

Liam L.H. Lau, Physics

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Education

- 2020-2021 **University of Cambridge, Gonville and Caius College**, MSci Theoretical Physics.
Modules including: Quantum Field Theory; Theories of Quantum Matter; Advanced Quantum Condensed Matter; Gauge Field Theory; Quantum Information and Superconductivity
Auditing: Statistical Field Theory and Groups and Representation Theory
- 2017-2020 **University of Cambridge, Gonville and Caius College**, BA Physics, Natural Sciences.
Third Year: First-Class in examined modules (Topics: Quantum Dynamics; Scattering Theory and Classical Field Theory). Others taken include: GR; Electrodynamics; Thermal and Statistical Physics and Quantum Physics
Second Year: First-Class in Physics A, 2.i in Physics B and Maths
First Year: First-Class in Maths and Physics. 2.i in Chemistry and Materials.

Research Experience

- Sep 2020 – **Part III Research Student in Topological Insulators** 📍TCM Group, Cambridge, UK ; [Dr. RJ Slager](#)
I am currently generalising the Euler topological insulator class to Amorphous materials with PT symmetry by first showing the preexistence of zero-modes using the Kernel-Polynomial Method, and then trying to formulate a real-space topological invariant.
- Jul-Dec 2020 **Summer Research Student in Quantum Dynamics** 📍TCM Group, Cambridge, UK ; [Dr. S. Dutta](#)
I was in charge of the theoretical and numerical modelling of a quantum walk of particles with fractional exchange statistics on a 1D lattice across a domain wall separating regions of different exchange phases. I showed that the Hanbury Brown-Twiss interference of two particles is dominated by reflections of these bunched waves off the interface, producing strong measurable asymmetries.
Submitted to **Physical Review Letters (PRL)** for review.
- May-Jul 2020 **Summer Research Student in Biophysics** 📍DAMTP, University of Cambridge, UK ; [Prof. Goldstein](#)
I programmed an N-body simulation in Python to investigate the stability of active bacteria at a boundary wall with periodic boundary conditions. The intuition is that the spontaneous circulation seen for circularly confined bacteria is seeded at the boundary.
- May 2020 **Research Project on Solving Differential Equations using Neural Networks with another student**
I coded a framework to solve ODEs using neural networks. I showed that the loss function from Piscopo et. al. can be approximated by a mean squared error. Submitted to **IOP** for review.
- Jul-Oct 2019 **Summer Research Student in Cosmology** 📍KICC, University of Cambridge, UK ; [Dr. W. Handley](#)
I developed an algorithm to find the coordinate of maximum tension between Planck and DES data given the LCDM model using a Bayesian approach. Developed software to find a numerical approximation to the coordinate by minimisation.
- 2018-2019 **Airbus Fly Your Ideas International Competition** 📍Toulouse, France
International finalist for Airbus Fly Your Ideas with Team Seren.
I modelled and simulated the specific power of the novel system of generating power in space. [Presented](#) in front of a live audience of 200 Airbus employees, judges and media.
- Jul-Aug 2018 **Summer Project Student in Surface Physics** 📍SMF Group, Cambridge, UK ; [Dr. J. Ellis](#)
Tested peltier modules in vacuum and coded the sample cooling and sample heating programs in MATLAB for the scanning helium atom microscope.

Publications

- [1] **Liam L.H. Lau** and Shovan Dutta. Quantum walk of two anyons across a statistical boundary. Submitted to **Physical Review Letters** for review. (Preprint) [arXiv:2012.03977](https://arxiv.org/abs/2012.03977), December 2020
- [2] **Liam L.H. Lau** and Denis Werth. ODEN: A Framework to Solve Ordinary Differential Equations using Artificial Neural Networks. Submitted to **IOP** for review. (Preprint) [arXiv:2005.14090](https://arxiv.org/abs/2005.14090), May 2020

Computational Skills

Python, C/C++, MATLAB, Linux, Bash, \LaTeX , vim, git, TensorFlow
Mathematica, Fortran

2.5 Years

6 Months

Extracurricular

2020–Present **Many-Body Quantum Physics Journal Club.**

Set up and lead an online many-body quantum physics reading group with people across **10.5 hours of time zone difference**. Our members are from **9 different countries and 6 different universities**. Topics included: *complexity in quantum information; thermalization and localization; and topology in quantum systems*.

2020 **PLANCKS 2020 Theoretical Physics International Competition.**

Winning team of PLANCKS 2020 London Theoretical Physics International Finals for bachelor and masters students, representing the University of Cambridge and the UK, beating 27 teams from 17 different countries in the 4 hour exam. We were one of the **top three teams representing the UK** after beating 29 other teams across the UK. Question topics included: gravitational wave detection; Chern-Simons electrodynamics and quantum information in the study of interactions of an electron's spin with a reservoir of many other spins.

2019–2020 **Co-Chair of the Cambridge University Physics Society.**

Organised academic talks and social events for undergraduate physics students. Speakers included *Professor J. Cardy*- notable for his work on CFT and 2019 Nobel Prize Laureate, *Professor D. Quelo*.

2017–2019 **Captain of the Gonville and Caius College Basketball Team.**

Talks Given

Sep 2020 **Many-Body Quantum Physics Journal Club: Holographic Principle, Online.**

Gave a two part colloquium talk introducing the holographic principle: GKPW equation; dynamical fields in the spacetime bulk sourcing operators in the QFT. I outlined the method of using finite temperature blackhole lattices in the AdS/CMT formalism to model optical conductivities.

Aug 2020 **Many-Body Quantum Physics Journal Club: Berry Electrodynamics, Online.**

Gave a colloquium talk on Chaudhary, Endres and Refael's paper on time dependent Berry connections and the effect on wavepacket motion. I re derived the gauge invariance the the Electric-field like quantity, subject to the local phase change of the state and showed the consequences of the semi-classical equations of motion.

Jun 2020 **Seminar talk on the Debye-Waller Factor in Surface Helium Microscopy, Online.**

Led a discussion on the Debye-Waller factor theory and its application to inelastic scattering in the SHeM for the Surface Physics Group faculty of the Cavendish Laboratories and the University of Newcastle, Australia.
<https://doi.org/10.5281/zenodo.3944438>

May 2020 **Many-Body Quantum Physics Journal Club: Thermalisation and Localisation, Online.**

Gave a seminar on a review of thermalisation and localisation in many-body quantum systems. I addressed how thermalisation can occur with unitary time evolution, Anderson localisation with random potentials, the role of ETH and MBL hopes. I based my talk around Nandkishore & Huse's review paper alongside Abanin, Altman, Bloch & Serbyn's review paper; but also on more recent developments such as Yao et al.'s paper on Quasi-Many-Body Localisation in Translation-Invariant Systems.

Attended Conferences and Workshops

Oct 2020 **KITP Conference, *Frontiers of Quantum Computing and Quantum Dynamics*.**

Jun 2020 **Princeton Summer School on Condensed Matter Physics , *Magnetism in Quantum Materials*.**

Aug 2019 **AstroHack Week 2019, *Bayesian Statistics & Data Visualisation*.**

Awards and Grants

Dec. 2020 Winning Team *PLANCKS London 2020 International Theoretical Physics Final*

Summer 2020 KNI Fellowship (cancelled due to Covid-19) *Kavli Nanoscience Institute, Caltech*

Summer 2020 Summer Research Grant *Gonville & Caius College*

Feb. 2020 Top Three UK Team *PLANCKS 2020 Theoretical Physics Competition*

Jan. 2020 Third Placed Team *International Theoretical Physics Olympiad for Undergraduate Students*

Jun. 2019 International Team Finalist *Airbus Fly Your Ideas Competition*

Summer 2019 Summer Research Grant *Kavli Institute for Cosmology, Cambridge*