WINQ/Quantum

Wallenberg Initiative on Networks and Quantum information

Sofia Qvarfort (on behalf of the quantum WINQ Team)

5th December 2024

What is WINQ?

WINQ | Wallenberg Initiative on Networks and Quantum information

NORDITA
The Nordic Institute for Theoretical Physics

Quantum Information

Thermodynamics

Quantum metrology

Measurements

Gaussian states

Qubits

Quantum optics

Complex Dynamical Networks

Networks

Stochastic processes

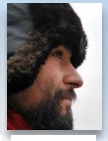
Graph theory

Percolation

Machine learning


Sreenath Manikandan


Robert Jonsson


Fabio Costa


Jing Yang


Andrea Maiani


Roope Uola


Sofia Qvarfort


Soon Hoe Lin

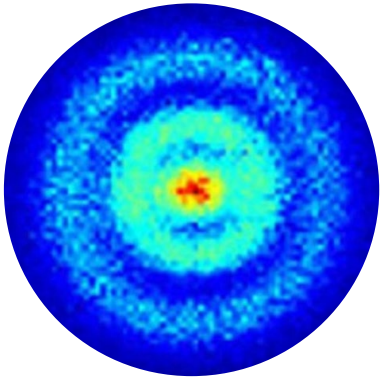

Matthew de Courcy-Ireland


Niccolò Zagli


Hanlin Sun

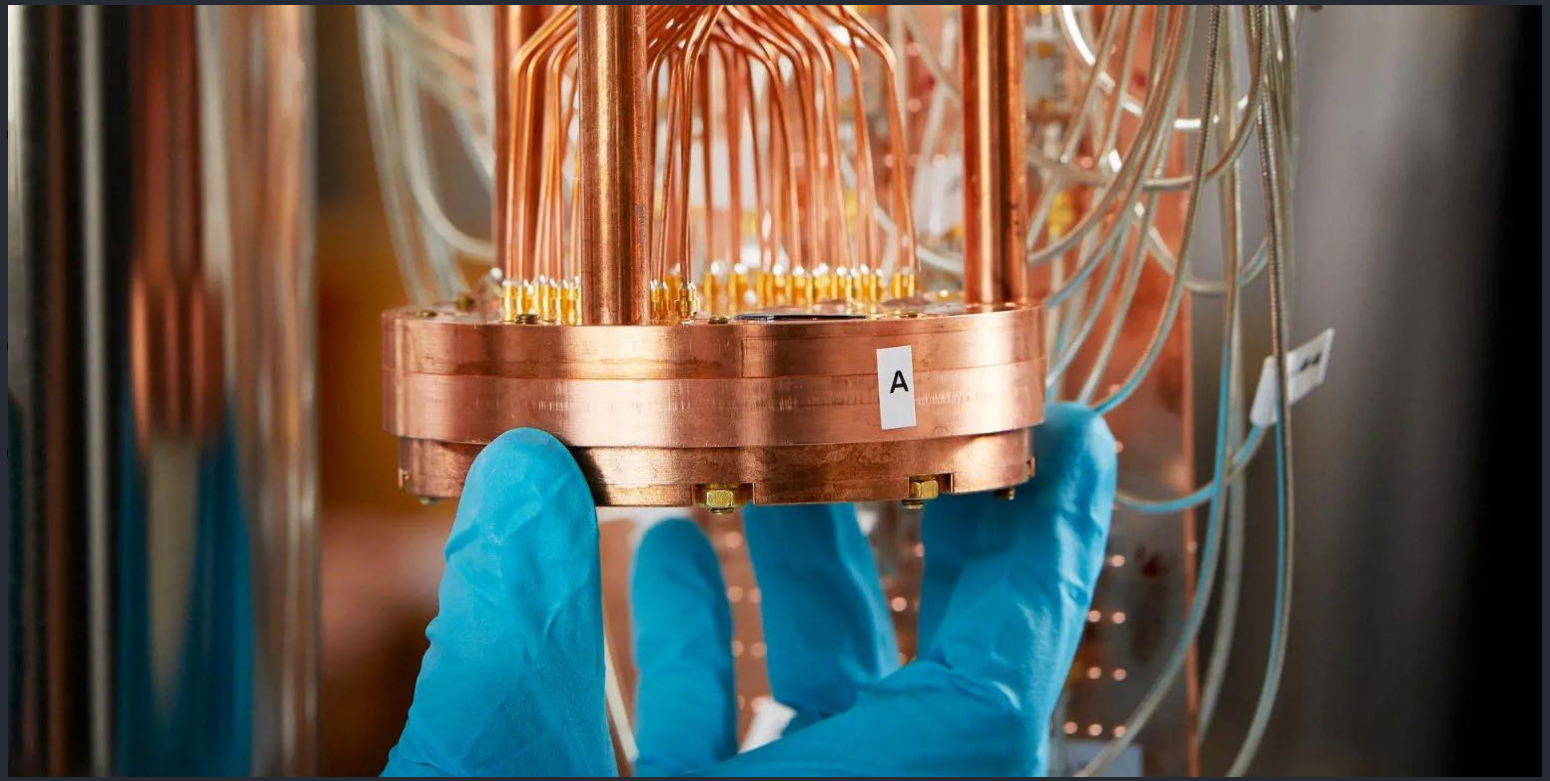

Henri Riihimäki

Quantum information theory



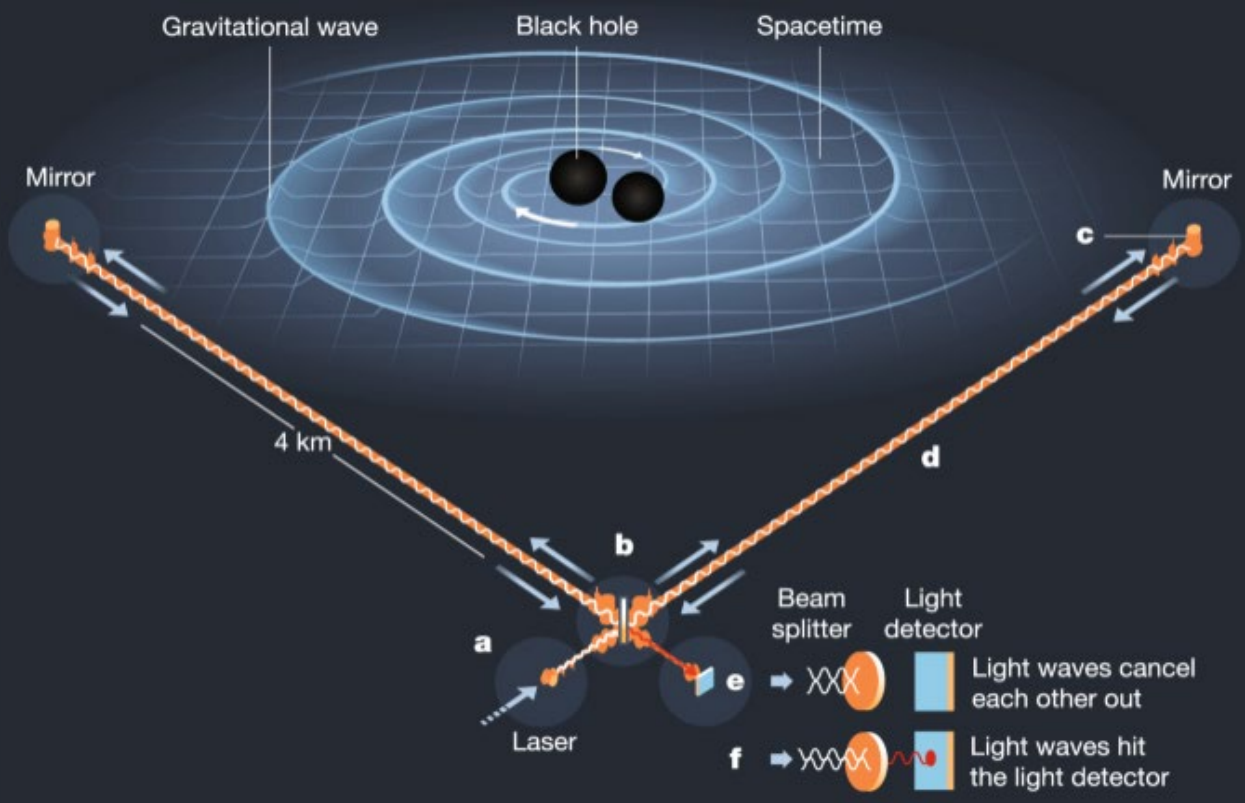
The study of quantum systems from an information-theoretic point-of-view

Quantum Computing



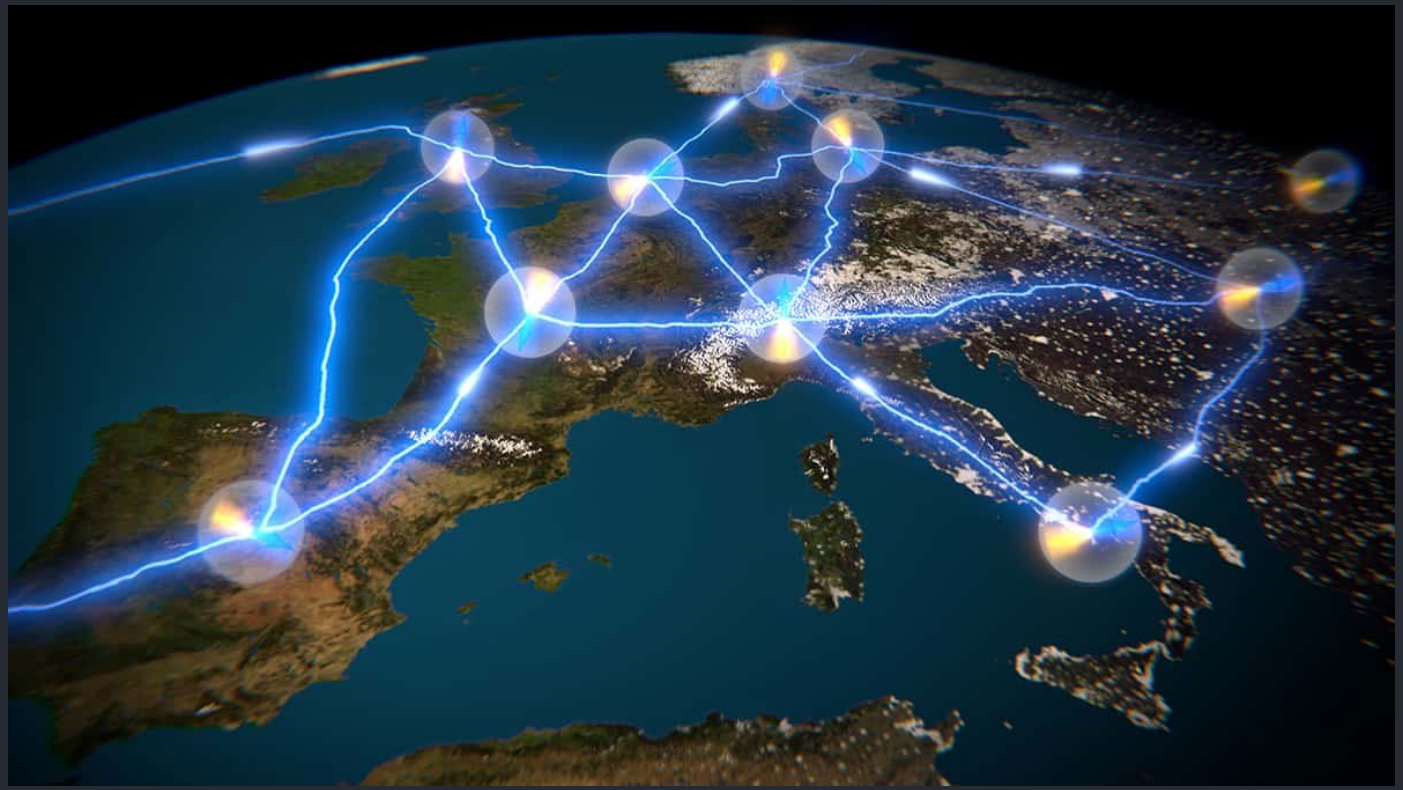
Credit: WACQTT quantum

Quantum Sensing



Credit: LIGO

Quantum Communication



Credit:

Robert Jonsson
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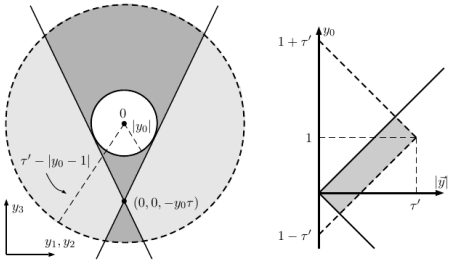
Topics: Casual fermionic systems, Gaussian states, relativistic quantum I nformation

Available project (start spring 2025):

Question: What most fundamental discrete spacetime structures arise in the framework?



Goals

- *Numerically and analytically explore toy model*
- *Speed up numerics*
- *Try machine learning methods…?*

See paper https://arxiv.org/abs/2201.06382 for background.

Andrea Maiani
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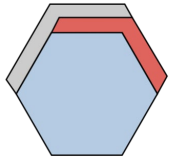
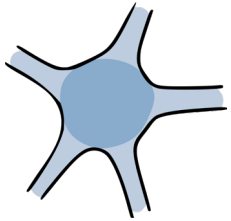
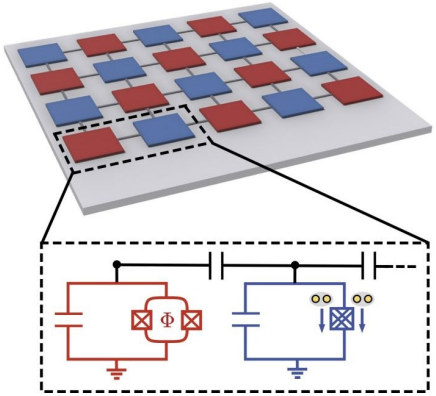




Topics: Quantum transport, complex heterostructures, superconducting qubits,

Available projects:

- Readout technique for parity-protected superconducting qubits
- Identification of higher harmonics in hybrid Josephson junction arrays
- Floquet scattering matrix approach to Josephson effect
- Microscopic theory of domain-wall superconductivity in ferromagnet-superconductor heterostructures
- Impurities in altermagnet-superconductor heterostructures



Sreenath Manikandan
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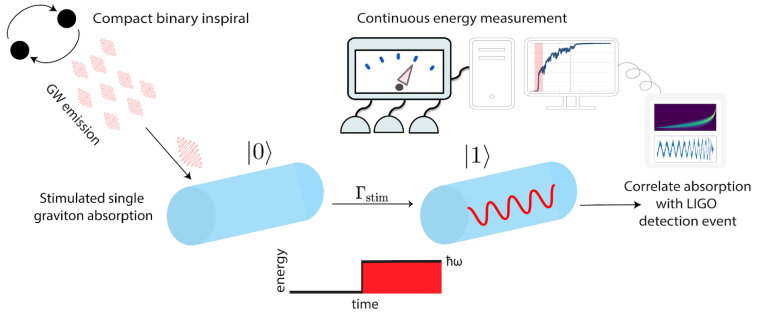
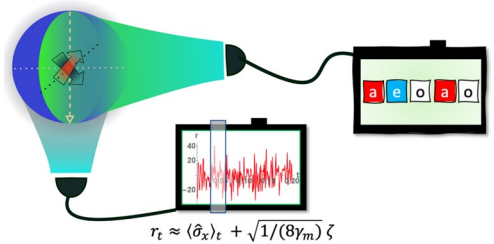
Topics: Quantum measurements, quantum thermodynamics, tests of fundamental physics

Available projects:

- Quantum mechanics and acoherence of resonant harmonic detectors for radiation fields
- Quantum mechanics of single photon emitters and resonant photodetectors





Roope Uola
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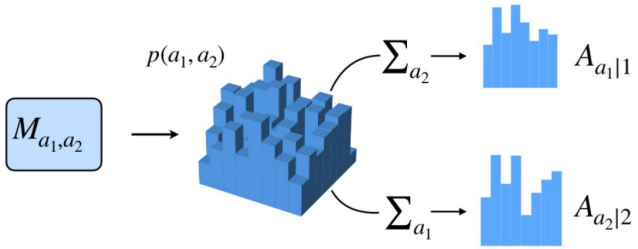
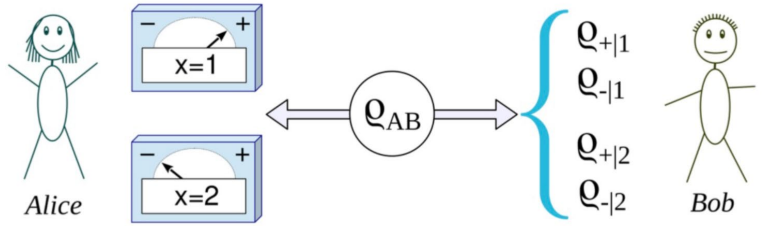
Topics: Quantum measurement theory, quantum information

Available projects:

- Sequential measurements and Heisenberg's microscope
- Signalling in quantum correlation experiments
- Measurement incompatibility in quantum metrology
- Contextuality of quantum transformations

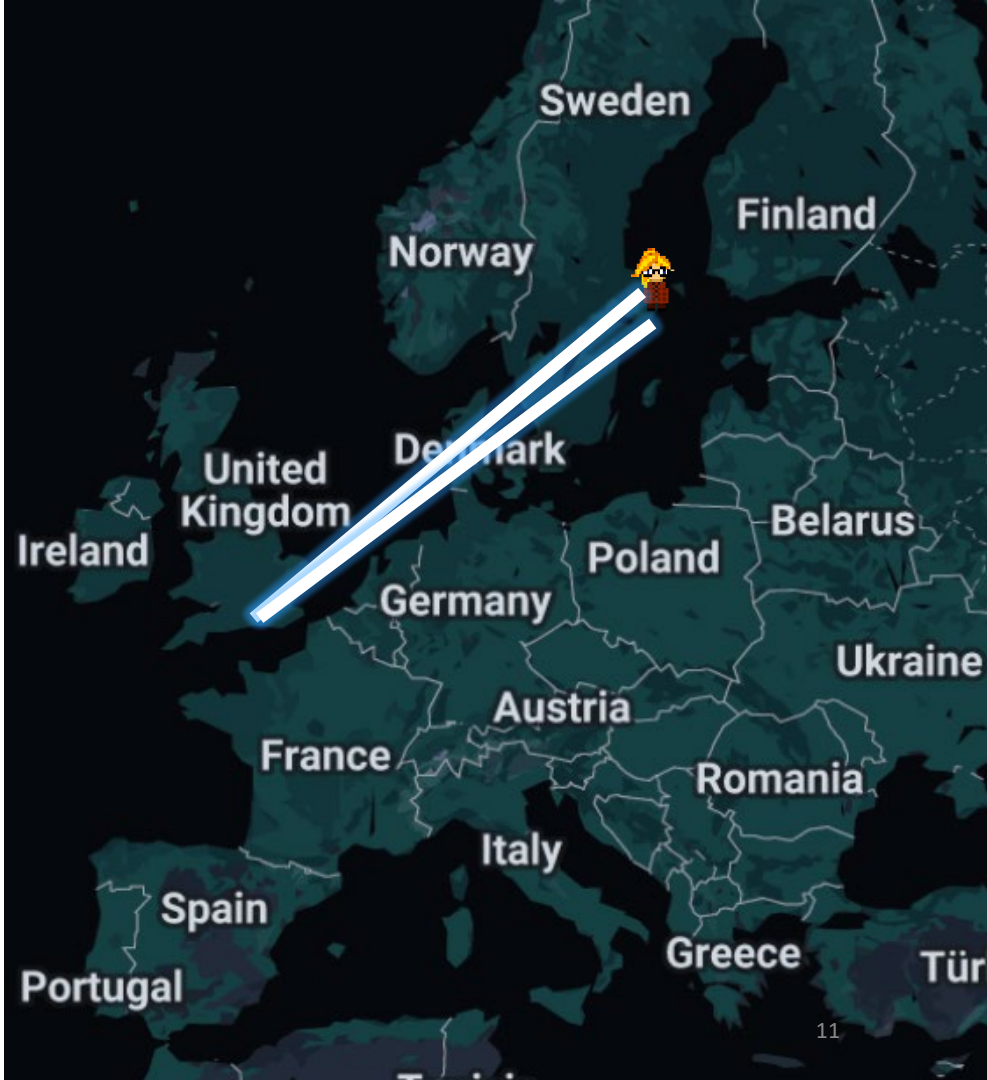




Who am I?

Academic journey

- 2011 Moved from Uppsala to London
- 2015 MSci in Physics at Imperial College
- 2020 PhD in Physics at UCL
- 2021 Marie-Curie and WINQ Fellowships Stockholm
- 2024 WINQ assistant professor at Nordita & Fysikum



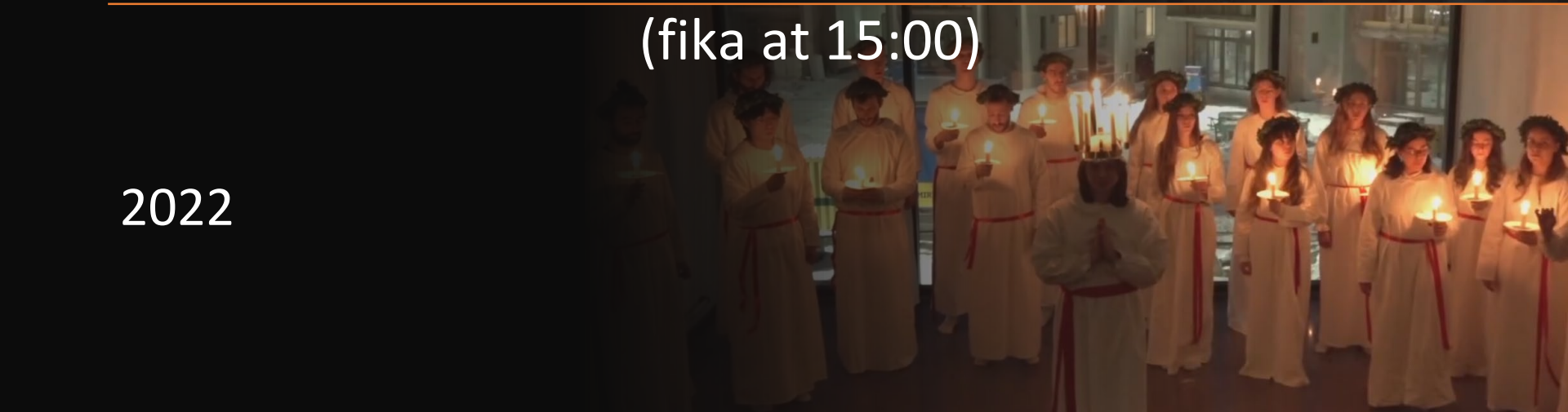
Lucia
2023

2022

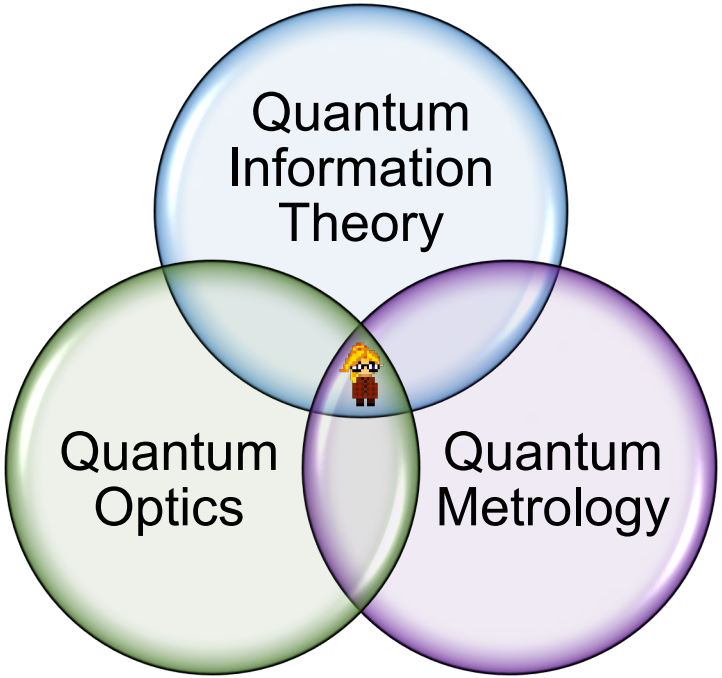
Lucia
2023

This year: 13th
December at 15:30
(fika at 15:00)

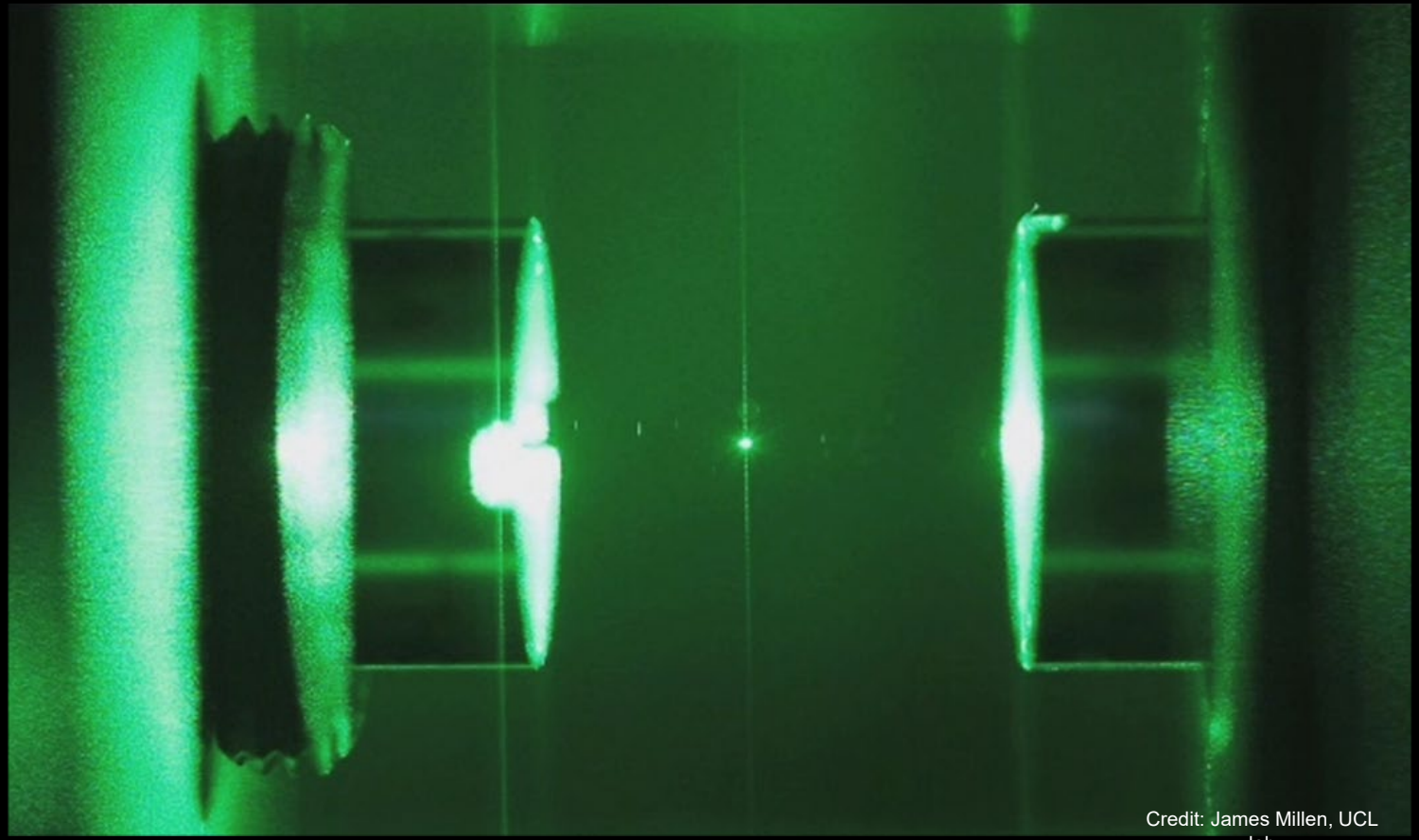
2022



My research

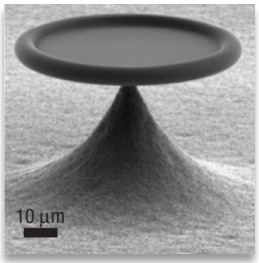


The study of nonlinear quantum dynamics for QIP and quantum sensing

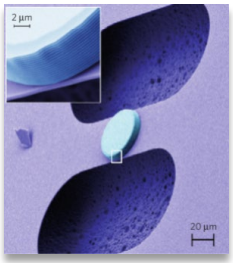


Credit: James Millen, UCL lab

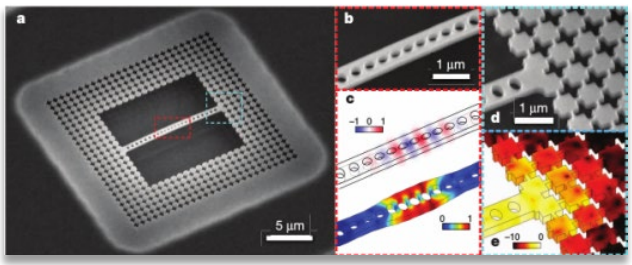
What is optomechanics?



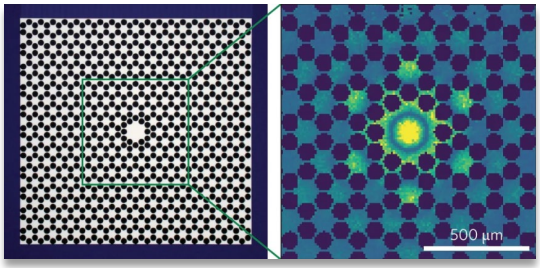
Schliesser *et al*. *Nature Physics* 4.5 (2008).



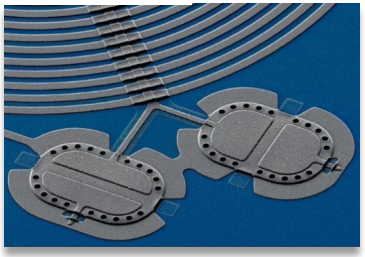
Gröblacher, *et al*. *Nature Physics* 5.7 (2009).



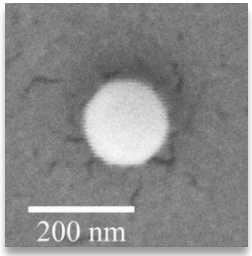
Chan, *et al*. Nature 478.7367 (2011).



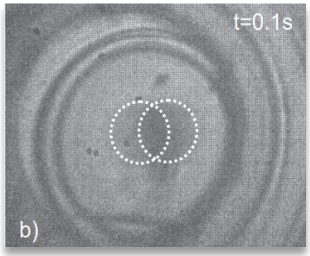
Tsaturyan, *et al*. *Nature Nanotechnology* 12.8 (2017): 776-783.



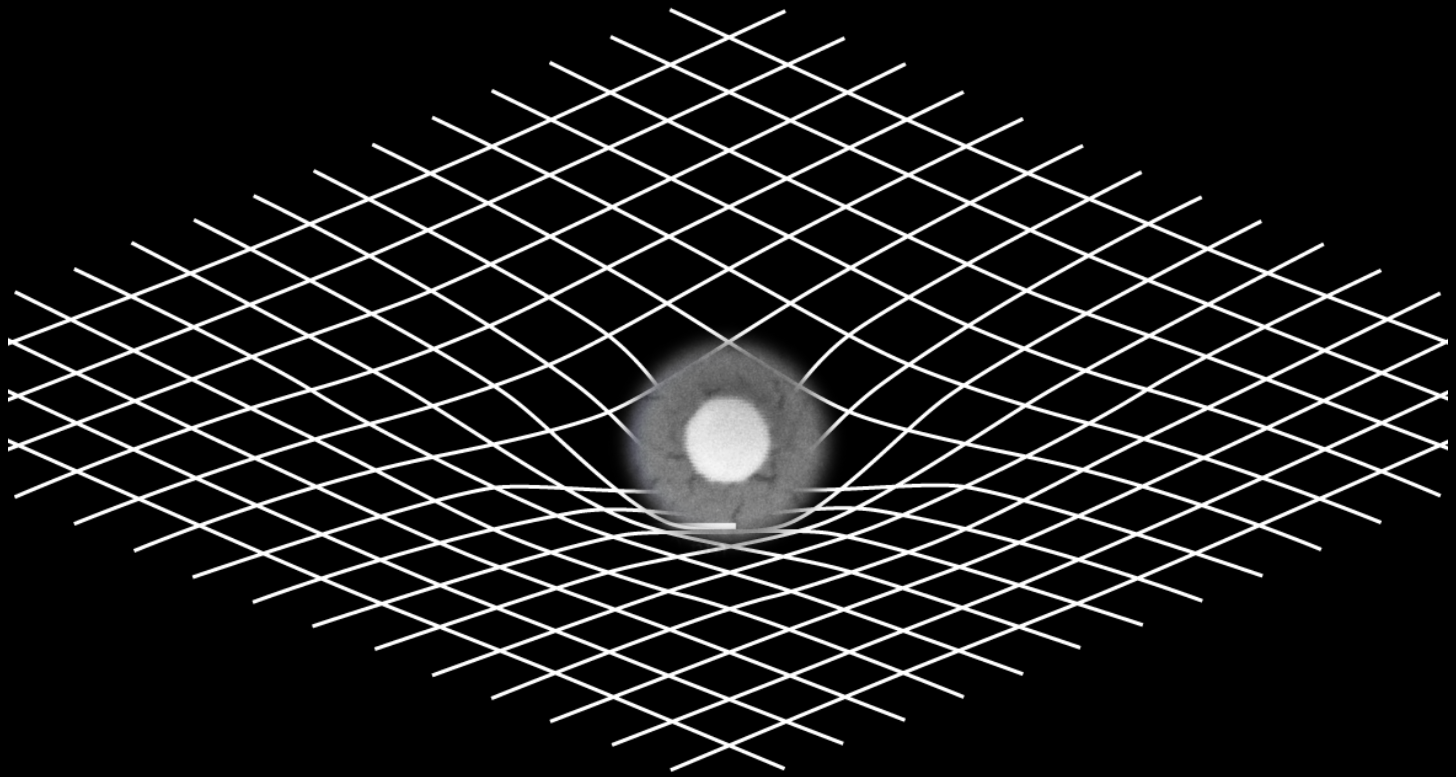
Kotler, *et al*. Science 372.6542 (2021).

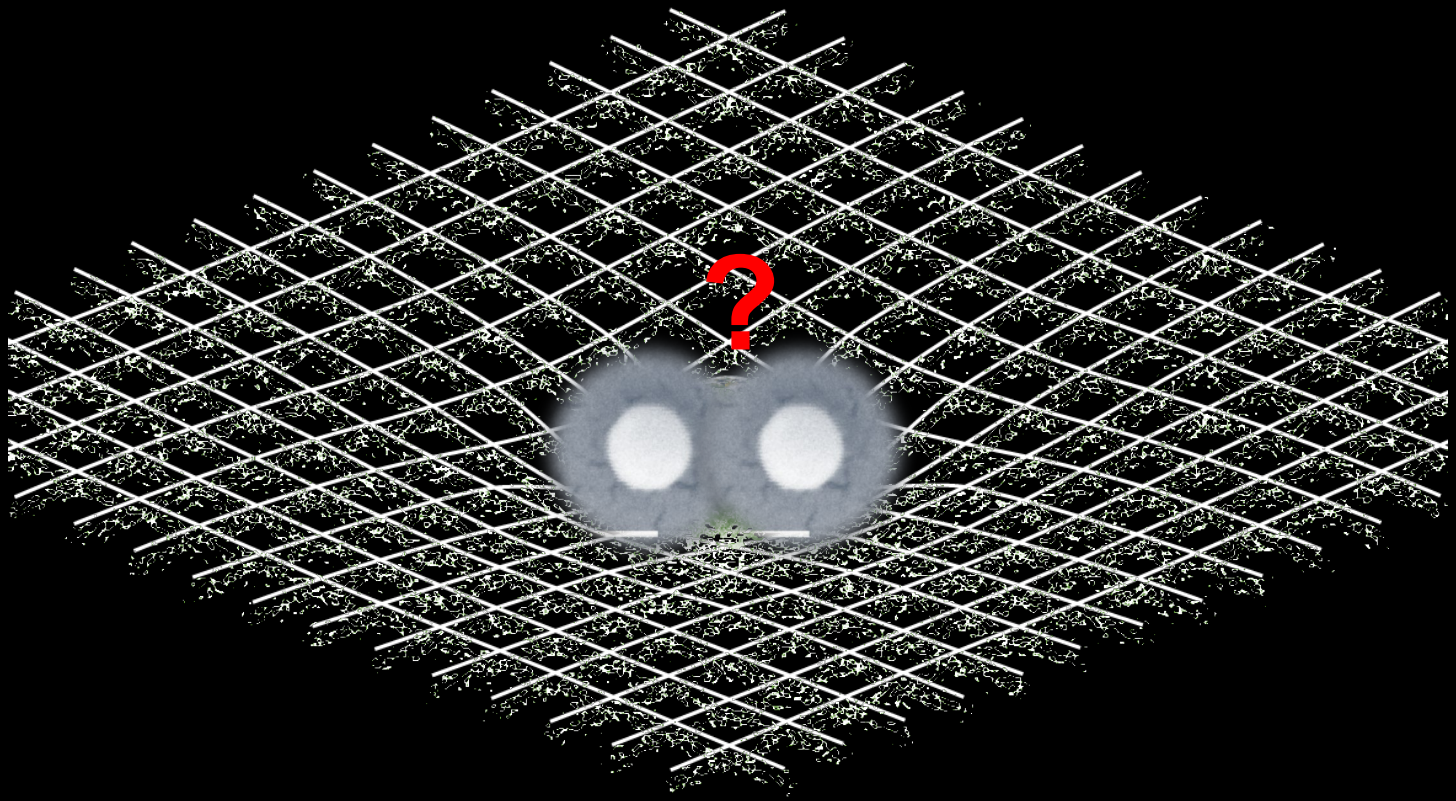


Delić, *et al*. *Science* 367.6480 (2020).



Latorre, *et al*. *Phys. Rev. App.* 19.5 (2023): 054047.

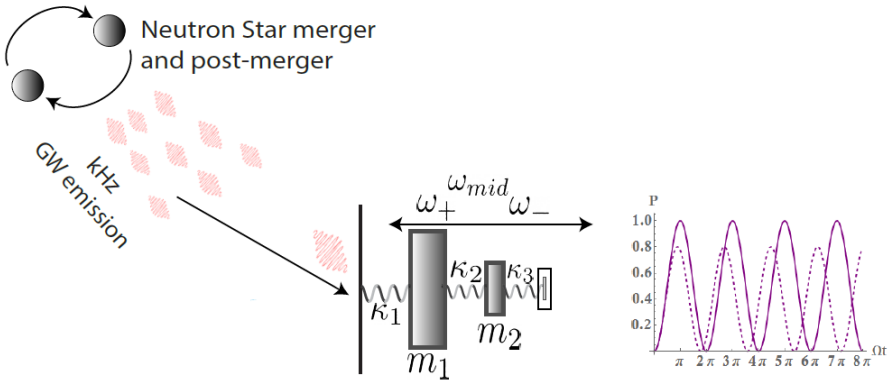




Project 1. Gravitational-Wave Induced Rabi Oscillations

Co-supervised with Germain Tobar (SU).

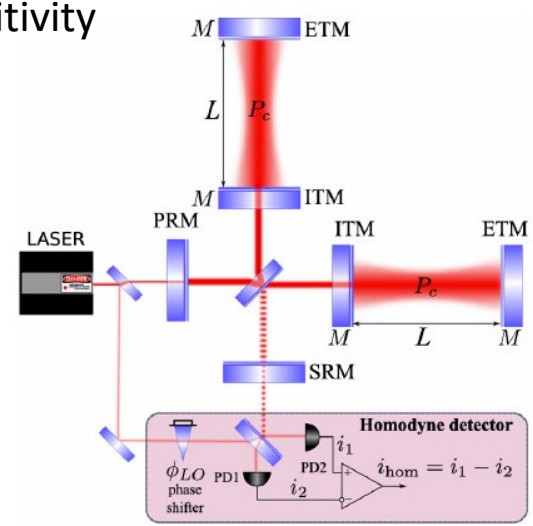
1. Understand how gravitational radiation interacts with phononic modes in gravitational-wave detectors
2. Construct and solve a dynamical model for how gravitational radiation interacts with a two-level system
3. Consider how the effects might be detected and read-out using standard quantum measurements



Project 2. Ponderomotive Squeezing of Light for Gravitational Wave Detection

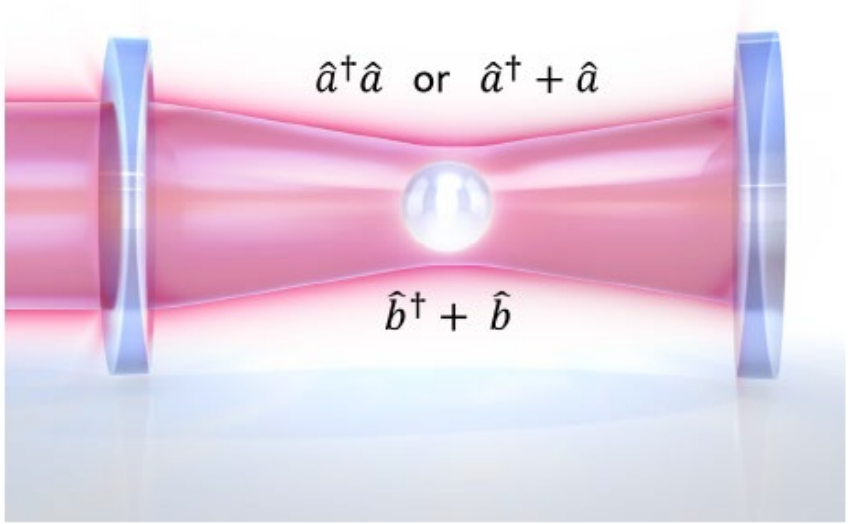
Co-supervised with Prof Vaishali Adya (KTH).

1. To understand, derive and solve the basic equations for ponderomotive squeezing
2. To study the basic sensitivity limits and how they are improved through squeezing
3. To apply the results to gravitational-wave detection in conjunction with other techniques to improve their sensitivity



Project 3. Probing the Power of a Quantum Sensor

1. Derive and understand the dynamics induced by radiation pressure.
2. Derive the quantum Fisher information for measuring a weak force in each case.
3. Determine which interaction term is the more efficient one given limited experimental resources.



Thank you!

Please come say hi in Hus 3!

Email:
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