Yuan Wang

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I am passionate about *quantum light-matter interaction*, *parallel computing*, and *AI for science*, with expertise in developing computational tools on GPU for quantum systems, applying machine learning to accelerate scientific discovery, and leveraging physical principles to enhance machine learning architectures (Science for AI).

Contact

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- **GitHub**: *github.com/ywang-phy* **LinkedIn**: *linkedin.com/in/ywang-phy*

Experience

- Jun 2025 - Oct 2025: Research Associate, University of Sheffield, United Kingdom
  mentored by Prof. Oleksandr Kyriienko
- Aug 2024 - May 2025: Postdoctoral Research Fellow, University of Exeter, United Kingdom
  mentored by Prof. Oleksandr Kyriienko
- Aug 2023 - July 2024: Visitor, University of Southampton, United Kingdom

Education

- Sept 2018 - Sept 2023: PhD in Physics, University of Southampton, United Kingdom
  Thesis entitled *"Tailored reservoir of exciton-polariton condensates"*
  mentored by Prof. Pavlos Lagoudakis, Prof. Simone De Liberato, and *unofficially* Dr. Helgi Sigurðsson
- Sept 2017 - Jul 2018: Master's Double Degree (M2 Nanoscience), University of Ferrara, Italy
- Sept 2016 - Jul 2017: Master's Double Degree (M1 General Physics), Paris-Saclay University, France
- Sept 2012 - Jul 2016: Bachelor's Degree in Physics, Anhui Normal University, China

Internship

- Feb 2018 - Jul 2018: Quantum Theory and Technology, University of Southampton, United Kingdom
  Topic: *Quantum theory of the intersubband polaritons*, mentored by Prof. Simone De Liberato
- Apr 2017 - Jul 2017: Quantum Optics, Sorbonne University - Pierre and Marie Curie Campus, France
  Topic: *Quantum squeezing variance in second-mode approximation*, mentored by Dr. Simon Pigeon

Activities

- Presentation at *Math + ML + X Seminar* (online, 24th April 2025)
  Yau Mathematical Sciences Center, Tsinghua University, Beijing, China
- Attendance at 2025 Winter School on *Physics of Machine Learning & Machine Learning for Physics*
  (12 Jan 2025 - 24 Jan 2025), The Nordic Institute for Theoretical Physics (Nordita), Stockholm, Sweden
- Poster presentation at *NeurIPS 2023 AI for Science Workshop*
- Co-organizer: *QLM Summer School 2019*, guided by Prof. Hendrik Ulbricht

Languages

- Chinese (Native) & English (Fluent)

Skills

- **Programming**: C++, CUDA, MATLAB, Python **Machine learning**: PyTorch **Version control**: Git, GitHub
- **CI/CD**: GitHub Actions **Simulation**: COMSOL Multiphysics **Editing**: HTML, LaTex, Microsoft Office

Interests

- **Parallel Computing** In the field of simulating polariton condensates, there's a strong emphasis on leveraging advanced numerical methods, underpinned by a specialized computational tool that utilizes the capabilities of graphics processing units (GPUs). The split-step Fourier method (SSFM) is one of the central technique used for these simulations, offering a streamlined approach to solving partial differential equations in parallel computing environments. This method is also notably efficient when integrated into machine learning frameworks, offering innovative solutions for complex equations. My focus lies in developing computational tools based on NVIDIA's CUDA architecture, using C++ and CUDA APIs. This expertise encompasses both CPU-based and GPU-based GPE solvers, with a particular emphasis on utilizing SSFM for efficient problem-solving in the realm of quantum fluid dynamics.

- **Neural Operator** A plethora of next-generation all-optical devices based on exciton-polaritons have been proposed in latest years, including prototypes of transistors, switches, analogue quantum simulators and others. However, for such systems consisting of multiple polariton condensates, it is still challenging to predict their properties in a fast and accurate manner. The condensate physics is conventionally described by polariton Gross-Pitaevskii equations (GPEs). While GPU-based solvers currently exist, we propose a significantly more efficient machine-learning-based Fourier neural operator approach to find the solution to the GPE coupled with exciton rate equations, trained on both numerical and experimental datasets. The proposed method predicts solutions almost three orders of magnitude faster than CUDA-based solvers in numerical studies, maintaining the high degree of accuracy.

- **Positional embedding in ML**
  - Graph Neural Networks (GNNs) are powerful tools for molecular property prediction, but their reliance on local message-passing mechanisms limits their ability to capture long-range dependencies in large graphs. We propose a physics-informed approach that enhances graph convolutional networks (GCNs) by incorporating positional embeddings derived from photonic dynamics simulation.
  - Photonic and polaritonic systems offer a fast and efficient platform for accelerating ML through physics-based computing. We propose a polaritonic ML approach for solving graph-based data problems. We demonstrate how lattices of condensates can efficiently embed relational and topological information from point cloud datasets. This information is then incorporated into a pattern recognition workflow based on convolutional neural networks (CNNs), leading to significantly improved learning performance compared to physics-agnostic methods. Our study introduces a distinct way of using photonic systems as fast tools for feature engineering, while building on top of high-performing digital machine learning.

- **Exciton-polariton condensate** The AlGaAs-like quantum wells within high-quality microcavities, can generate exciton-polaritons (polaritons) in the strong coupling regime. At cryogenic temperatures, the polariton condensates can be formed through optically excited high-energy excitons. I focus on the theoretical development of the methods for enhancing and focusing these condensates, utilizing localized nonresonant asymmetric-shaped excitation. A significant aspect of my work involves increasing spatial coherence and optimizing interaction strength between polaritons, paving the way for the realization of all-optical transistors and contributing to large-scale polariton condensates networks.

Workshop

[1] Surya T. Sathujoda*, **Yuan Wang***, Kanishk Gandhi, *Exciton-Polariton Condensates: A Fourier Neural Operator Approach*, NeurIPS 2023 AI for Science Workshop (2023)

Journal/Work in progress

[9] **Y. Wang** and O. Kyriienko, *Photonics-informed graph convolutional networks*, manuscript near submission (2025)

[8] K. Fripp, **Y. Wang**, O. Kyriienko, AV Shytov, and VV Kruglyak, *Magnonic Full Adder using Nanoscale Chiral Magnonic Resonators*, manuscript near submission (2025)

[7] **Y. Wang**, S. Scali, and O. Kyriienko, *Polaritonic Machine Learning for Graph-based Data Analysis*, arXiv.2507.10415 (2025)

[6] **Y. Wang***, Surya T. Sathujoda*, K. Sawicki, K. Gandhi, A. I Aviles-Rivero, and P. G. Lagoudakis, *A Fourier Neural Operator Approach for Modelling Exciton-Polariton Condensate Systems*, arXiv.2507.10415 (2025)

[5] K. Sawicki, D. Dovzhenko, **Y. Wang**, T. Cookson, H. Sigurðsson, and P. G. Lagoudakis, *Occupancy-driven Zeeman suppression and inversion in trapped polariton condensates*, Physical Review B **109**, 125307 (2024)

[4] **Y. Wang**, *Tailored reservoir of exciton-polariton condensates*, University of Southampton, PhD Thesis (2023)

[3] **Y. Wang**, P. G. Lagoudakis, and H. Sigurdsson, *Enhanced coupling between ballistic exciton-polariton condensates through tailored pumping*, Physical Review B **106**, 245304 (2022)

[2] **Y. Wang**, H. Sigurdsson, J. D. Töpfer, and P. G. Lagoudakis, *Reservoir optics with exciton-polariton condensates*, Physical Review B **104**, 235306 (2021)

[1] **Y. Wang** and S. De Liberato, *Theoretical proposals to measure resonator-induced modifications of the electronic ground state in doped quantum wells*, Physical Review A **104**, 023109 (2021)