

JAMES FOSTER

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PROFILE

Senior lecturer (associate professor) in mathematics at the University of Bath with interests in the numerical analysis of stochastic differential equations and the applications of differential equations to machine learning.

RESEARCH

- *Strong Stochastic Flow Maps*. Sam McCallum, Zander Blasingame, Timothy Herschell, Niklas Rindtorff, Alexander Tong and **James Foster** (2026). arxiv.org/abs/2606.01086.
- *ARCANE: Scalable high-degree cubature formulae for simulating SDEs without Monte Carlo error*. Peter Koepernik, Thomas Coxon and **James Foster** (2026). arxiv.org/abs/2602.17151.
- *Reversible Deep Equilibrium Models*. Sam McCallum, Kamran Arora and **James Foster** (2025). arxiv.org/abs/2509.12917.
- *Efficient, Accurate and Stable Gradients for Neural ODEs*. Sam McCallum and **James Foster** (2025). arxiv.org/abs/2410.11648.
- *On the convergence of adaptive approximations for stochastic differential equations*. **James Foster** and Andraž Jelinčič (2025). arxiv.org/abs/2311.14201.
- *Single-seed generation of Brownian paths and integrals for adaptive and high order SDE solvers*. Andraž Jelinčič, **James Foster** and Patrick Kidger (2025). arxiv.org/abs/2405.06464.
- *Underdamped Langevin MCMC with third order convergence*. Max Scott, Dáire O’Kane, Andraž Jelinčič and **James Foster** (2026). Journal of Machine Learning Research (JMLR), 27(126):1–63.
- *Approximating the signature of Brownian motion for high order SDE simulation*. **James Foster** (2026). Stochastic Analysis and Applications 2025, Springer.
- *Generative Modelling of Lévy Area for High Order SDE Simulation*. Andraž Jelinčič, Jiajie Tao, Will Turner, Tom Cass, **James Foster** and Hao Ni (2025). SIAM Journal on Mathematics of Data Science, 7(4):1541–1567.
- *High order splitting methods for SDEs satisfying a commutativity condition*. **James Foster**, Gonçalo dos Reis and Calum Strange (2024). SIAM Journal on Numerical Analysis, 62(1):500–532.
- *Brownian bridge expansions for Lévy area approximations and particular values of the Riemann zeta function*. **James Foster** and Karen Habermann (2023). Combinatorics, Probability and Computing, 32(3):370–397.
- *An asymptotic radius of convergence for the Loewner equation and simulation of SLE traces via splitting*. **James Foster**, Terry Lyons and Vlad Margarint (2022). Journal of Statistical Physics, 189(18).
- *The shifted ODE method for underdamped Langevin MCMC*. **James Foster**, Terry Lyons and Harald Oberhauser (2021). arxiv.org/abs/2101.03446.
- *Efficient and Accurate Gradients for Neural SDEs*. Patrick Kidger, **James Foster**, Xuechen Li and Terry Lyons. Neural Information Processing Systems 2021.
- *The Signature Kernel is the solution of a Goursat PDE*. Cristopher Salvi, Thomas Cass, **James Foster**, Terry Lyons and Weixin Yang (2021). SIAM Journal on Mathematics of Data Science, 3(3):873–899.
- *Neural SDEs as Infinite-Dimensional GANs*. Patrick Kidger, **James Foster**, Xuechen Li, Harald Oberhauser and Terry Lyons. International Conference on Machine Learning 2021.
- *Neural Rough Differential Equations for Long Time Series*. James Morrill, Cristopher Salvi, Patrick Kidger, **James Foster** and Terry Lyons. International Conference on Machine Learning 2021.
- *Neural Controlled Differential Equations for Irregular Time Series*. Patrick Kidger, James Morrill, **James Foster** and Terry Lyons. Neural Information Processing Systems 2020 (Spotlight).
- *An Optimal Polynomial Approximation of Brownian Motion*. **James Foster**, Terry Lyons and Harald Oberhauser (2020). SIAM Journal on Numerical Analysis, 58(3):1393–1421.

EDUCATION

University of Oxford, Worcester College

DPhil in Mathematics

October 2016 – October 2021

(Thesis published online in 2020)

- DPhil thesis on the topic of [Numerical approximations for stochastic differential equations](#) can be found online.
- Under the supervision of Prof. Terry Lyons and Prof. Harald Oberhauser, discovered a new relationship between Brownian motion and a class of orthogonal polynomials that has applications to numerical methods for SDEs.
- A Matlab demonstration of this result can be found at chebfun.org/examples/stats/RandomPolynomials.html.
- Awarded full EPSRC studentship which includes a maintenance grant and covers both college and tuition fees.

University of Oxford, St John's College

MMath in Mathematics

October 2012 – September 2016

MMath (First Class Hons), BA (First Class Hons)

ACADEMIC PRIZES

- IMA Leslie Fox Prize for Numerical Analysis 2025 (joint first) awarded for research on SDE splitting methods.
- Presented a [poster](#) in the STEM for Britain 2021 competition (finalist in the mathematical sciences category)
- G-Research PhD Prize in Maths and Data Science awarded for research on numerical methods for SDEs (2020).

PROFESSIONAL EXPERIENCE

University of Bath, Department of Mathematical Sciences

Senior Lecturer (associate professor)

June 2026 – Present

Bath

University of Bath, Department of Mathematical Sciences

Lecturer (assistant professor)

August 2022 – May 2026

Bath

University of Oxford, Mathematical Institute

Postdoctoral Research Associate

May 2020 – July 2022

Oxford

J.P. Morgan Chase & Co, Global Credit Markets

Quantitative Research Intern (12 weeks)

June 2016 – September 2016

London

Credit Suisse International, Fixed Income Division

Quantitative Summer Analyst (10 weeks)

June 2015 – August 2015

London

Shell U.K. Limited, Development Engineering Department

Reservoir Engineer Intern (12 weeks)

June 2014 – September 2014

Aberdeen

Altera Europe Limited, European Technology Centre

Intern (1 month)

September 2013

High Wycombe

Roxar Limited, Software Solutions Division

Summer Intern (9 weeks)

June 2013 – August 2013

Oxford

RESEARCH TALKS

- *From $1/\sqrt{n}$ to $1/n$: Accelerating SDE Simulation with Cubature Formulae.* BIRS Workshop on “New Trends in Rough Analysis: Open Challenges and Applications”, 23/06/2026.
- *Efficient, Accurate and Stable Gradients for Neural Differential Equations.* Beijing Institute of Mathematical Sciences and Applications (BIMSA) Computational Math Seminar, 09/10/2025.
- *High order splitting methods for SDEs.* Workshop “Milstein’s method: 50 years on”, University of Nottingham, 30/06/2025.
- *High order splitting methods for SDEs satisfying a commutativity condition,* IMA Leslie Fox Prize Meeting, University of Strathclyde, 23/06/2025.
- *Efficient, Accurate and Stable Gradients for Neural Differential Equations,* Workshop on “Recent Developments in Theoretical Machine Learning”, Imperial College London, 13/01/2025.
- *Splitting methods and generative modelling for high order SDE simulation.* One World Stochastic Numerics and Inverse Problems seminar, 27/11/2024.
- *An improved Runge-Kutta method for SDEs with additive noise,* Meeting on “Directions in Rough Analysis”, Oberwolfach Research Institute for Mathematics, Germany, 07/11/2024.

- *On the convergence of adaptive approximations for SDEs*, Workshop on “New Impacts of Rough Analysis”, University of Warwick, 25/07/2024.
- *Algebraically reversible solvers for neural differential equations*, Conference on “Signatures of paths and images”, Hotel Lysebu, Oslo, 10/06/2024.
- *Using GANs to improve the simulation of stochastic differential equations*, Joint seminar (“Optimisation and Numerical Analysis” & “Data Science and Computational Statistics”), University of Birmingham, 08/02/2024.
- *High order splitting methods for SDEs*, Stochastic Analysis Seminar, Imperial College London, 30/01/2024.
- *On the convergence of adaptive approximations for SDEs*, CUWB Conference, Playa del Carmen, Mexico, 08/01/2024.
- *High order numerical methods for SDEs*, North-East and Midlands Stochastic Analysis (NEMSA) Seminar, Oxford, 26/09/2023.
- *Markov Chain Cubature for Bayesian Inference*, Minisymposium on “Methodological advancement in rough paths and data science”, International Congress on Industrial and Applied Mathematics (ICIAM), 24/08/2023.
- *High order splitting methods for SDEs satisfying a commutativity condition*, Invited session on “Numerical methods for SDEs” at the Conference on Stochastic Processes and Applications, Lisbon, Portugal, 24/07/2023.
- *Markov Chain Cubature for Bayesian Inference*, BIRS Workshop on “New interfaces of Stochastic Analysis and Rough Paths”, 08/09/2022.
- *Applications of high order SDE solvers in machine learning*, Dagstuhl Seminar on “Differential Equations and Continuous-Time Deep Learning”, Schloss Dagstuhl, Wadern, Germany, 16/08/2022.
- *Neural Stochastic Differential Equations for Time Series Modelling*, “ICMS at Oxford” workshop on Advances in N -body Computations, 11/04/2022.
- *A high order method for underdamped Langevin MCMC*, International Conference on Monte Carlo Methods and Applications, 18/08/2021.
- *Log-signatures and Neural Rough Differential Equations*, ICERM Workshop on Applications of Rough Paths: Computational Signatures and Data Science, 7/03/2021.
- *Understanding randomness with polynomials*, STEM for Britain – Mathematical sciences category, 03/03/2021.

TEACHING EXPERIENCE (BATH)

- Colecturer (with Eike Mueller) for a first year undergraduate course on “Programming for Mathematics” (2025)
- Lecturer (or unit convenor) for a new graduate course on “Applied Machine Learning” (2024–25)
- Lecturer (or unit convenor) for a second year undergraduate course on “Numerical Analysis” (2023 – present)
- Lecturer (or unit convenor) for a SAMBa PhD course on “Applied Stochastic Differential Equations” (2023-24)
- Delivered a lecture and coursework on “Brownian motion and Stochastic Differential Equations” as part of a first year undergraduate course called “Connections” (2023). Tutor for first year programming labs (2023-25)
- Supervisor for SAMBa Research Group Project on “Exploring applications of smarter subsampling” (2025-26)
- Supervisor for SAMBa Interdisciplinary Research Project on “Multiscale Flow in Porous Media” (2023-24)
- Supervisor on eight separate reading courses on SDEs or machine learning for SAMBa PhD students (2022-24)
- Contributed to exam and coursework marking for the undergraduate course “Numerical analysis” (2022-24)
- Seminar leader for “Foundations”, an introductory course on university mathematics for students (2022-23)

TEACHING EXPERIENCE (OXFORD)

- Contributed to the exam marking for the undergraduate course “Probability, Measure and Martinagles” (2022)
- Tutor for the undergraduate courses: Information Theory (2021, 2022) and Communication Theory (2018)
- Member of selection committee for undergraduate admissions at Worcester College (2017, 2019, 2020)
- Graduate lecturer at Worcester College, tutoring Linear Algebra and Real Analysis (2017 – 2018)
- Teaching assistant for courses on Financial Derivatives (2017) and Communication Theory (2016, 2017)

PHD STUDENTS

- Harry Semple (Bath). Primary supervisor with Eike Mueller as secondary supervisor (2026 – present).
- Timothy Herschell (Bath). Primary supervisor with Tony Shardlow as secondary supervisor (2025 – present).
- Samuel McCallum (Bath). Primary supervisor with Neill Campbell as secondary supervisor (2024 – present).
- Maximilian Scott (Bath). Primary supervisor with Chris Budd as the secondary supervisor (2024 – present).
- Andraž Jelinčič (Bath). Primary supervisor with Neill Campbell as secondary supervisor (2023 – present).
- Peter Crew (Bath). Secondary supervisor with Avi Mayorcas as lead supervisor (2025 – present).
- Dáire O’Kane (Bath). Secondary supervisor with Avi Mayorcas as lead supervisor and Chris Budd as third supervisor (2023 – present).
- Calum Strange (Edinburgh). Secondary supervisor with Gonçalo dos Reis as the lead supervisor (2021-2023). The first half of Calum’s thesis is on the topic of [Path-based splitting methods for SDEs](#) and is available online.
- Aaron Fordonnell (Bath, Engineering). Secondary supervisor with Benjamin Metcalfe as the lead supervisor and Matthew Nunes as third supervisor (2023 – 2025).

SUPERVISION OF STUDENT PROJECTS

- Bradley Earley (Bath, BSc). Summer project on “Seoncd-order exponential integrators for ODEs” (2026)
- Jacob Adriano (Bath, MEng). Summer project on “Cubature vs Monte Carlo for optimal control” (2026)
- Nathan Evans (Bath, BSc). Summer project on the “Structured Noise to Reduce Deep BSDE Training Loss”, jointly funded by the LMS and the University of Bath. The [report](#) and Python code are available [online](#) (2025)
- William Warren (Bath, BSc). Bsc project on “Numerical methods for stochastic differential equations” (2025)
- Dylan Nimmo (Bath, MSc). Masters project on the “Deep BSDE method for high-dimensional PDEs” (2024-25)
- William Warren (Bath, BSc). Summer project on “Using recombination for creating cubature formulae” (2024)
- Samuel McCallum (Bath, PhD). Reading course on “Parameter inference for SDEs from time series data” (2024)
- Kamran Arora (Bath, PhD). Reading course on “High order splliting methods for SDEs and SPDEs” (2024)
- Yasir Abdi (Bath, PhD). Reading course on “Interacting particle optimization for sampling problems” (2024)
- Julia Zysko (Bath, MSc). Masters project on “Numerical methods for stochastic differential equations” (2023-24)
- Joshua Abbs (Bath, MSc). Masters project on “Cutting-Edge Audio Deepfake Generation Techniques” (2023)
- Sébastien Vol (Telecom SudParis, MEng). Summer internship on “SDE Cubature for Derivative Pricing” (2023)
- Pablo Arratia Lopez (Bath, PhD). Reading course on “Parameter inference for SDEs from snapshot data” (2023)
- Daniel Burrows (Bath, PhD). Project on “Clustering algorithms for SDE-based particle methods” (2022-23)
- Patrick Fahy (Bath, PhD). Reading course on “High order numerical methods for additive noise SDEs” (2022)
- Veronika Chronholm (Bath, PhD). Reading course on “Multilevel Monte Carlo for high order methods” (2022)
- Guannan Chen (Bath, PhD). Reading course on “Neural Differential Equations” with Lisa Kreusser (2022)
- Pablo Arratia Lopez (Bath, PhD). Reading course on “Neural Differential Equations” with Pranav Singh (2022)
- Andraž Jelinčič (Oxford, MMathCompSci). Masters project on “GAN-based Lévy area Simulation” (2022-23)
- Akira Terada (Edinburgh, MSc). Masters project on “High order Antithetic Multilevel Monte Carlo” (2022)
- Katie Zhang (Oxford, MMath). Summer project on “Cubuture for SDEs” and funded by Marshall Wace (2022)
- Matthew Young (UCL, MSc). Summer project on “Cubuture for SDEs” as part of UNIQ+ Internship (2022)

ORGANISATION AND SERVICE

- Organiser of the [Numerical Analysis seminar](#) at the University of Bath (2024 – present).
- Lead organiser of an ICMS Strategic Workshop on [New Directions for Stochastic Differential Equations and Machine Learning](#) at the Bayes Centre, University of Edinburgh (3-7 June 2024).
- Member of organising committee for a conference on [Modern Topics in Stochastic Analysis and Applications](#) at Imperial College London (22-26 April 2024). Editor for the conference proceedings (to be published in 2025).
- Member of organising committee for a workshop on [Dynamics, Data and Deep learning](#) (25-26 March 2024).

- Internal PhD examiner at the University of Bath for Ivan Cheltsov – who is expected to graduate in 2026.
- Reviewer of a proposal for a Leverhulme Trust Research Project.
- Reviewer for the International Centre for Mathematical Sciences (ICMS) “Research in Groups” programme.
- Reviewer for the SIAM Journal on Numerical Analysis, SIAM Journal on Mathematics of Data Science and the SIAM Journal on Control and Optimization.
- Reviewer for SIAM Journal on Financial Mathematics and the Risk Journal on Computational Finance.
- Reviewer for International Conference on Neural Information Processing Systems (NeurIPS), 2021 and 2022. Received a NeurIPS Outstanding Reviewer Award in 2021 (given to the top 8% of reviewers)
- Reviewer for International Conference on Learning Representations (ICLR), 2022.