Dylan Rubini

Mechanical Engineer

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Research Interests

- Computational modelling of complex multiphysics and multiscale transport problems, including thermofluids and catalytic reacting flows.
- Working at the intersection of machine learning, computational science and aerothermochemical design to develop multiphysics & multidisciplinary numerical tools accelerate the net-zero energy transition.
- Modelling transonic turbulent flow interactions within internal and external flows using high-fidelity computations.
- Developing numerical flow solvers for multicore CPU & GPU hardware.

Academic Positions

2024–Present **IAA Doctoral Impact Postdoctoral Research Fellow**, *University of Oxford*.

- *Research Projects*:
  1. Commercialisation of machine-learning-accelerated aerochemical modelling platform and development for catalytic modelling.
  2. *Collaborative Project:* Computational multiphysics modelling of multiscale nanomembrane transport phenomena within CO_2 direct air capture systems.
  3. *Collaborative Project:* Automating engineering design & simulation using multi-agent large language model systems.

Education and Research

2020–2024 **PhD in Engineering Science on EPSRC scholarship**, *University of Oxford*.

- *Supervisors*: Budimir Rosic (Oxford) and Liping Xu (Cambridge).
- *Lab*: Oxford Thermofluids Institute - leading thermofluids & heat transfer lab
- *Main Thesis*: pioneering work developing multi-fidelity machine-learning-assisted model to accelerate multiphysics coupling in a new class of turbomachines for zero-carbon high-temperature chemical processes. This enables aerochemically-guided design optimisation for the first time in turbomachinery.

- *Further Research Contributions*:
  1. developed unstructured computational fluid dynamics solver using highly-optimised code generation for both multi-core CPU & GPU backends.
  2. developed `Python`-based numerical tool for chemical kinetic analysis in turbomachines.
  3. numerically investigated complex aerothermal flow interactions and quantified aerodynamic loss mechanisms in turbomachines for high-temperature processes.
  4. implemented and leveraged multiobjective chemical-reaction-guided design optimisation for a new class of turbomachines.

2016–2020 **MEng Engineering Science, First Class**, *University of Oxford*.

- *Final Year Dissertation*: first work computationally modelling the uniquely complex aerothermodynamics for a new class of high-speed turbomachines to decarbonise industry. This helped inform aerodynamic design decisions.
- *Achievements*: top mark in the cohort for the 4^{th} year project (scoring **93%**), as well as scoring above an average of **80%** overall.
- *3^{rd}-year Advanced Courses:* Electronic Devices, Circuits & Communications, Software Engineering, Information Engineering Systems, Fluid Mechanics (Turbulence, Compressible Flow and Turbomachinery.)
- *4^{th}-year Advanced Courses:* Aerothermal Engineering, Hydraulics, Sustainable Energy, Microelectronics, Machine Learning, Electrochemical Energy Technology.

2008–2016 **A-Levels**, *A*A*A*, **GCSEs** *8A*s, 4As*.

Awards and Achievements

2024 **Letter of commendation for DPhil thesis**, *Oxford Engineering Departement*.
2024 **Drapers Company Junior Research Fellow**, *St Anne's College (Oxford)*.
2024 **Awarded competitive IAA Doctoral Impact prize**, *University of Oxford*.
2024 **Presented at Reynolds competition**, *University of Manchester*.
2024 **Best paper award**, *ASME Journal of Turbomachinery*, Ref. [4].
2023–2025 **Awarded 20k computing research grant**, *UKRI ARCHER2 HPC access*.
2023 **Best paper award**, *Journal of Global Power & Propulsion Society*, Ref. [3].
2022 **Best poster award**, *ASME Turbo Expo: Power for Land, Sea and Air*.
2020–2024 **Doctoral scholarship**, *UKRI DTP EPSRC*.
2020 **Prestigious IMechE Project Award**, *Institution of Mechanical Engineers*.
2020 **Top mark in 4^{th} year MEng project (93%)**, *Oxford Engineering Dept*.
2020 **Best project poster award**, *Oxford Engineering Dept*.
2018–2020 **Academic prize awards**, *Oriel College, University of Oxford*.

Industry Experience

Autumn 2024 **Mitsubishi Heavy Industries**, *Japan*, Placement.

- Computational multiphysics modelling of high-temperature corrosion (nitridation and oxidation) in zero-carbon novel ammonia combustors.

2019–2024 **Coolbrook Oy**, *Finland*, Collaborator.

- Collaborating on developing new numerical tools for modelling complex aerothermochemical flows within a new class of high-speed turbomachines.

Summer 2017 **GNL Quintero**, *Chile*, Intern.

- Investigated failures in pipes used for liquefied natural gas transport.

Academic Community Contributions

Session Chair, 2024 — Combustion - GPPS Turbomachinery Technical Conference, Greece

Reviewer, 2023 — Organic Rankine Cycles - Journal of the Global Power and Propulsion Society

Reviewer, 2023 — Elsevier Journal of Cleaner Production

Research Experience

Summer 2019 **Research Intern**, *Oxford Thermofluids Institute*, Advisor: Budimir Rosic.
`MPI`-parallelised an in-house computational fluid dynamics solver

Summer 2018 **Research Intern**, *Oxford Thermofluids Institute*, Advisor: Peter Ireland.
Designed flow measurement and instrumentation systems within a new wind tunnel

Journal Publications

[1] **D. Rubini**, B. Rosic, and L. Xu. Efficient Modeling of Aerochemical Interactions in Novel Turbomachines for Conducting Low-Carbon Chemical Reactions. 2025. In Preparation.

[2] **D. Rubini**, B. Rosic, and L. Xu. Energy Conversion Mechanisms in Turbomachines for High-Temperature Endothermic Reactions: Redefining Energy Quality. *Appl. Therm. Eng.*, 2025.

[3] **D. Rubini**, N. Karefyllidis, B. Rosic, L. Xu, and E. Nauha. Decarbonisation of High-Temperature Endothermic Chemical Reaction Processes Using a Novel Turbomachine: Robustness of the Concept to Feed Variability. *J. Glob. Power Propuls. Soc.*, 2024 (Best Paper).

[4] N. Karefyllidis, **D. Rubini**, B. Rosic, L. Xu, and V.-M. Purola. A Novel Axial Energy-Imparting Turbomachine for High-Enthalpy Gas Heating: Robustness of the Aerodynamic Design. *ASME J. Turbomach.*, 2023 (Best Paper).

[5] **D. Rubini**, N. Karefyllidis, L. Xu, B. Rosic, and H. Johannesdahl. Accelerating the Development of a New Turbomachinery Concept in an Environment With Limited Resources and Experimental Data: Challenges. In *ASME Turbo Expo*, 2022.

[6] **D. Rubini**, N. Karefyllidis, L. Xu, B. Rosic, and H. Johannesdahl. A New Robust Regenerative Turbo-Reactor Concept for Clean Hydrocarbon Cracking. *J. Glob. Power Propuls. Soc.*, 2022.

[7] **D. Rubini**, L. Xu, B. Rosic, and H. Johannesdahl. A New Turbomachine for Clean and Sustainable Hydrocarbon Cracking. *ASME J. Eng. Gas Turbines Power*, 2021.

Talks and Conference Presentations

2024 **Invited Talk**, *The University of Tokyo, Japan*, "Enabling the Net-Zero Transition: Integrating Complex Aerochemistry Efficiently at the Design Optimisation Level".

2023 **Conference**, *Global Power and Propulsion Society, Hong Kong*, "Ref. [3]".

2023 **Invited Talk**, *Mitsubishi Heavy Industries, Japan*, "Ultra-Fast Multiphysics Coupling Tools Required for the Future Decarbonised World".

2022 **Invited Talk**, *Osney Thermofluids Institute, Oxford*, "Designing a Turbo-Reactor to Selectively Control Chemical Reactions".

2022 **Invited Talk**, *Coolbrook Oy, Finland*, "Accelerated Aerochemistry Coupling Toolchain Enabling a Controllable, Selective and High-Yield Turbo-Reactor Design".

2022 **Conference**, *ASME Turbo Expo, Rotterdam*, "Ref. [5]".

2021 **Conference**, *Global Power and Propulsion Society, Xi'an*, "Ref. [6]".

2021 **Conference**, *ASME Turbo Expo, London*, "Ref. [7]".

Teaching

Spring 2025 1st year mathematics (Planned)

2020–Present Supervising PhD & MEng students and mentoring prospective Oxford applicants

Technical Skills

Languages 1 *Experienced:* `Python`, `Fortran`, `Matlab`, `MPI` programming, Domain Specific Languages, LaTeX, Shell scripting

Languages 2 *Familiar:* `C/C++`, `Cuda`, `OpenMP` programming

ML libraries TensorFlow, Pymoo (multiobjective genetic optimisation)

Software

Fluids Ansys Fluent (CFD), BoxerMesh (meshing), Icem (meshing), in-house code Tblock (CFD), Lattice Boltzmann OpenLB (CFD), SolidWorks CAD, ParaView (post-processing)

Chemistry Rmg-Py (generating heterogeneous kinetics), Cantera (solving kinetics)

General Git, Visual Studio Code, Sublime Text, CorelDraw, Inkscape, Overleaf

HPC Facilities ARCHER2, Advanced Research Computing Facility (Oxford)

OS Linux (Ubuntu & CentOS), Windows, macOS

Certified Courses

OpenLB Learnt to develop custom lattice Boltzmann PDE solvers

Referees

Available upon request