Maniru Ibrahim

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Research Profile

Computational mathematician specialising in nonlinear PDEs, multiphysics modelling, and computational mechanics of degrading materials. Experienced in coupled diffusion–reaction–mechanics, moving-boundary and phase-field-type formulations, and finite element simulation (Python, MATLAB, COMSOL). Currently interested in electro-chemo-mechanical modelling of solid-state batteries, void evolution, and interface instabilities.

Education

2021–2025 **PhD in Applied Mathematics**, Research Ireland Centre for Research Training in Foundations of Data Science, University of Limerick, Ireland
Thesis: *Modelling of drug release from degrading and eroding polymers*
Viva date: *15 December 2025*
Supervisors: Prof. Michael Vynnycky & Dr. Kevin Moroney

2019–2021 **MSc Mathematics** *(Distinction)*, COMSATS University Islamabad, Pakistan & International Centre for Theoretical Physics, Trieste, Italy
Thesis: *Moving least squares deformation and applications in multidimensional projections*

2013–2017 **BSc Mathematics** *(First Class)*, Usmanu Danfodiyo University, Nigeria

Research Experience

PhD Researcher, Applied Mathematics Sep 2021 – Dec 2025
University of Limerick, Ireland

- Developed nonlinear PDE/ODE models for coupled diffusion, dissolution, and degradation in polymer and soft-matter systems, with strong analogies to electro-chemo-mechanical problems in solid-state batteries.
- Performed asymptotic reductions and boundary-layer analysis for stiff multiscale systems, including moving-boundary and phase-field-type interface descriptions.
- Built and validated multiphysics numerical solvers (FEM/FDM; Python, MATLAB, COMSOL) for coupled transport–structure problems.
- Collaborated with industry and academic partners on model development and interpretation; prepared first-author journal manuscripts in computational mechanics and applied analysis.
- Awarded 2nd place in the 2025 CRT 3-Minute Thesis Competition for research communication.

Visiting Postgraduate Researcher, Biomedical Engineering June 2023 – Aug 2024
IAC–CNR Rome, Italy & University of Glasgow, UK

- Formulated and analysed coupled degradation–diffusion–mechanics models for drug release from eroding polymer matrices, incorporating time-dependent material weakening and transport–structure coupling.
- Performed matched asymptotic analysis to characterise boundary layers, moving fronts, and multiscale regimes in erosion-driven interface evolution.
- Implemented finite element simulations of coupled PDE systems in COMSOL / MATLAB, reproducing moving-interface dynamics closely related to phase-field models of damage and fracture.
- Investigated chemo-mechanical feedback mechanisms and stress-driven transport in soft materials, forming the basis of two manuscripts in preparation.
- Strengthened cross-institutional collaboration between modelling groups in Rome, Glasgow, and Limerick; presented results to senior researchers in applied mechanics.

Group Project, Wave Energy Converter Modelling (Limerick Wave) Sep 2021 – Jan 2022
Research Ireland Centre for Research Training in Foundations of Data Science

- Formulated a mass–spring–damper model describing WEC dynamics under wave forcing, capturing hydrodynamic response, damping, and stiffness.
- Derived analytical solutions for simplified regimes; implemented numerical solvers in MATLAB for the full model.
- Validated model behaviour using experimental buoy data and integrated over 800,000 wave observations for long-term performance prediction.
- Evaluated power capture for multiple WEC types and conducted 25-year cost/payback modelling.

Selected Modelling Projects

Modelling contaminant capture in packed-column systems April 2024
ICMS & MAC-MIGS Modelling Camp, Edinburgh, UK

- Developed a continuum adsorption–transport model (advection–diffusion–reaction) for contaminant capture in packed columns (water treatment, gas purification).
- Reduced the governing PDE system via scaling and model reduction; implemented numerical solvers and analysed breakthrough curves.

Industry Modelling and Data Projects 2022–2024

- Applied statistical learning and NLP (Python, SQL, Azure) to large-scale organisational datasets (British Red Cross, Tata Consultancy Services, Fareshare), developing reproducible analysis pipelines and dashboards.

Publications

- **Ibrahim, M.**, Moroney, K. M., & Vynnycky, M. (2025). Finite dissolution-rate drug release: From a continuous-field description to a moving-boundary problem. *Journal of Computational and Applied Mathematics,* 473, 116857.
- Abubakar, S. S., **Ibrahim, M.**, & Abubakar, N. (2019). Applications of PDEs in heat transfer. *Journal of Applied Physical Science International,* 11 (3), 88-94.
- **Ibrahim, M.**, Moroney, K. M., & Vynnycky, M. (2025). Asymptotic analysis of drug binding in arterial stent tissue. *Manuscript prepared and under review by co-authors, expected submission December 2025.*
- **Ibrahim, M.**, Moroney, K. M., Vynnycky, M. Pontrelli G., & McGinty S. (2025). Mathematical Modelling of polymer degradation and erosion. *Manuscript in preparation, expected submission January 2026.*

Presentations/Talks

Drug Eluting Maths (Poster) Aug 2025
Irish Mathematical Society Meeting, Maynooth University, Ireland.

A Moving Boundary Approach to Control Drug Release with Finite Dissolution Rate Apr 2024
British Applied Mathematics Colloquium, Newcastle University, UK.

Modelling Drug Release from Eroding Porous Structures Apr 2023
SIM Talk, Department of Mathematics and Statistics, University of Limerick.

Modelling and Prediction of Wave Power Off the Irish Coast Jan 2022
Science Foundation Ireland, Winter Symposium, Remote.

Technical Skills

Computational Mechanics	Phase-field and moving-interface modelling; continuum mechanics of degrading materials; electro-chemo-mechanical coupling; asymptotic and boundary-layer methods.
Numerical Simulation	Finite element / finite difference methods; multiphysics PDE solvers; COMSOL Multiphysics; Python (NumPy/SciPy), MATLAB; stability and sensitivity analysis.
Scientific Computing	Python, C++, R, MATLAB; Git; optimisation; high-performance simulation workflows; reproducible research.
Data & Tools	SQL, Linux, LaTeX; Tableau, Power BI; Azure cloud.

Selected Training: CISM Course "Interfacial Flows and Asymptotic Methods" (2023); graduate modules in mathematical modelling and data science.

Teaching Experience

Graduate Teaching Assistant, University of Limerick 2021–Present
Engineering Mathematics, Linear Algebra, Calculus, Differential Equations, Applied Data Analysis

Tutor, Maths Learning Centre, University of Limerick 2023–Present
Provided drop-in and structured learning support across mathematics and statistics.

Founder & Tutor, Arewa Tutorials (YouTube) 2019–Present
Produced accessible mathematics tutorials for broad audiences.

Fellowship & Awards

Science Foundation Ireland Centre for Research Training in Foundations of Data Science 2021–2025
Total award €105,000: stipend, tuition fees, travel and expenses.

2nd Place (out of 31), Three-Minute Thesis Competition 2025
Research Ireland CRT in Foundations of Data Science.

ICTP–COMSATS Full MSc Scholarship 2019–2021
Tuition fees, stipend, health insurance, travel, and accommodation.

NNPC/TotalEnergies National Merit Scholarship (NMSS) 2016–2017
Highly competitive national award supporting outstanding undergraduates across Nigeria; provided annual financial support of ₦150,000.

MTN Foundation Science & Technology Scholarship 2015–2017
Awarded to top-performing STEM undergraduates in Nigerian public universities; annual support of ₦200,000 is maintained until graduation.

Bronze Medal, National Mathematics Competition for University Students (NAMCUS) 2017
National undergraduate mathematics competition (Nigeria); bronze medallist.

Academic Memberships

- Irish Mathematical Society (IMS), member.
- SIAM–UL Student Chapter, ordinary committee member (2021–2022).
- Member, MACSI Physical Modelling Journal Club, University of Limerick.

Leadership & Volunteering

Founder & Tutor, Arewa Tutorials 2019–Present
Produced mathematics tutorials and workshops; built and managed an education-focused online community.

President, A. A. Raji Alumni Association (class of 2013) 2020–2025
Organised large-scale reunion and outreach events; led budgeting and coordination for 100+ participants.

Referees

Prof. Michael Vynnycky
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Dr. Kevin Moroney
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