

## **Unit Name**

Quantum Systems Unit  
Professor Thomas S Busch

## **Collaborations**

Tomoki Ozawa, Tohoku University Japan, Japan, Topological Properties of Cold Atomic Systems  
Mark Mitchison, Kings College London, United Kingdom, Thermometry in Ultracold Quantum Gases  
Doerte Blume, Oklahoma University, USA, Anyons in 1D Gases  
Miguel Garcia March, Universidad Politécnic de Valencia, Spain, Strongly Interacting Quantum Gases  
Karen Kheruntsyan, Brisbane University, Australia, STAs in GHD  
Takao Aoki, Waseda University, Japan, Quantum Nano-Optics Systems  
Felipe Isaule, Pontifical Catholic University of Chile, Chile, Mobile Impurities in Hubbard Chains  
Le Bin Ho, Tohoku University Japan, Japan, LMG Heat Engines  
Gediminas Juzeliūnas, Vilnius University, Lithuania, Atomic Systems in Nanoscale Potentials

## **Research Personnel**

Thomás Fogarty, Staff Scientist  
Kritika Jain, Postdoctoral Scholar  
Wenbin He, Postdoctoral Scholar  
Giedrius Žlabys, Postdoctoral Scholar  
Jacek Dobrzyniecki, Postdoctoral Scholar  
Abhijit Pendse, Postdoctoral Scholar  
Abel Rojo Francàs, Postdoctoral Scholar  
Emma Laird, Postdoctoral Scholar  
Wirawat Kokaew, PhD Student  
Maxfield Linus Hartley, PhD Student  
Keerthy Karthikeyan Menon, PhD Student  
Tuan Duc Hoang, PhD Student  
Sarika Sasidharan Nair, PhD Student  
Hoshu Hiyane, PhD Student  
Raul Alejandro Hidalgo Sacoto, PhD Student  
Andres Felipe Galindo Salgado, Research Intern  
Domantas Burba, Research Intern  
Santiago Eduardo Henriquez Lira, Research Intern  
Mariami Shengelia, Research Intern

Hannah Louise Moskowitz Dauvergne, Research Intern

Swathi Hm, Research Intern

### **Scholarly Contributions and Creative Productions (by Faculty)**

#### **Journal Article**

1. Brattegard, S.; Fogarty, T.; Busch, T.; Mitchison, M. T.  
Correlated Decoherence and Thermometry with Mobile Impurities in a One-Dimensional Fermi Gas. *Physical Review A* 2026, *113*, 013302.
2. Campbell, S. and et al.  
Roadmap on Quantum Thermodynamics. *Quantum Science and Technology* 2026, *11*, 012501.
3. Pelayo, J.C.; Bougas, G. A.; Fogarty, T.; Busch, T. h.; Mistakidis, S. I.  
Droplet-Gas Phases and Their Dynamical Formation in Particle Imbalanced Mixtures. *Quantum Science and Technology* 2025, *10*, 045074.
4. Menon, K.; Busch, T.; Fogarty, T.  
Leveraging Quantum Statistics to Enhance Heat Engines. *Quantum Science and Technology* 2025, *10*, 045039.
5. Braver, Y.; Burba, D.; Nair, S. S.; Žlabys, G.; Anisimovas, E.; Busch, T.; Juzeliūnas, G.  
Light-Induced Localized Vortices in Multicomponent Bose-Einstein Condensates. *Phys. Rev. A* 2025, *112*, 033301.
6. Hiyane, H.; Fogarty, T.; Pelayo, J. C.; Busch, T.  
Condensate-Mediated Dimerization of Impurities in Atomic BECs. *New Journal of Physics* 2025, *27*, 124502.
7. Hidalgo-Sacoto, R.; Busch, T.; Blume, D.  
Universal Momentum Tail of Identical One-Dimensional Anyons with Two-Body Interactions. *Phys. Rev. A* 2025, *112*, 063309.
8. Hidalgo-Sacoto, R.; Busch, T.; Blume, D.  
Two Identical One-Dimensional Anyons with Zero-Range Interactions: Exchange Statistics, Scattering Theory, and Anyon-Anyon Mapping. *Physical Review A* 2025, *112*, 063310.
9. Duong, A.-T., Tran; García-March, M. A.; Busch, T.; Fogarty, T.  
Quantum Correlations and Spatial Localization in Trapped One-Dimensional Ultra-Cold Bose–Bose–Bose Mixtures. *New Journal of Physics* 2025, *27*, 073201.
10. Pelayo, J. C.; Bougas, G.; Fogarty, T.; Busch, T.; Mistakidis, S. I.  
Phases and Dynamics of Quantum Droplets in the Crossover to Two-Dimensions. *SciPost Physics* 2025, *18*, 129.
11. G'omez-Lozada, F.; Hiyane, H.; Busch, T.; Fogarty, T. 'as.  
Bose--Fermi  $\mathbb{Z}_2$ -Polaron State Emergence from Correlation-Mediated Blocking of Phase Separation. *Phys. Rev. Res.* 2025, *7*, 023053.

#### **Presentation at Conference**

1. Busch, T.  
Using Quantum Statistics to Create Work: The Pauli Engine and Beyond  
Cold-Atom Based Quantum Simulators and Forthcoming Quantum Technology Applications,  
Bangalore, India\_Invited
2. Busch, T.  
From Quantum Statistics to Work: The Pauli Engine and Beyond  
Conference on Optics, Atoms, and Laser Applications (KOALA2025), Auckland, New Zealand \_Invited
3. Busch, T.  
Making statistics work: quantum engines in ultracold gases  
Laser Physics 2025, Ashtarak, Armenia\_Invited
4. Busch, T.  
Topological Properties of Strongly Interacting Ultracold Few-Body Systems  
The 9th International Conference on Quantum Information, Spacetime Simulation, and Quantum  
Topological Matter (QuIST IX), Madrid, Spain\_Invited
5. Busch, T.

From Quantum Statistics to Work: The Pauli Engine and Beyond. The 15th European Conference on Atoms, Molecules, and Photons (ECAMP15)

6. Busch, T.

Strongly Interacting Ultracold Few-Body Systems in Nanoscale Potentials

The workshop on Unconventional Optical Lattices (UOL2025), Vilnius, Lithuania\_Invited

**Scholarly Contributions (by Unit Members)**

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Jacek Dobrzyniecki	Journal Article	Tunable two-species spin models with Rydberg atoms in circular and elliptical states	Phys. Rev. Research	APS	2025
Sarika Sasidharan Nair	Poster Presentation at Conference	Exploring Quench dynamics and two particle physics in topologically nontrivial Kronig-Penney type model	The 29th Central European Workshop on Quantum Optics (CEWQO29)		2025
Sarika Sasidharan Nair	Poster Presentation at Conference	Exploring Quench dynamics and two particle physics in topologically nontrivial Kronig-Penney type model	Workshop on Unconventional Optical Lattices (UOL2025)		2025
Jacek Dobrzyniecki	Poster Presentation at Conference	Tunable two-species spin models with Rydberg atoms in circular and elliptical states	Quantum Optics XI		2025
Giedrius Žlabys	Poster Presentation at Conference	Topological transport properties of height modulated subwavelength barrier lattices	The 29th Central European Workshop on Quantum Optics (CEWQO29)		2025
Giedrius Žlabys	Poster Presentation at Conference	Topological transport properties of height modulated subwavelength barrier lattices	Workshop on Unconventional Optical Lattices (UOL2025)		2025
Thomás Fogarty	Poster Presentation at Conference	The role of quantum correlations on multi-polaron formation in Bose-Fermi mixtures	International Conference on Bose–Einstein Condensation 2025 (BEC 2025)		2025
Giedrius Žlabys	Poster Presentation at Conference	Emergent topological properties in spatially modulated sub-wavelength barrier lattices	2nd Japan-Germany Workshop Correlated and Topological Quantum Materials		2026
Duc Tuan Hoang	Poster Presentation at Conference	Variational quantum algorithm for ergotropy estimation in quantum many-body batteries	Advances in Quantum Control - Techniques, Applications, and Challenges		2025
Abhijit Pendse	Poster Presentation at Conference	Shortcuts to Adiabaticity in Bose-Einstein Condensates: The role of quantum fluctuations	2025 Symposium of the JP-DE ASPIRE “Neutral-atom QC”		2025
Giedrius Žlabys	Poster Presentation at Conference	Topological transport properties of height modulated subwavelength barrier lattices	15th European Conference on Atoms Molecules and Photons (ECAMP15)		2025
Raul Hidalgo	Poster Presentation at Conference	Interacting Anyons in One Dimension: zero-range interactions beyond Bose-Fermi statistics	15th European Conference on Atoms Molecules and Photons (ECAMP15)		2025
Raul Hidalgo	Poster Presentation at Conference	Interacting Anyons in One Dimension: zero-range interactions beyond Bose-Fermi statistics	Young Atom Opticians Conference 2025		2025

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Thomás Fogarty	Presentation at Conference	Bose-Fermi N-polaron state emergence from correlation-mediated blocking of phase separation	Division of Atomic, Molecular and Optical Physics (APS DAMOP 2025)		2025
Giedrius Žlabys	Presentation at Conference	Topological effects in sub-wavelength barrier systems	2025 Tokyo-Beijing-Sendai Joint Workshop on Quantum Matter		2025
Thomás Fogarty	Seminars	Variational quantum algorithm for ergotropy estimation in quantum many-body batteries	IBM Zurich		
Hoshu Hiyane	Seminars	Emergence of nonequilibrium Lieb excitations in periodically driven strongly interacting bosons	Tokyo University of Science		
Hoshu Hiyane	Seminars	Emergence of nonequilibrium Lieb excitations in periodically driven strongly interacting bosons	Research Group on Ultracold Quantum Gases, Leibniz University Hannover, Germany		
Hoshu Hiyane	Seminars	Emergence of nonequilibrium Lieb excitations in periodically driven strongly interacting bosons	Hatano Laboratory, Institute of Industrial Science, the University of Tokyo		
Raul Hidalgo	Seminars	Interacting Anyons in One Dimension: zero-range interactions beyond Bose-Fermi statistics	Innsbruck University		
Jacek Dobrzyniecki	Seminars	Pair up or separate? Competition between attraction & spin-dependent external force in a Hubbard model	Warsaw University		
Thomás Fogarty	Seminars	The important role of quantum correlations on multi-particle polaron formation in Bose-Fermi mixtures.	Universitat de Valencia		
Jacek Dobrzyniecki	Seminars	Pair up or separate? Competition between attraction & spin-dependent external force in a Hubbard model	Institute of Physics of the Polish Academy of Sciences		
Hoshu Hiyane	Seminars	Emergence of nonequilibrium Lieb excitations in periodically driven strongly interacting bosons	The University of Electro-communications		

*Workshops and Seminars [Organized and Hosted by Faculty/Units]*

Speaker Name(s)	Title	Location	Term	Fiscal Year
Takano Taira, Kyushu University, Japan	Non-Hermitian Quantum Physics in Open and Closed Quantum Systems	L4E01, OIST	Term 2 2026	2026-03-17

Speaker Name(s)	Title	Location	Term	Fiscal Year
Tim Keller, Waseda University, Japan	Addressing requirements for crosstalk-free quantum-gate operation in many-body nanofiber cavity QED systems	C700, OIST	Term 2 2026	2026-03-04
Eloisa Cuestas, Jülich Research Centre (FZJ), Germany	High-fidelity and fast circularization of interacting Ry atoms through pulse-shaping	C209, OIST	Term 2 2026	2026-03-10
Michał Tomza, University of Warsaw, Poland	Ultracold highly magnetic and polar molecules for quantum simulation and new physics search	L4E01, OIST	Term 1 2025	2025-10-08
Eloisa Cuestas, Jülich Research Centre (FZJ), Germany	Fast neutral-atom transport and transfer between optical tweezers.	C700, OIST	Term 1 2025	2025-10-17
Andreas Ruschhaupt, University College Cork, Ireland	Enhanced Shortcuts to Adiabaticity: Quantum Control and Quantum Thermodynamics	B503, OIST	Term 3 2025	2025-06-04
Felipe Isaule, Pontifical Catholic University of Chile, Chile	Ultracold polarons and impurities: from lattice polarons to effective field theories	C209, OIST	Term 3 2025	2025-07-25