Dr. Matthew Lilley

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Plasma physicist with extensive experience working in a collaborative multidisciplinary research environment, primarily on non-linear phenomenon, instabilities and dynamical systems. Passionate about pursuing fusion as a sustainable energy source for the future.

Education and Training:

October 2005 - August 2009
Imperial College London, PhD in Plasma Physics

October 2001 – June 2005
University of Warwick, MPhys 1st Class (89%, top of class) in Mathematics and Physics

Research Experience:

Imperial College London, UK
Junior Research Fellow
September 2011 - August 2014
Research focus - Fusion energy: Nonlinear modelling of plasma instabilities driven by energetic particles, electrostatic confinement and particle dynamics in systems with discrete symmetry.

Achievements:
- Published 7 peer-reviewed articles in collaboration with national and international laboratories, including an Editor's Highlight Physical Review Letter [8-14]
- Discovered a new class of high frequency Compressional Alfvén eigenmode instability on MAST [14]
- Built PIC version of the bump-on-tail (BOT) fast particle code I created during my postdoc
- Optimised BOT (written in Matlab) and re-coded in Fortran, increasing speed by a factor of 4, allowing an investigation of long-time evolution of beam-driven nonlinear waves
- Invited to lecture at York University [F] and UCL [G] and to present invited talks at national [H] and international [I,J] conferences on the non-linear evolution of a fast-particle driven waves.
- Fostered collaboration with industrial partner, Tokamak Energy, securing a gift of a £1M experimental device
- Constructed and costed a research proposal worth £1.6M involving negotiations with multiple stakeholders
- Coordinated experiments with scientists at CCFE and the International Tokamak Physics Activity panel to gather data on fast particle instabilities.

Responsibilities:
- Manage a personal research budget of £25,000 and a student research budget of £12,000
- Supervise research of a PhD student, 2 Masters students and 1 third-year student
- Manage and execute a personal research programme
- Train postgraduates: lectures in advanced mathematical methods

Chalmers University of Technology, Sweden
Research Associate
September 2009 - August 2011
Research focus - Fusion energy: nonlinear modelling of plasma instabilities

Achievements:
- Built open source MatLab software (BOT) now used by several laboratories (https://github.com/mklilley/BOT) to study fast particle instabilities.
- Published 2 peer-reviewed articles [6,7]
- Invited to give a summer school lecture [C] and present invited talks at two international conferences [D,E]
- Received a highly competitive Junior Research Fellowship position at Imperial College

Responsibilities:
- Manage and execute a personal research programme
- Mentoring and informal supervision of a PhD student
- Training masters students: lectures in electromagnetic waves

Imperial College London, UK
PhD student
September 2005 - August 2009
Research focus - Fusion energy: Compressional Alfvén eigenmodes in spherical tokamaks

Achievements:
- Published several peer-reviewed articles on both theoretical and experimental topics, including a Physical Review Letter [1-5].
- Presented prize-winning poster and oral presentations [A] at national and international conferences. Was invited to lecture at the Culham theory meeting [B].
- Organised the 2008 Institute of Physics conference on plasma physics.
- Engaged with MP to promote the importance of fusion to the public.

Responsibilities:
- Manage and execute a personal research programme
- Running problem-solving classworks for undergraduates
- Mentoring a student with learning difficulties

Other Professional Experience:

Project IDA, UK
Founder
10th February 2020 – Present
- Founded an open science internet platform (https://www.project-ida.org) for the discussion of research in the emerging field of solid-state nuclear science
- Wrote computational essays on quantum dynamics, in the form of Jupyter notebooks, which I open sourced on GitHub (https://github.com/project-ida/two-state-quantum-systems) and made accessible on the research section of IDA (https://www.project-ida.org/research-codes)

Decoded, UK
Product Developer / Freelance facilitator
August 2017 – September 2018 / January 2019 - Present
- Creating new, and enhancing existing, educational experiences in the area of technology, e.g. blockchain, machine learning, data, code and quantum computing
- Create hands-on tools to help bring tech concepts to life
- Delivering the courses to non-technical audiences

Retail Insight, UK
Senior Analyst - Decision Science
July 2015 – December 2015
- Created an algorithm in python to optimise price reductions and times in order to minimise supermarket waste
- Provided informal training for employees to introduce mathematical rigour into their data analysis techniques
- Presented results to clients

Level 8 Ltd, UK
Founder
November 2013 – January 2020
- Founded a company with 2 fellow physicists in order to fund our fusion energy ideas
- Created a hybrid app called Squidler (https://squidler.com) using Ionic, ActionHeroJS, Redis and MongoDB

Self-employed, UK
Freelance Physicist, Tutor & Developer
September 2014 - August 2017
- Published a peer-reviewed article with international collaborators [15]
- Taught maths and physics to students with a variety of abilities
- Designed and created a brand http://mattlilley.com/ for my services and for others (http://rchapmanharris.com/)

- Became Chief Technology Officer for The Curtain Works (https://thecurtainworks.com). Added new and extended existing features to flesh out the initial site design and took the site live.

Publications – Peer Reviewed:

[15] Eriksson F, Nyqvist R M, **Lilley M K**, 2015, Kinetic theory of phase space plateaux in a non-thermal energetic particle distribution, **Physics of Plasmas**, Vol: 22, 092126

[14] Sharapov, S E, **Lilley M K**, et.al, 2014, Bi-directional Alfvén Cyclotron Instabilities in the Mega-Amp Spherical Tokamak, **Physics of Plasmas** Vol:21, 082501

[13] **Lilley M K**, Nyqvist R M, Formation of Phase Space Holes and Clumps, 2014, **Physical Review Letters**, Vol:112, 155002 **- Editor's Highlight**

[12] Meyer H, et.al, 2013, Overview of physics results from MAST towards ITER/DEMO and the MAST Upgrade, **Nuclear Fusion**, Vol:53, 104008

[11] Sharapov S E, et.al, 2013 Energetic Particle Instabilities in Fusion Plasmas, **Nuclear Fusion**, Vol:53, 104022

[10] Gryaznevich M, Svoboda V, Stockel J, et al., 2013, Progress in application of high temperature superconductor in tokamak magnets, **Fusion Engineering and Design**, Vol:88, 1593

[9] Nyqvist R M, **Lilley M K**, Breizman BN, 2012, Adiabatic description of long range frequency sweeping, **Nuclear Fusion**, Vol:52, 094020

[8] **Lilley M K**, Breizman B N, 2012, Convective transport of fast particles in dissipative plasmas near an instability threshold, **Nuclear Fusion**, Vol:52, 094002

[7] Lloyd B, Akers RJ, Alladio F, et al., 2011, Overview of physics results from MAST, **Nuclear Fusion**, Vol:51, 094013

[6] **Lilley M K**, Breizman BN, Sharapov SE, 2010, Effect of dynamical friction on nonlinear energetic particle modes, **Physics of Plasmas**, Vol:17, 092305

[5] Meyer H, Akers RJ, Alladio F, et al., 2009, Overview of physics results from MAST, **Nuclear Fusion**, Vol:49, 104017

[4] **Lilley M K**, Breizman B N, Sharapov SE, 2009, Destabilizing Effect of Dynamical Friction on Fast-Particle-Driven Waves in a Near-Threshold Nonlinear Regime, **Physical Review Letters**, Vol:102, 195003

[3] Zhang Y, Heidbrink WW, Zhou S, et al., 2009, Doppler-shifted cyclotron resonance of fast ions with circularly polarized shear Alfven waves, **Physics of Plasmas**, Vol:16, 055706

[2] Gryaznevich M P, Sharapov SE, **Lilley M**, et al., 2008, Recent experiments on Alfven eigenmodes in MAST, **Nuclear Fusion**, Vol:48, 084003

[1] **Lilley M K**, Sharapov S E, 2007, Compressional Alfven and ion-ion hybrid modes in the deuterium-tritium plasma of a spherical tokamak power plant**, Physics of Plasmas**, Vol:14, 082501

Invited Talks:

[K] Research Laboratory of Electronics, MIT, Experiments in metal hydrogen systems, 2019

[J] 55th Sherwood Fusion Theory Conference, On the Formation of Phase Space Holes and Clumps, 2014

[I] European Physical Society Plasma Physics Conference, Energetic Particle Modes from bump on tail to tokamak, 2012

[H] Institute of Physics Plasma Physics Conference, Nonlinear wave-particle interactions in plasmas, 2012

[G] UCL, Feeling the Fusion Burn, 2013

[F] York Plasma Institute, Dynamics of a nonlinear resonance, 2011

[E] European Fusion Theory Conference, Nonlinear energetic particle modes: from bump on tail to tokamak, 2011

[D] 12th IAEA TCM on Energetic Particles in Magnetic Confinement Systems, Nonlinear energetic particle modes: from bump on tail to tokamak, 2011

[C] ITER Summer School, Nonlinear energetic particle modes: from bump on tail to tokamak, 2011

[B] Culham Theory Meeting – January, Destabilizing effect of dynamical friction on fast particle driven waves, 2009

[A] 50th Sherwood Fusion Theory Conference, Destabilizing effect of dynamical friction on fast particle driven waves – PRIZE WINNER, 2009