

# CURRICULUM VITAE

Dr RICHARD HOWL

## CONTACT DETAILS

Room W052, Wilson Building, Department of Physics,  
Royal Holloway University of London,  
Egham Hill, Egham TW20 0EX.  
E-mail: [rjhowl@gmail.com](mailto:rjhowl@gmail.com), [richard.howl@rhul.ac.uk](mailto:richard.howl@rhul.ac.uk)

## BACKGROUND

I am a group leader at Royal Holloway, University of London. I work principally in the field of quantum technology for fundamental physics and my main focus is testing quantum gravity with quantum technology. My research interests also include general topics on the interplay of quantum information and quantum gravity/high-energy physics; cold atoms and quantum fluids; relativistic quantum information theory; analogue gravity; gravitational waves; and high-energy particle physics, such as String Theory and Grand Unified Theories.

## EDUCATION AND ACADEMIC EMPLOYMENT HISTORY

- Junior group leader, Department of Physics, Royal Holloway, University of London (1<sup>st</sup> March 2023 –).
- Senior post-doctoral research assistant, Department of Computer Science, Quantum Group Group (Professor Aleks Kissinger), University of Oxford (Sep 2021 – Feb 2023).
- Post-doctoral research fellow, Department of Computer Science, QICI Group (Professor Giulio Chiribella), University of Hong Kong (Sep 2020 – Sep 2021).
- Post-doctoral research fellow, Quantum Correlations Group (Professor Gerardo Adesso), School of Mathematical Sciences, University of Nottingham, UK (Jan 2020 – Sep 2020).
- Post-doctoral research fellow, Relativistic Quantum Technologies Group (Professor Ivette Fuentes), School of Mathematical Sciences, University of Nottingham, UK (Oct 2017 – Jan 2020).
- Post-doctoral research associate, Relativistic Quantum Information and Metrology Group (Professor Ivette Fuentes), Faculty of Physics, University of Vienna, Austria (2016 - Oct 2017).
- PhD in High-Energy Theoretical Physics, University of Southampton, UK.
- Masters and Bachelors in Physics (MPhys), University of Oxford, UK.

## INDUSTRIAL EMPLOYMENT

- Science teacher, Bluecoat Academy, Nottingham (2015)
- Computer Scientist, D-Cubed Components, Cambridge (2010-2015).

## SELECTED PUBLICATIONS

1. Relativistic locality can imply subsystem locality, A Di Biagio, R Howl, C Brukner, C Rovelli, M Christodoulou, arXiv preprint arXiv:2305.05645 (2023).
2. Gravitationally-induced entanglement in cold atoms, R Howl, N Cooper, L Hackermüller, arXiv preprint arXiv:2304.00734 (2023).
3. Gravity entanglement, quantum reference systems, degrees of freedom, M Christodoulou, A Di Biagio, R Howl, C Rovelli, *Class. Quantum Grav.* **40** 047001 (2023).
4. Locally mediated entanglement through gravity from first principles, M Christodoulou, A Di Biagio, M Aspelmeyer, Č Brukner, C Rovelli, R Howl, *Phys. Rev. Lett.* **130**, 100202 (2023).
5. Quantum frequency interferometry: With applications ranging from gravitational wave detection to dark matter searches, R Howl, I Fuentes, *AVS Quantum Sci.* **5**, 014402 (2023)
6. Non-Gaussianity as a Signature of a Quantum Theory of Gravity, R Howl, Vlatko Vedral, D Naik, M Christodoulou, Carlo Rovelli, A Iyer, *PRX quantum* **2**, 010325 (2021).
7. Exploring the Unification of Quantum Theory and General Relativity with a Bose-Einstein Condensate, R Howl, R Penrose and I Fuentes, *New Journal of Physics* **21**, 043047 (2019).

8. Quantum simulation of dark energy candidates, D Hartley, C Käding, R Howl and I Fuentes, Phys. Rev. D **99**, 105002 (2019).
9. Dynamical response of Bose–Einstein condensates to oscillating gravitational fields, D. Ratzel, R. Howl, J. Lindkvist, and I. Fuentes, New Journal of Physics **20**, 073044 (2018).
10. Analogue simulation of gravitational waves in a 3-dimensional Bose-Einstein condensate, D Hartley, T Bravo, D Rätzel, R Howl, I Fuentes, Physical Review D **98** (2), 025011 (2018).
11. Gravity in the quantum lab, R. Howl, L. Hackermuller, D. E. Bruschi, and I. Fuentes, Advances in Physics: X **3**, 1383184 (2018).
12. Minimal E(6) Supersymmetric Standard Model (SM), R. Howl and S.F. King, JHEP 0801 030.
13. Planck Scale Unification in a Supersymmetric SM, R. Howl and S.F. King, Phys. Lett. B 652 331.

## TEACHING

- Mathematics, Royal Holloway, University of London.
- Quantum Optics, University of Vienna.
- Relativistic Quantum Information and Metrology MSc course, University of Vienna.
- Tutorial course on Relativistic Quantum Information Theory, University of Hong Kong.
- Tutorial course on High Energy Physics at the University of Nottingham.
- Mathematical Physics (demonstrator and marker), University of Nottingham.
- Science teacher, Bluecoat Academy, Nottingham, trained through the Researchers in Schools (RIS) programme.
- Private mathematics and physics tutoring.
- Training for employees of D-Cubed and industrial customer VTK.

## WRITING AND MODERATING EXAMINATIONS

- MSc course Quantum Optics, University of Vienna, examiner and moderator.
- Undergraduate course Theoretical Physics, University of Vienna, examiner and moderator.
- Tutorial helper and marker at the University of Nottingham.

## MEDIA COVERAGE

- My publication “Non-Gaussianity as a Signature of Quantum Gravity” received a lot of media attention, with articles in Physics World <https://physicsworld.com/a/quantum-gravity-could-soon-be-tested-using-ultracold-atoms/>, IEEE Spectrum Magazine <https://spectrum.ieee.org/tech-talk/at-work/innovation/quantum-gravity-tests-particle-accelerators-to-tabletop-bose-einstein-condensates>, and numerous media outlets, such as Phys.org, Science Daily etc., as well as blogs, such as Medium <https://john-99387.medium.com/measuring-the-quantum-foam-add6a093e067>, and the universe today <https://www.universetoday.com/150206/a-new-approach-could-tease-out-the-connection-between-gravity-and-quantum-mechanics/>.
- My publication “Exploring the unification of quantum theory and general relativity with a Bose-Einstein condensate” was awarded the most thought-provoking paper of the week in MIT Technology Review.

## GRANTS

- Career Development Award (2023-2025) €165,000, John Templeton Foundation.
- Co-investigator on large John Templeton Foundation (JTS) grant Quantum Information Structure of Spacetime Phase 2 (QISS2) Sep 2022 – May 2025. This is a theory grant for building an international consortium on the interplay of quantum information and quantum gravity, including the theory of table-top tests of quantum gravity. I am part of the organizing committee of the grant and also lead the cross-consortium visiting programme, which provides travel funds for successful applications to visit nodes of the grant (inc. Perimeter

Institute, University of Oxford and University of Vienna).

- Co-investigator on small JTF grant ID 62420 (leading organisation is the University of Nottingham). This grant aims to take the first experimental steps of my publication “Non-Gaussianity as a Signature of Quantum Gravity”.
- Co-leader on FXQi grant “Benasque session on Relativistic Quantum Observers” for \$11,260.00.
- STFC Fellowship for PhD funding.
- I have also contributed to three ERC collaborative (FET) grants, a European QuantERA grant, and a UKRI collaboration grant.

## **ORGANISED CONFERENCES, WORKSHOPS and PUBLIC TALKS**

I have co-organised the following conferences, workshops and public talks:

- QISS2 PhD Spring School 2023, Château de Goutelas, France (invited speakers include: Carlo Rovelli, Fay Dowker, Markus Aspelmeyer).
- Gravity in the lab workshop 2018, Centro de Ciencias de Benasque Pedro Pascual, Benasque, Spain (invited speakers included: Carlo Rovelli, Francesca Vidotto, Tim Muadlin, Hendrik Ulbricht, Sougato Bose, Daniel Oi and Philippe Bouyer).
- “Can we see black holes?”, public talk with Sir Roger Penrose and Professor Ivette Fuentes, University of Nottingham, 2018.
- The Penrose Institute Inauguration workshop, University of Nottingham, 2018.
- Detecting gravitational waves with phonons of a BEC workshop, University of Vienna, 2016.

## **TALKS AT INVITED SEMINARS AND CONFERENCES**

I have presented many talks at conferences, workshops and seminars, with over 20 invited talks. My most recent invited talks include “A look at the interface between gravity and quantum theory workshop”, Italy (2023); seminar at RHUL 2023, seminar at ZARM, University of Bremen, Germany (2023); QISS@Western conference at Western University, London, Canada (2022) etc.

## **SUPERVISION**

Full supervision of PhD student (Joseph Aziz) at Royal Holloway, University of London. Co-management of several students and post-doctoral researchers at Royal Holloway, University of London; University of Nottingham,;and University of Vienna.

## **OUTREACH**

- Physics presentations for 9-11 year olds at Bluecoat academy, Nottingham.
- Organisation of public talk “How can we see black holes?” by R. Penrose and I. Fuentes at the University of Nottingham.
- Demonstrating at Science Festival at University of Nottingham.
- Demonstrating for A-level students at open day workshops at the University of Southampton.

## **REFEREING**

Nature Physics, Science Advances, Nature Communications, New Journal of Physics, Physics Letters A and B.

## **PROGRAMMING**

Mathematica, MATLAB, C++, Python, LaTeX.