Dr James Graham

jsnsgraham@gmail.com | +44 7960 778220

EDUCATION

UNIVERSITY OF OXFORD
DPhil Theoretical Physics
Thesis title: Mechanics and Collective Cell Migration
2025 | Pembroke College, Oxford, UK

UNIVERSITY OF OXFORD
MSc Mathematical and Theoretical Physics
Distinction (85%)
2017 | Pembroke College, Oxford, UK

NORTHWESTERN UNIVERSITY
BS Applied Mathematics
summa cum laude (3.96/4.00)
2016 | Evanston, IL, USA

SKILLS

PROGRAMMING
Competent:
C++ • Python • LaTeX
Basic:
MATLAB • Mathematica • R

LANGUAGES
German • Russian

COURSEWORK

GRADUATE
QFT • Nonperturbative QFT • GR
Plasma Physics • Kinetic Theory
Nonequilibrium Statistical Physics
Quantum Information
Perturbation Methods

UNDERGRADUATE
Linear Algebra • ODEs • PDEs
Dynamical Systems • Complex Analysis
Deterministic Models & Optimization
Numerical Methods • Fluid Mechanics
Quantum Mechanics • Astrophysics
Cosmology

EMPLOYMENT

TEACHER OF PHYSICS St Edward's School
2024-2025 | Oxford, UK
- Taught iGCSE and IB curricula to ∼110 pupils in years 9-13;
- Developed IB scheme of work to integrate knowledge and skills with Fundamental British Values;
- Developed curriculum to teach Special Relativity to IB pupils in year 13;
- Set and marked internal exams for all year groups;
- Led small-group sessions during weekly physics clinic;
- Provided one-on-one science and maths tuition during weekly boarding house duty.

PHYSICS TUTOR St Hilda's College
2023 | Oxford, UK
- Marked four problem sheets on mathematical methods for each of eight students in the course of one term;
- Led discussions on topics including Fourier series and transforms, Legendre and Hermite polynomials, and ordinary and partial differential equations;
- Motivated the need for orthogonal functions and PDEs in quantum mechanics.

TEACHING ASSISTANT Mathematical Institute
2021 | Oxford, UK
- Marked four problem sheets for each of eleven students for the module 'General Relativity II';
- Presented at least one problem in each of four remote classes held using Microsoft Teams;
- Helped class tutor to answer students' questions on maths and physics.

EDUCATION COORDINATOR Mathnasium of Tysons
2019-2020 | Vienna, VA, USA
- Maintained individualized curricula for more than 150 students to respond to long-term learning needs and short-term school requirements;
- Supervised more than 15 instructors to ensure consistent, responsive and personalized instruction;
- Managed relationships with parents to set expectations, report students progress and achieve learning goals.

INSTRUCTOR Mathnasium locations owned by Temple Ventures
2017-2019 | Northern Virginia, VA, USA
- Taught students one-on-one in topics from counting to trigonometry;
- Managed individualized workflow of several students simultaneously;
- Enthused students in mathematics by relating my experiences to theirs.

TEACHING ASSISTANT Northwestern University Department of Mathematics
2015-2016 | Evanston, IL, USA
- Led weekly discussion sections in single- and multivariable calculus;
- Invigilated and marked weekly quizzes and three exams per term.

RESEARCH ASSISTANT Northwestern University Department of Engineering Science and Applied Mathematics
2014-2015 | Evanston, IL, USA
- Modelled Hodgkin-Huxley neurons using Python package BRIAN to provide comparison to simplified and mean-field models;
- Simulated mixed-mode oscillations composed of sub-threshold oscillations and voltage spikes subject to noisy stimulus;
- Showed the full Hodgkin-Huxley system exhibits multistable mixed-mode oscillations depending on noise and stimulus timing and strength;
- Project yielded one publication.

CONFERENCES, PRESENTATIONS & SCHOOLS

2024 | Pembroke College 3CR Talk Series
Gave a talk on cells flowing in a channel with intercellular friction to members of college from the Junior, Middle and Senior Common Rooms

2023 | Pre-APS-DFD Satellite Meeting on Enivronmental and Biological Fluid Dynamics
Presented a talk on phase separation in mixtures of epithelial cells

2022 | EMBO Workshop on Physics of cells: PhysCell2022
Presented poster 'Modelling Motility in Confined Epithelia: From Single-Cell to Collective Behaviours'

2022 | International School on Biological Physics of Cells
Pre-EMBO Workshop series of lectures and poster presentations

2022 | XXVIII International Summer School Instituto Nicolás Cabrera
Presented poster 'Modelling Motility in Confined Epithelia: From Single-Cell to Collective Behaviours'

2022 | Pembroke College 3CR Talk Series
Gave a talk on two-, four-, and six-fold orientational order in layers of cells with head-tail symmetry

AWARDS

2024 | Senior Studentship
From Pembroke College in recognition of research progress

2016 | Roger Boye Oxbridge Bursary
From Northwestern to support study at Oxford

2016 | Outstanding Graduate Prize in Applied Mathematics
Recognition as top graduate from my department at Northwestern

2014 | Summer Research Opportunities Award
To support research at Northwestern June-Sept. 2014

2013 | Merck Index Award
Recognition as top student in first-year organic chemistry at Northwestern

EMPLOYMENT (CONTINUED)

RESEARCH ASSISTANT Northwestern University Department of Engineering Science and Applied Mathematics
2013 | Evanston, IL, USA

- Modelled the piriform cortex, part of the brain responsible for smell, as a neural network using MATLAB;
- Simulated the learning and recall of multiple stimuli in sequence and parallel;
- Investigated the effects of neural inhibition and existing connectivity on the learning of new stimuli;
- Project yielded one publication.

PROJECTS

MULTI-PHASE FIELD MODEL FOR EPITHELIA DPhil Research

- Inherited and developed legacy codebase in C++ and Python and conducted data analysis using Pandas;
- Modelled epithelial cells as interacting density fields;
- Implemented heterogeneous dipolar forces that resulted in phase separation;
- Implemented fluctuating interactions that resulted in cell motility and a fluidised tissue;
- Modelled intercellular friction as a force density that resulted in tissue-level flows, as seen in experiment;
- Proved that the algorithm used to solve the intercellular friction problem converges;
- Developed and implemented metrics for rotational order, and four- and six-fold orientational order in a monolayer;
- Project yielded two manuscripts in addition to thesis.

SHARP-INTERFACE MODEL FOR EPITHELIA DPhil Side Project

- Used C++ to implement a model for epithelial cells based on Saito & Ishihara (2024);
- Used Fourier modes to describe the shapes of epithelial cells;
- Implemented active polar forces to reproduce tissue flocking behaviour.

NON-PERTURBATIVE METHODS IN QUANTUM FIELD THEORY
MSc Coursework

- Simulated a U(1) lattice gauge theory using C++;
- Linked lattice sites to their neighbours in 2+1D using pointers;
- Used pointers to construct plaquettes and other loops in the lattice simulation;
- Implemented the Metropolis algorithm to update the values of the U(1) field;
- Used MATLAB and Excel to calculate and analyse correlation functions to find the masses of particles in the gauge theory.

PUBLICATIONS

- **JN Graham** & J Rozman. Junctional-Fluctuation-Mediated Fluidisation of Multi-Phase Field Epithelial Monolayers (2025), *in submission*. https://doi.org/10.48550/arXiv.2508.18987
- **JN Graham**, G Zhang & JM Yeomans. Cell sorting by active forces in a phase-field model of cell monolayers (2024), *Soft Matter*, 20, 2955-2960. https://doi.org/10.1039/D3SM01033C
- W Adams, **JN Graham**, X Han & H Riecke. Top-down inputs drive neuronal network rewiring and context-enhanced sensory processing in olfaction (2019), *PLoS Comput Biol*, 15(1): e1006611. https://doi.org/10.1371/journal.pcbi.1006611
- AJ Karamchandani, **JN Graham** & H Riecke. Pulse-coupled mixed-mode oscillators: Cluster states and extreme noise sensitivity (2018), *Chaos*, 28(4): 043115. https://doi.org/10.1063/1.5021180