. SANDERS
- Formulate intelligent search for computational problems showing a quantum speed up
- Enhance quantum algorithms for preparing the ground state of free quantum field theories
- Propose faster lower-power pulse sequences for two and multi-qubit gates in various quantum computing implementations
- Commence collaboration with potential end users of quantum algorithms in epigemetics, block-chain, ab initio chemistry and/or facial recognition
- Complete surveys of status and challenges of a quantum-secure internet
- Install a functional quantum-satellite ground station in Calgary with Oblak

CHRISTOPH SIMON
- Propose a quantum transducer based on optomechanical arrays
- Propose photonic communication between neurons based on oxygen and cytochrome oxidase
- Propose a quantum simulator based on Rydberg excitons in cuprous oxide
- Compare two-qubit quantum gates between individual defects in solids
- Write a review of approaches to quantum transduction
- Propose quantum networks based on individual erbium-167 ions in yttrium orthosilicate
- Compare approaches for quantum repeaters taking into account finite-memory lifetimes

ROBERT THOMPSON
- Complete upgrade and commission ALPHA-g apparatus at CERN
- Resolve atomic structures of antihydrogen
- Commission plasma ion source for TITAN

SIMON TRUDEL
- Understand structural evolution of catalysts using in operando, synchrotron based methods
- Develop printing methods for charge transport layers for use in organic light-emitting diodes
- Study mechanism for memristive behaviour in amorphous metal-oxide thin films
Name and Affiliation

1. The name of the organization shall be the Institute for Quantum Science and Technology (hereinafter referred to as “Institute”). The Institute formally reports to the Faculty of Science and is governed by the Faculty of Science Research Institutes Policy (hereinafter referred to as “Policy”).

Reporting Structure

2. The Institute reports to the Dean, Faculty of Science (s. 4.7).

Approval and Review Bodies

3. The body responsible for approving, reviewing, and renewing the Institute under the Policy (s. 5.1) is the Faculty of Science Executive Committee.

Term of the Institute

4. Under the Policy Institutes are normally established for a five (5) year term (s. 4.3). The current term of the Institute ends 14 September 2023. The Institute is eligible for renewal upon favourable review (s. 4.4).

Goals

5. In keeping with the Policy (s. 4.1) the goals of the Institute shall be:
   a) to conduct leading research in key theoretical and experimental topics of quantum science and technology;
   b) to provide excellent education and training in quantum science and technology and cognate areas;
   c) to foster linkage between the Institute and other quantum science and technology institutes and with industrial partners.

Schedule of Review

6. The review process is specified in the Faculty of Science Research Institutes Procedures (hereinafter referred to as: “Procedures”). Reviews will occur as specified in the Procedures (s. 2.6). The Procedures call for notice of review to be given no later than 9 months before the end of term of the Institute, with a decision no later than 3 months before the end of the term.

Institute Board of Directors

7. a) The governing body of the Institute shall be referred to as the “Board of Directors” (hereinafter “Board”).
   
   b) Membership of the Board shall comprise:
      i. The Dean of Science (or designate) will Chair the Board and appoint a Vice Chair from among other board members;

appendix

Charter of the Institute for Quantum Science and Technology
ii. At least 4 “members at large,” drawn from or nominated by
   • companies whose primary operations are synergistic with quantum information science
   • agencies that provide funding for quantum information science research in Alberta; and
   • leading members of the quantum information science academic community.
   At least one (1) “member at large” shall be appointed from each of these three categories.

c) The Dean of Science shall appoint “members at large”. Terms of appointment, commencing on
   April 1, shall normally be for three years. This length of appointment may be varied to ensure
   an appropriate staggering of terms. Members of the Board shall be eligible for re-appointment
   for consecutive terms of office.

d) The Board shall be responsible for the overall success and governance of the Institute. More
   particularly, its responsibilities include:
   i.     approving and/or amending this Charter under the provisions of clause 10 below
   ii.     ensuring that relevant University policies are respected (see section 9 below)
   iii.    appointing a Director for the Institute
   iv.     approving the Institute’s budget and strategic plans
   v.      determining membership categories and requirements for the Institute
   vi.     determining the procedures and requirements of general meetings of institute members
           (with at least one such meeting required annually)
   vii.    helping to create opportunities for the Institute
   viii.   facilitating the periodic reviews and external assessments of the Institute, as required by
           the Policy and Procedures of the Faculty of Science.

e) The Board shall appoint a Secretary of the Board for a three-year term. The Board can revoke
   such appointment at any time. The Secretary is not a Board Member and is not eligible to
   vote.

f) The Board shall meet not less than once in each calendar year, prior to the annual general
   meeting of Institute members. Special Meetings of the Board shall be convened by the Chair of
   the Board or upon the written request of at least two (2) members of the Board addressed to
   the Chair.
   i. At least thirty days notice of any meeting shall be given in writing to each member of the
      Board. Such notice shall specify the time, place and agenda of the meeting.
   ii. At any meeting of the Board 50 percent of members, present physically or via
       teleconference, shall constitute a quorum.

g) The cost for Board members of attending Board meetings (annual and special) will be incurred
   by the Institute.

Director

8. a) The Director reports to the Board and to the University through the Dean of the Faculty of
     Science (who, directly or through a designate, chairs the Board).

   b) The Director exercises a general superintendence over the operational affairs of the Institute in
      accordance with the goals of the Institute, and within Board-approved budgets and strategic
      plans.
The Institute shall submit an annual report (July 15) on its activities to the Dean of the Faculty of Science.

c) The duties of the Director shall include, but not be limited to, the following:
   i. preparing an annual budget and strategic plan for consideration and approval by the Board;
   ii. preparing periodic financial updates for consideration by the Board;
   iii. ensuring that all Institute policies and procedures adopted by the Board are made widely known among Institute members and stakeholders, including the broader University of Calgary community;
   iv. preparing an annual report on the Institute's affairs, which shall include reporting on measures of success;
   v. making any additional submissions or reports, as appropriate or requested, to the Board or the University of Calgary on any matter affecting the Institute;
   vi. facilitating the periodic reviews and external assessments of the Institute required by the Policy and Procedures of the Faculty of Science.

Policies and Procedures

9. The Institute will operate in accordance with all applicable University of Calgary policies and procedures.

Amendments

10. Amendments to this Charter shall require approval by the Dean and two-thirds of the Board. The Dean will refer proposed amendments to the Faculty of Science Executive Committee.
IQST adds value to the University of Calgary in the following ways:

- Enables multidisciplinary research through financial and logistical support
- Builds a quantum science and technology community through visitor, seminar, and colloquium programs
- Assists new faculty members to become productive researchers rapidly
- Publishes reports and web pages that showcase the institute as a leader in quantum information science
- Supports recruitment of outstanding faculty, researchers, and graduate students
- Sponsors and supports leading conferences held locally
- Partners with other quantum institutes
- Enhances the university’s reputation by delivering outstanding research results
- Benefits the wider community by contributing new knowledge in a strategic area