
QUANTUM RESEARCH AT TRINITY

John Goold
School of Physics

UCD
May 30, 2022



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

THE RESEARCH, FUNDING AND
TCD TEAMS WORKING ON QUANTUM

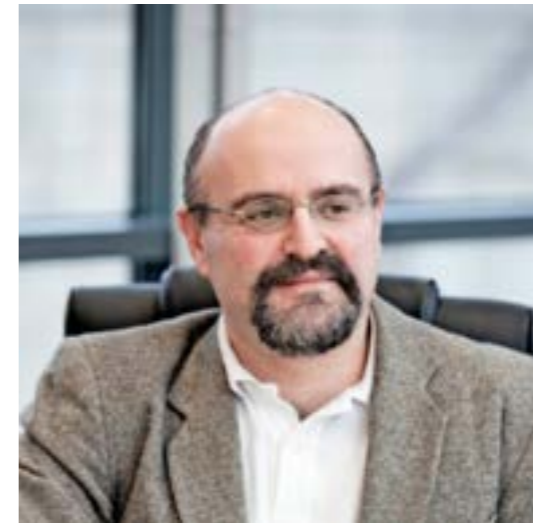
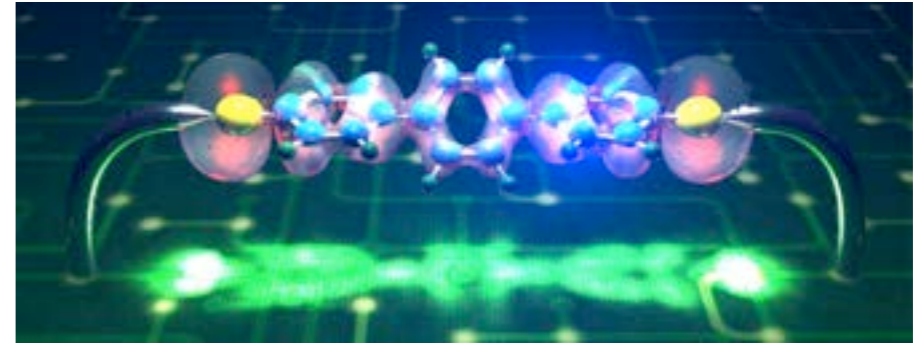
ADVANCED MATERIAL DESIGN

PI: Stefano Sanvito (Head of CRANN)
(Appointed: 2002)

Topics: Materials modelling,
Computational physics, machine learning
Methodology development
Electronic structure theory

Team Composition: ~20 members, constant

Funding: ERC, IRC, SFI, EU, KAUST, Qater partnership, IMRA, Western digital, Rolex,
~2 million at steady state



QUANTUM LIGHT AND MATTER GROUP

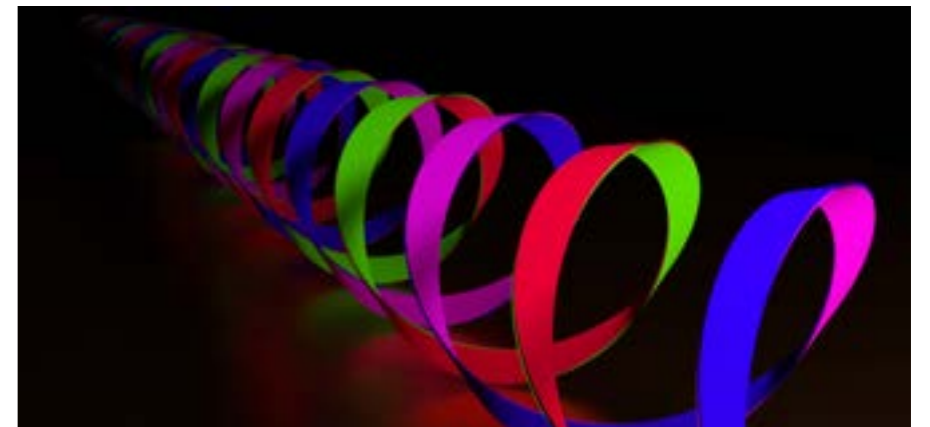
PI: PAUL EASTHAM
(Appointed: 2009)



Topics: Light matter interactions,
Semi-conductor nanostructure,
Many-body physics

Team Composition: ~5 members, 4 Phd students

Funding: SFI SIRG, IRC, H2020

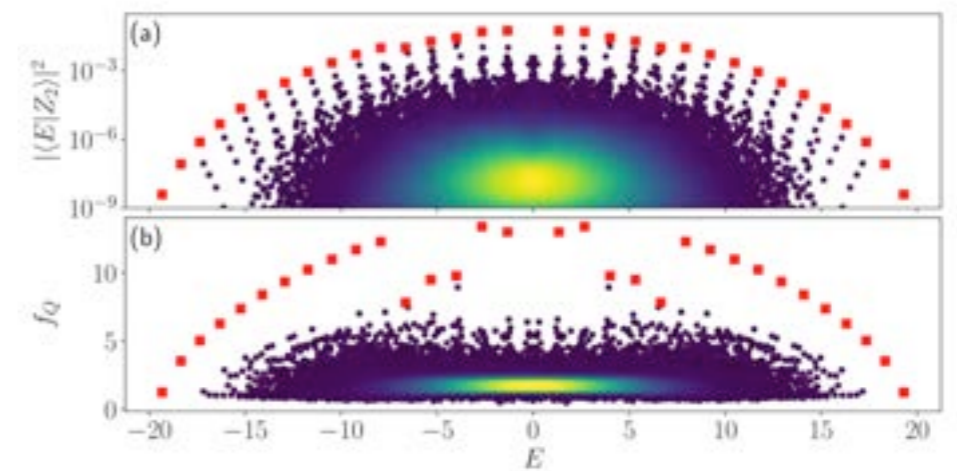


QUSYS - THERMODYNAMICS OF AND ENERGETICS OF QUANTUM SYSTEMS GROUP

PI: John Goold
(Appointed 2018)



Topics: Non-equilibrium quantum thermodynamics,
quantum information,
quantum many-body physics,
Simulation (quantum and classical) of quantum systems



Team Composition: ~15 members, 8 Phd students, 5 postdocs, visitor, 50% administrator

Funding: ERC Starting grant, ERC Proof of Concept, SFI-Royal Society, Marie-Curie, SFI- Frontier for the Future, SFI-EPRSC (Belfast-Bath-TCD), Microsoft, IRC postgrad ~3.5 million (running out quick)

QUANTUM NANOPHOTONICS GROUP

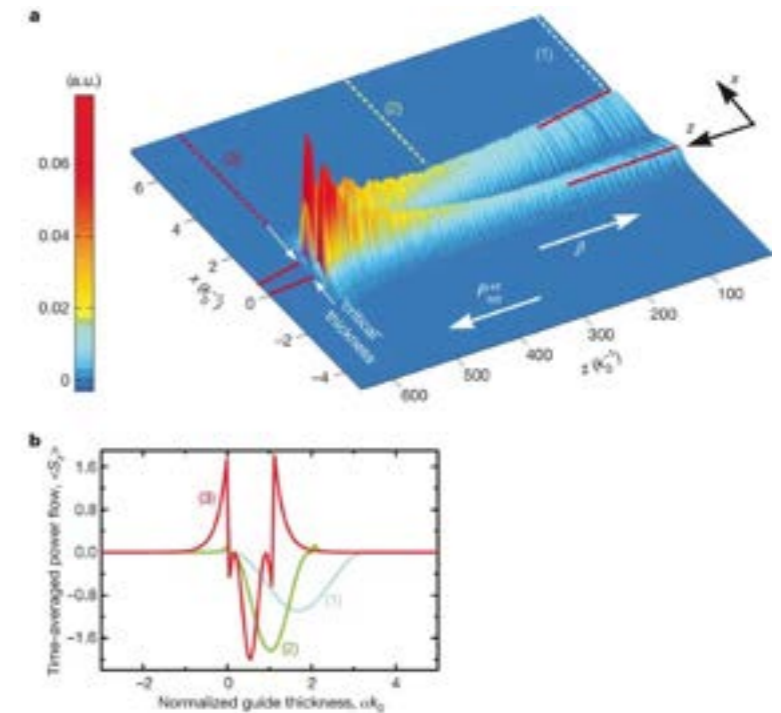
PI: Ortwin Hess
(Appointed: 2020)



Topics: Quantum nano-photonics,
quantum meta materials,
laser dynamics

Team Composition: ~16 members, 7 Phd students, 8 postdocs, visitor

Funding: SFI Research Professorship, Quanterra, EPSRC ~3.5 million

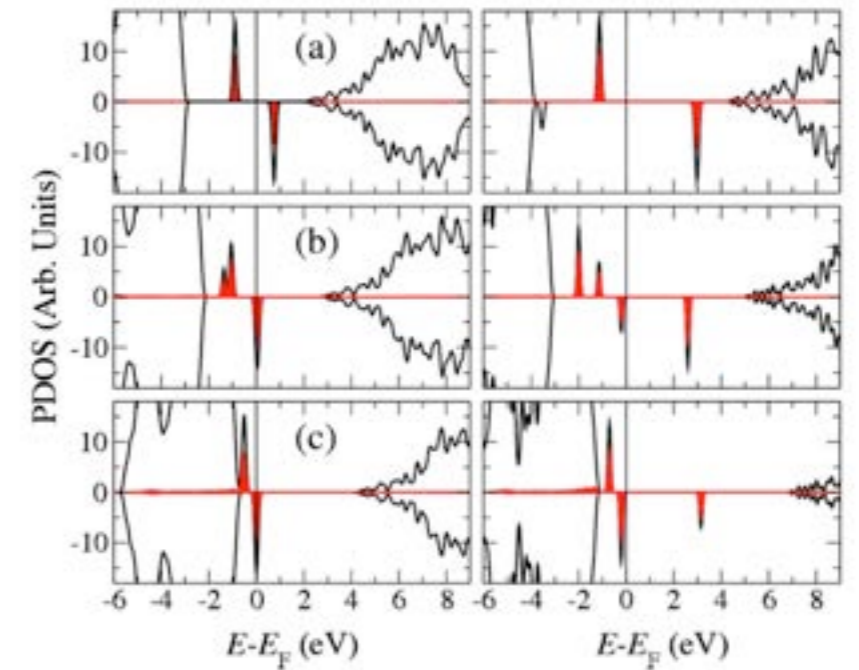


QUANTUM TRANSPORT GROUP

PI: ANDREA DRONGHETTI
(URF 2020)



Topics: Quantum transport ,
correlated electronic systems ,
quantum many-body physics,
nanoscale devices and materials

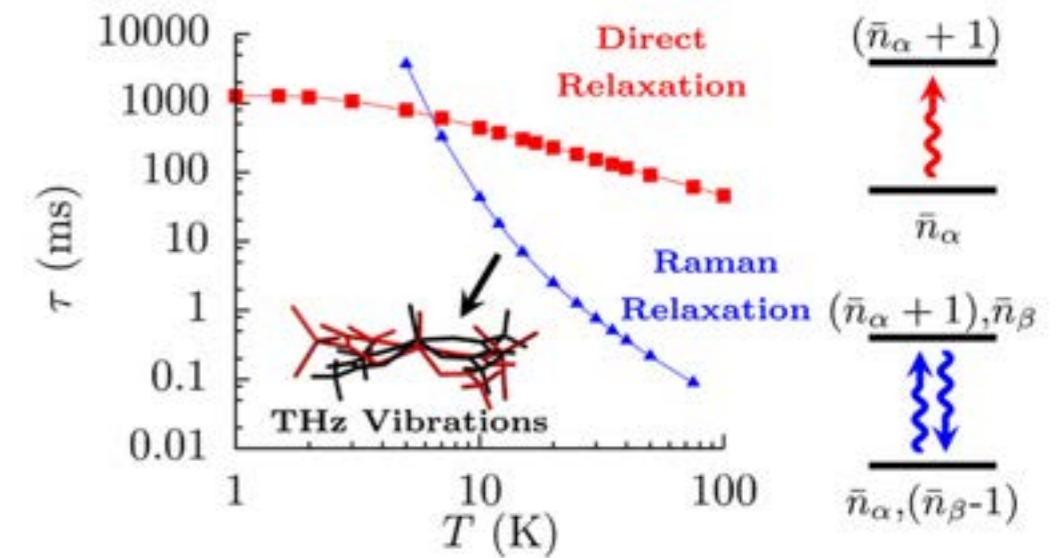


Team Composition: ~5 members, 2 Phd students, 2 postdocs,

Funding: SFI-Royal Society, FET Open, Marie-Curie, IRC postgrad ~1 million

QUANTUM MATERIAL DYNAMICS GROUP

PI: Alessandro Lunghi
(Appointed: 2021)



Topics: Spin qubits,
quantum chemistry,
Ab initio methods, material modelling

Team Composition: ~6 members, 2 Phd students, 3 postdocs,

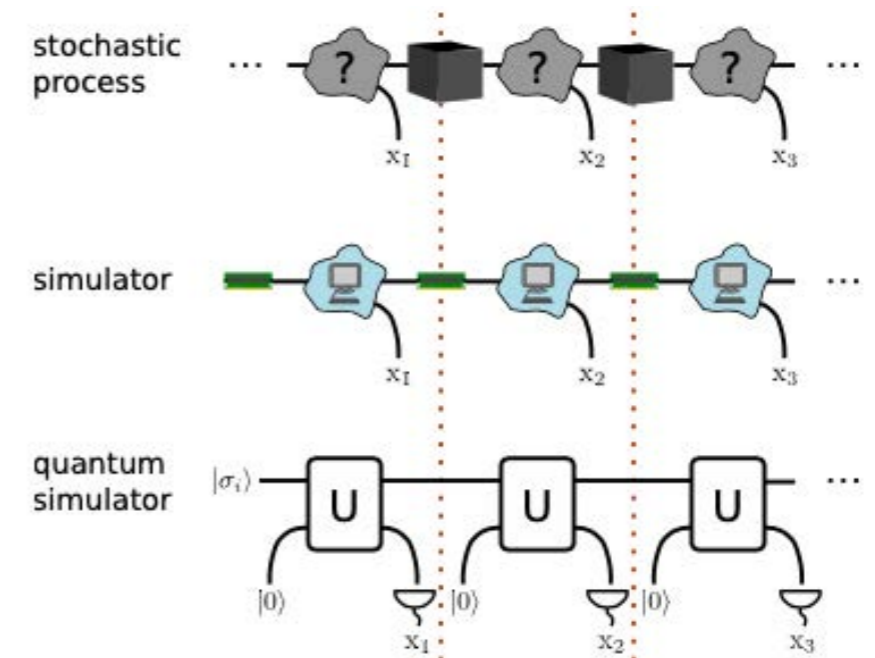
Funding: ERC Starting grant (1.5 million)

BINDER GROUP - PHYSICS OF (QUANTUM) INFORMATION PROCESSING

PI: Felix Binder
(Appointed 2021)



Topics: Stochastic process,
quantum information,
quantum thermodynamics,
Complexity



Team Composition: ~7 members, 3 Phd students, 3 postdocs in October

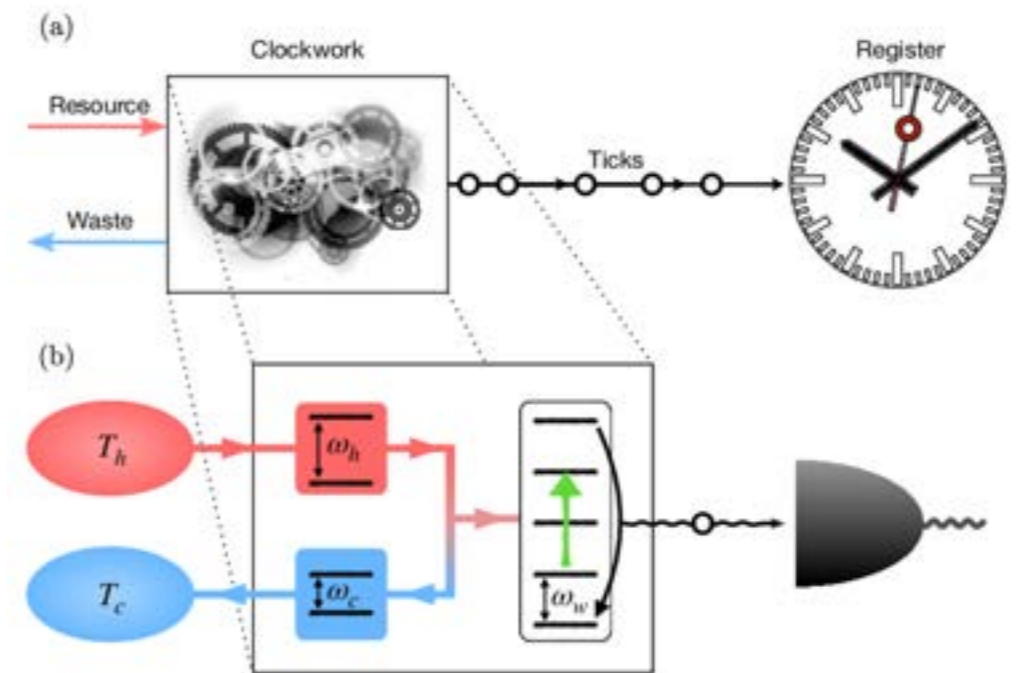
Funding: FQXI, IRC, Marie Curie, (good news recently but I know nothing :), 700k

THEORY OF CONTROLLED QUANTUM SYSTEMS

PI: Mark Mitchison
(Appointed 2021)



Topics: Open quantum systems,
Quantum metrology and control,
Quantum thermodynamics



Team Composition: ~7 members, 5 Phd students, 1-2 postdocs in October

Funding: IRC, First Irish Quantum Flagship Project: 2.9 million euro on precision thermodynamics in nanoscale devices and thermodynamics!

TCD, Oxford, Vienna, Chalmers and Murcia

BEYOND SCHOOL OF PHYSICS

Sinead Ryan (Mathematics) HPC

Dan Kilper (Connect) Quantum Networks and communications

Nicola Marchetti (Engineering) Quantum Communications

Marco Ruffini (Computer Science) Quantum Communications

Harun Siljak (Engineering) Quantum Communications

Biswajit Basu (Engineering) Quantum computation

Alessio Benavoli (Computer science) Machine learning , quantum foundations

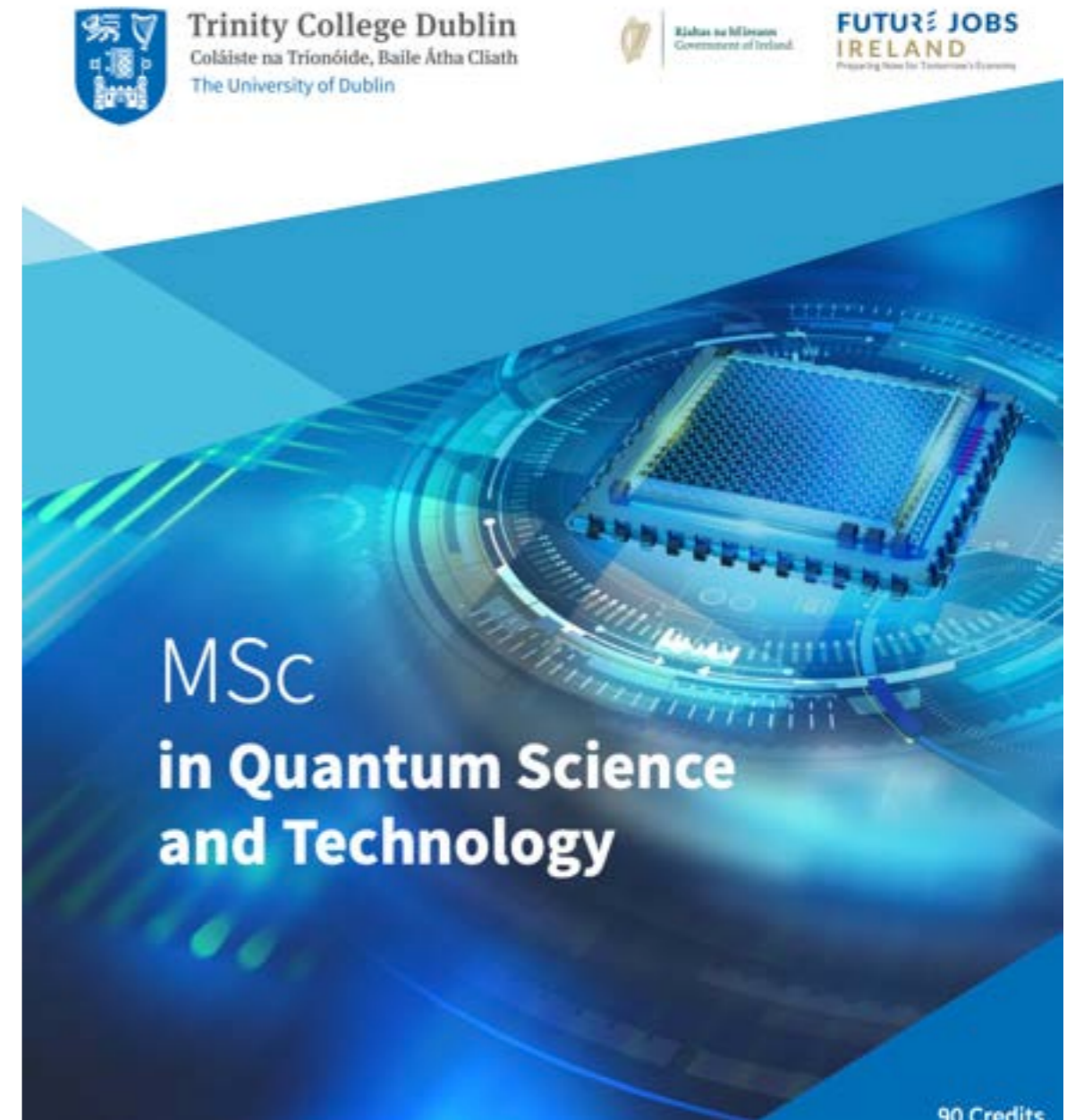
EDUCATIONAL PROGRAMME IN QUANTUM SCIENCE

Funded by HEA as part of
TCD bid Pillar 3 (1.5 million)



11 students 21/22

Internships for all students,
5 in industrial paid internship
currently



**MODULE 1:
Introduction to Quantum
Information Science**

Introduction to quantum information theory

Core concepts e.g. no-cloning, teleportation and entanglement theory

**MODULE 2:
Special topics and the
quantum industry**

Current challenges and opportunities in the quantum sector

Industrial and academic speakers

**MODULE 3:
Open Quantum Systems**

Dynamical aspects of quantum mechanics

Quantum technologies from an open system perspective

**MODULE 4:
Quantum Material Science**

Harnessing quantum effects in superconducting systems

The role of quantum materials and quantum nano-photonics in reducing the impact of thermal fluctuations and disorder

**MODULE 5:
Physical implementations of quantum technology**

The physical principles behind the operation of quantum devices

The criteria for application in technology

**MODULE 6:
Quantum computation and algorithm**

Introduction to quantum computation and algorithms

Writing elementary quantum programs

**MODULE 7:
Quantum project/Internship**

This module will enable students to develop key research skills and offer them the opportunity to understand how quantum researchers work in either an industrial or academic environment. Students will complete a cutting-edge research project and present their findings to the quantum researchers in the School.

ENGAGEMENT WITH QUANTUM INDUSTRY

Joe Fitzsimons (Horizon Quantum)

Leonie Mueck (Riverlane)

Brendan Reid (Riverlane)

Shengru Ren (1Qbit)

Brian Flynn (Phasecraft)

Mathias Soeken (Microsoft)

Shane Mansfield (Quandela)

Terry Rudolph (PsiQuantum)

Callum McPherson (Quantinuum – Cambridge Quantum)

Seyon Sivarajah (Quantinuum – Cambridge Quantum)

Tommaso Demarie (Entropica Labs),

Will Zeng (Goldman-Sachs, and Unitary Fund),

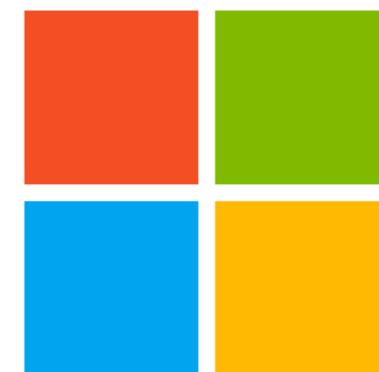
Guillermo García-Perez (Algorithmiq)

Sabrina Maniscalco (Algorithmiq)

Martin Mevissen (IBM)

river
lane

1QBit



PHASECRAFT



Rhys Lewis (National Physical Laboratory - UK), Deirdre Ahern (Trinity Law),

Niamh Wylie (Trinity Business School), Stephen Clark (Bristol) - course on Tensor Networks

Shane Bergin (UCD)



Ψ PsiQuantum



IBM Research Europe – Dublin and Trinity College Dublin announce new Pre-doctoral Fellowship Program



Dublin, Ireland, – November 3, 2021 – IBM Research Europe – Dublin and Trinity College Dublin (TCD) are pleased to announce their new Pre-doc Fellowship Program.

The program aims to give pre-doc students who have been exemplary in their academic achievements the unique opportunity to work in a corporation side by side experienced scientists on solving real-world problems. As part of the program, the pre-doc students will work on a mutually agreed research project and be supervised by IBM Research mentors as well as TCD professors. Each recipient will also be employed by IBM Research in Dublin for the duration of their PhD study.

Project focus areas include the following research topics:

Quantum Computing / Quantum Systems

Artificial Intelligence

Future of Computing

Security and privacy

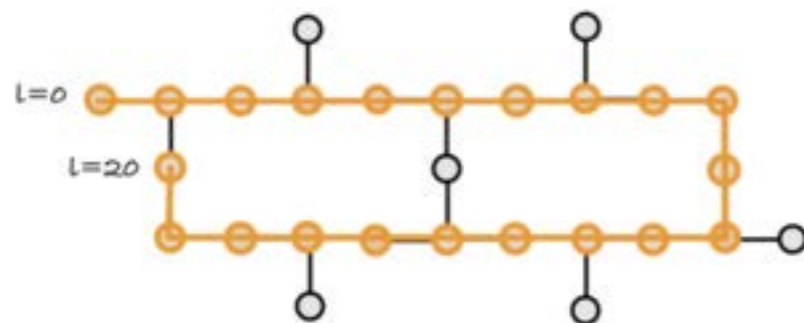


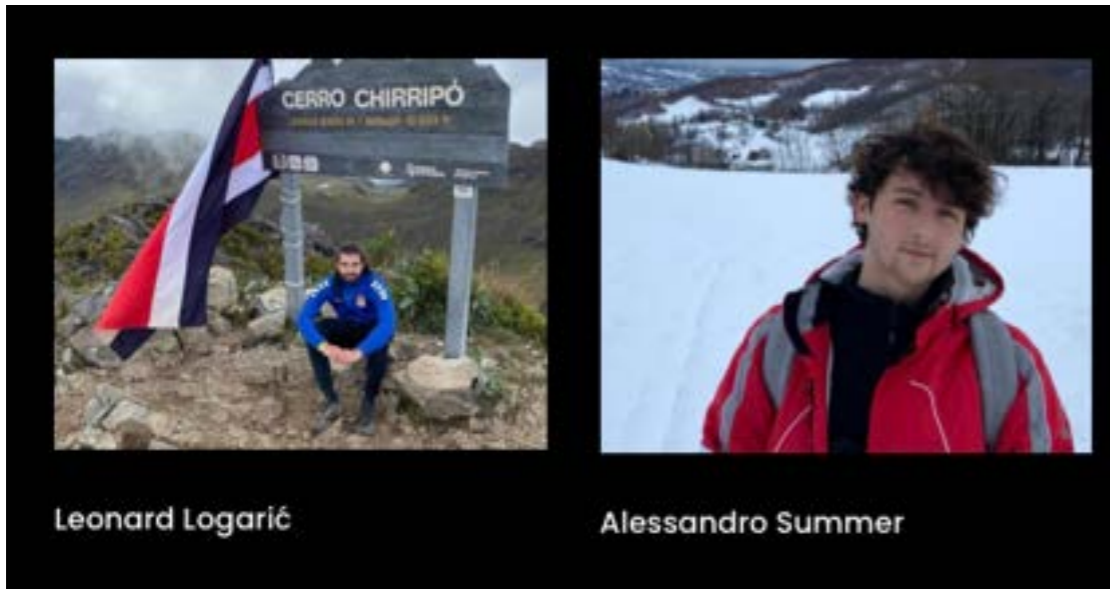
Figure 1. Mapping of a 21 qubit XXZ chain on the IBM device Montreal. We perform the randomisation on qubits 1-20, leaving qubit 0 alone.



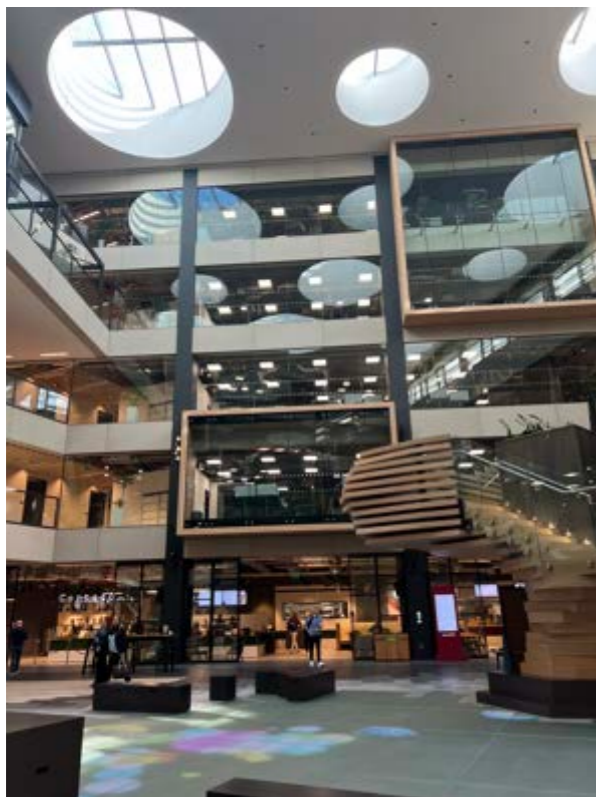
Technology

Trinity College teams up with Microsoft on quantum computing programme

Tech firm to provide funding for research

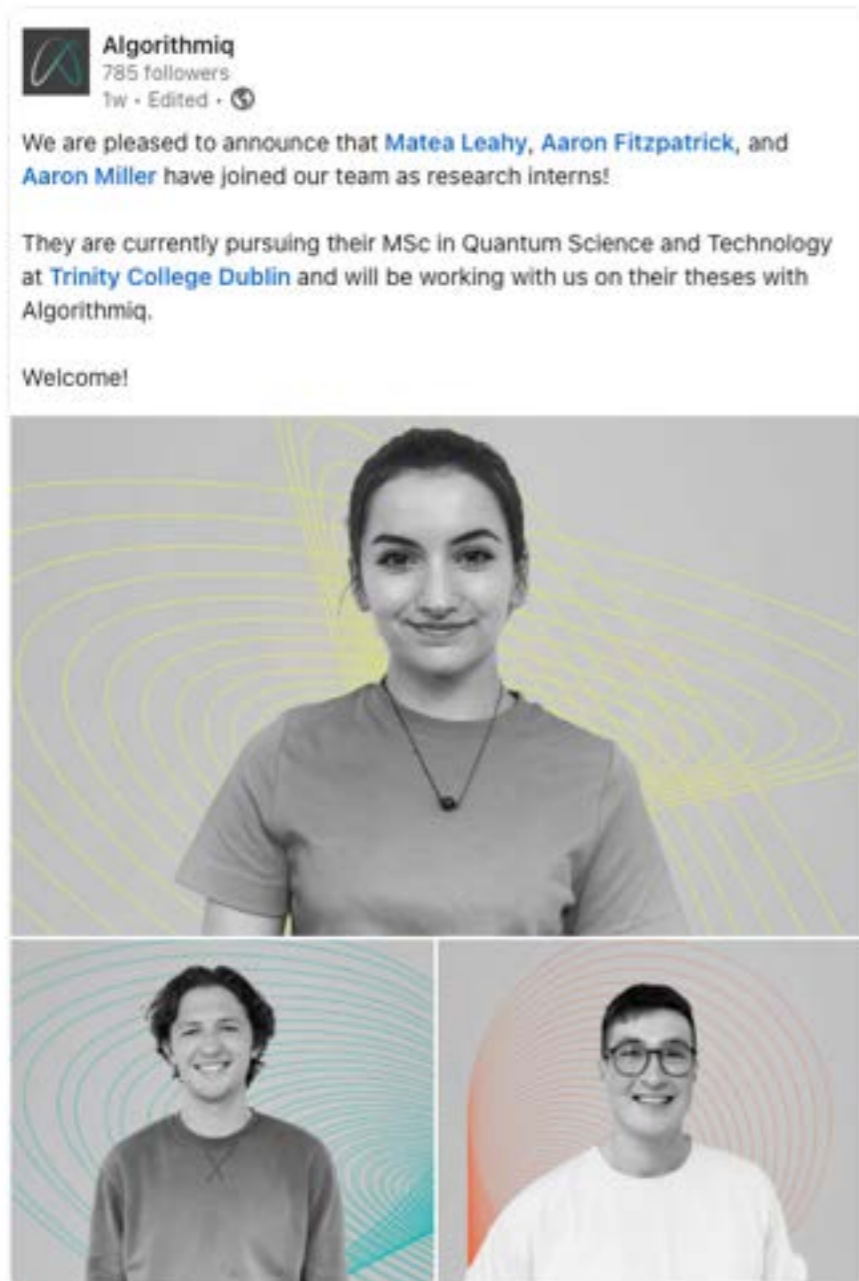


2 PhD Students,
6 MSc Scholarships (2 per year)
20k each for best female applicants to the MSc



Special thanks to Kieran McCurry !

IN PROCESS



3 Paid internships for 5 months
Intention to hire as industrial PhDs if they perform well

Currently in the middle of signing a longer lasting collaboration between algorithmic and TCD

QUANTUM MEITHAL AT TCD

1. To continue our success in **basic** quantum research at TCD
2. To build upon our MSc educational programme in Quantum Science - ideally by getting a quantum doctoral training centre to slot on top
3. To continue our engagement with the quantum industry, forming collaborations in quantum simulation and other relevant topics
4. To work with our MNC colleagues and funding agencies etc, to establish a broader quantum tech community in Ireland
5. Success and great places are only a function of the people that are involved.

meitheal

Meitheal is an old Irish term that describes how neighbours would come together to assist in the saving of crops or other tasks. The meitheal would work on the farms of all members. It's an Irish language (Gaeilge) word pronounced 'mehal' with all syllables of equal stress.

THANKS