Dr David MacTaggart PhD FIMA FRAS FHEA

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Research interests

continuum mechanics, topological fluid dynamics, magnetohydrodynamics (MHD), solar physics, stability theory, magnetic reconnection, mathematical modelling, numerical and analytical solution of partial differential equations.

Education

2002-2006	University of Glasgow	MSci Mathematics (1st)
2006-2007	Oxford University	MSc Mathematical Modelling & Scientific Computing
2007-2010	University of St Andrews	PhD Applied Mathematics, Supervisor: Prof. A.W. Hood, Title: *Theoretical magnetic flux emergence*
2012-2013	University of Abertay	P.G. Cert. in Higher Education Teaching

Academic positions

2010-2011	Niels Bohr Institute (Univ. Copenhagen)	Postdoc. in solar fluid dynamics
2012-2014	University of Abertay	Lecturer in applied mathematics (grade 7)
2014	University of Catania	Visiting researcher
2015-now	University of Glasgow	Lecturer in applied mathematics (grade 8)
2016	University of Catania	Visiting researcher
2019	University of Trento	Visiting professor

Professional membership

Fellow of the Institute of Mathematics and its Applications (FIMA)

Fellow of the Royal Astronomical Society (FRAS)

Fellow of the UK Higher Education Academy (FHEA)

Member of the Edinburgh Mathematical Society

Member of EUROMECH

Member of Gruppo Nazionale per la Fisica Matematica (Italy)

Member of the Project Management Board of DiRAC (STFC)

Reviewing activity

Editorship: Guest editor (in 2021, invited by Professor Andrew Soward FRS) of Geophysical and Astrophysical Fluid Dynamics (Taylor & Francis Group) for Special Issue: "Recent developments in magnetohydrodynamics and dynamo theory"), Topic Editor (2020-2022) for Fluids (MDPI)

Ad hoc referee: Journal of Fluid Mechanics, Geophysical & Astrophysical Fluid Dynamics, Astronomy & Astrophysics, Physics of Plasmas, Monthly Notices of the Royal Astronomical Society, Astrophysical Journal, Europhysics Letters, Nature Scientific Reports, European Physics Journal Plus, Frontiers in Applied Mathematics and Statistics and Frontiers in Physics (Review Editor for Mathematical Physics), Bulletin of the London Mathematical Society, Fluids, Annales Geophysicae.

Grant application bodies: UK Science and Technology Facilities Council (STFC), Carnegie Trust.

Book reviews: CRC Press (Taylor & Francis Group), The Aeronautical Journal (The Royal Aeronautical Society)

Conference organization

Organizer of BAMC mini symposium: Recent developments in magnetohydrodynamics and dynamo theory (Glasgow, 2021, 41 participants)

Organizer of CISM Advanced Summer School (Udine, 2018): Advanced topics in MHD (28 participants; a book based on the school has been published by Springer)

Organizer of UKMHD 2016 (Glasgow, 2016, 63 participants)

Organizer of RAS Specialist Meeting: Flux emergence and its consequences in the solar atmosphere (London, 2016, 20 participants)

Teaching experience

Tutorials in linear algebra, mathematical modelling and complex analysis at St Andrews (2008-2010).

Lecturing 1st to 4th year students at Abertay (2012-2014). Topics range from linear algebra and Newtonian mechanics to fluid dynamics and the numerical solution of PDEs.

Lecturing/tutoring 1st to 5th year students at Glasgow (2015-now). 1st year: calculus, linear algebra; 2nd year: Newtonian mechanics; 3rd Year: rigid body mechanics and basic deformations, dynamical systems, ordinary differential equations; 4th year: numerical analysis, continuum mechanics, partial differential equations; 5th year: magnetohydrodynamics.

Undergraduate project supervision: I have supervised 20 4th year projects and 3 5th year projects (multigrid methods, MHD stability theory and shock waves).

Head of Level 5/MSc (5th year/Masters year, $\sim$20 students *per annum*) at Glasgow from 2015-2019; Head of Level 2 (2nd year, $\sim$450 students *per annum*) at Glasgow from 2020.

Postgraduate teaching: A 2018 summer school for PhD students and postdoctoral researchers, entitled "Advanced topics in MHD", at the International Centre for Mechanical Sciences (CISM) in Udine. A 2019 course for PhD students at the University of Trento entitled "Numerical Modelling", with course topics: continuum mechanics, fluid stability theory, pseudospectral methods.

Postgraduate supervision

PDRA: Breno Raphaldini (Developing photospheric magnetic winding inputs as a flare forecasting diagnostic; 2020-)

PhD: James Quinn (Anisotropic viscosity in magnetohydrodynamics; 2016-2020)

Ifeanyi Sunday Onah (Shock wave propagation along retinal blood vessels; 2019-)

Parag Gupta (Modelling the effects of differential rotation and meridional flows on solar and stellar dynamos; 2020-)

Emma Hunter (The annulus model of rotating magnetoconvection; 2021-)

MSc: Manuel Santos (Pseudospectra and Hartmann flow; 2017)

Nicole Huggins (On the tearing instability; 2018)

Pheeyidi Samuel (Topological invariants in magnetohydrodynamics; 2020)

Postgraduate viva examination

As internal examiner:

PhD: Nan Qi, Finite element-immersed boundary method and its application to mitrial valves (External: Prof. Michel Destrade, Supervisor: Prof. Xiaoyu Luo)

PhD: Andrey Melnikov, Bifurcation of thick-walled electroelastic cylindrical and spherical shells at finite deformation (External: Prof. Graham Rogerson, Supervisor: Prof. Ray Ogden FRS)

As external examiner:

PhD: Gareth Hawkes (University of Exeter), Magnetic helicity flow in the Sun and Heliosphere (Internal: Prof. Andrew Gilbert, Supervisor: Prof. Mitch Berger)

Invited talks (seminars and conferences)

2008: University of St Andrews: "Lagrangian-remap schemes in fluid dynamics" **2009**: University of St Andrews: "Theoretical flux emergence" **2011**: Bern (ISSI): "Straight/toroidal flux tubes and the 'sliding-doors' effect" **2012**: University of Central Lancashire: "Theoretical Flux Emergence: Context and Connections" **2013**: University of Durham: "Solar Flux Emergence" **2014**: University of Warwick: "Excursions in MHD"; University of Hull: "On magnetic reconnection and flux rope formation in emerging active regions "; University of St Andrews: "On magnetic reconnection and flux rope formation in emerging active regions"; University of Dundee: "Topological flux emergence" **2015**: University of Plymouth: "How to make a flux rope - applications of topological fluid dynamics" **2016**: University of Durham: "Transverse isotropy in magnetohydrodynamics" **2017**: University of Cambridge: "Optimal energy growth in current sheets"; University of St Andrews (SPDE17): "Optimal energy growth in current sheets" **2018**: University of Dundee: "The non-modal onset of the tearing instability"; University of St Andrews: "Interpreting magnetic helicity flux in solar flux emergence" **2019**: University of Trento: "Magnetic helicity flux: a topological measure of solar storms"; University of Durham: "Magnetic helicity in multiply connected domains" **2020**: 9th International Conference on Mathematical Modeling in Physical Sciences (Topological Methods in Physical Sciences): "Magnetic winding - understanding field line topology in flux emergence"; London Mathematical Society Durham-Oxford-Strathclyde network on Anisotropic Materials: "Anisotropy in magnetohydrodynamics - effects on nonlinear instabilities" **2021**: Astronomy and Astrophysics Seminar (Glasgow): "Direct evidence that twisted flux tube emergence creates solar active regions."

Contributed talks

2008: Flux Emergence Workshop (Kyoto): "Breakout from multiple flux emergence" **2009**: 2nd Solaire Network Meeting (Catania): "Breakout from multiple flux emergence; UKMHD (Coventry): "The emergence of toroidal flux tubes"; Flux Emergence Workshop (Puerto della Cruz): "Toroidal flux emergence" **2010**: Flux Emergence Workshop (UCL): "The 'sliding doors' effect in flux emergence"; National Astronomy Meeting (Glasgow): "Simulations of magnetic flux emergence with an overlying field" **2011**: 4th Solaire Network Meeting (MPS, Teistungen): "Flux emergence within mature solar active regions" **2013** UKMHD (Glasgow): "Finite deformation in Ideal MHD: analytical twisted current layers" **2015**: UKMHD (Northumbria): "Topological flux emergence"; Flux Emergence Workshop (HAO, Boulder): "Topological flux

emergence" **2016**: RAS Special Meeting (London): "The pre-penumbral magnetic canopy in the solar atmosphere" **2017**: UKMHD (Durham): "Optimal energy growth in current sheets" **2018**: BAMC/UKMHD (St Andrews): "The emergence of braided magnetic fields" **2019**: ISMP Seminar (Glasgow): "Magnetic helicity in multiply connected domains" **2020** Applied Mathematics Seminar (Glasgow): "Magnetic winding: what is it and what is it good for?"; Helicity 2020 (online international conference): "Magnetic winding – a key to unlocking topological complexity in flux emergence" **2021**: UKMHD (Newcastle): "Magnetic winding: what is it and what is it good for?"; ESWW17: "Direct evidence that twisted flux tube emergence creates solar active regions."

Computing skills

C, Fortran, Matlab, VisIt, LaTeX, Git, standard office packages

Linux and Windows operating systems

Experience of running parallel codes on supercomputers in the UK and Denmark

Outreach

Mathematics activities with primary school children in Glasgow

Participated in STEM for Britain 2016 at the Houses of Parliament

Curator of an exhibition on the history of mathematics at the University of Glasgow

Invited to write an article for www.sciencetrends.com

Grants awarded

2021 STFC DiRAC high-performance supercomputing facility (shared with two colleagues at Glasgow), 4.5M CPU-hours
2020 AFOSR Space Science Program (Developing photospheric magnetic winding inputs as a flare forecasting diagnostic, co-I with Univ. Durham): £12716 (grant total $170766)
2019 University of Trento, Visiting Professor: €6000
2018 Quarterly Journal of Mechanics and Applied Mathematics Trust (support for CISM School): £2000
2018 Edinburgh Mathematical Society (support for CISM School): £500
2017 Edinburgh Mathematical Society (support for research): £625
2016 STFC Consolidated Grant (co-I with Astronomy & Astrophysics Group): £36407 (grant total £910175)
2016 EPSRC PhD studentship (for James Quinn): £70000
2016 Carnegie Trust Research Incentive Grant (Helicity in the dynamic solar atmosphere): £4900
2015 STFC conference support (support for UKMHD): £2000
2015 Edinburgh Mathematical Society (support for UKMHD): £1600
2015 Glasgow Mathematical Journal Trust (support for UKMHD): £1015
2015 SOLARNET Mobility Grant (Univ. Catania, Sicily from June to July): €1800
2014 SFC Innovation Voucher (support for research): £5000
2014 SOLARNET Mobility Grant (Univ. Catania, Sicily from June to August): €1800
2014 Carnegie Trust Grant (Flux Rope Topology): £1000
2013 RAS grant (for conference travel): £170

Publications

All publications are available on request or *via* the links below. Current h-index: 11.

Homepage

ORCID

Google Scholar

Publons

Books

MacTaggart, D., Hillier, A. (eds), Topics in magnetohydrodynamic topology, reconnection and stability theory 2020, CISM International Centre for Mechanical Sciences, 591, Springer

Mainline research papers (* indicates corresponding author):

32. Raphaldini, B., Prior*, C., MacTaggart, D., Winding as an indicator of flaring in solar active regions, submitted

31. Faraco, D., Lindberg, S., MacTaggart*, D., Valli, A., On the proof of Taylor's conjecture in multiply connected domains 2022, Applied Mathematics Letters, 124, 107654

30. MacTaggart*, D., Prior, C., Raphaldini, B., Romano, P., Guglielmino, S.L., Direct evidence that twisted flux tube emergence creates solar active regions 2021, Nature Communications, 12, 6621

29. Candelaresi, S., Hornig, G., MacTaggart*, D., Simitev, R., On self and mutual winding helicity 2021, Communications in Nonlinear Science and Numerical Simulation, 103, 106015

28. Quinn*, J., MacTaggart, D., Simitev, R., Kelvin-Helmholtz instability and collapse of a twisted magnetic null point with anisotropic viscosity 2021, Astronomy and Astrophysics, 650, A143

27. MacTaggart*, D., Prior, C., Helicity and winding fluxes as indicators of twisted flux emergence 2020, Geophysical and Astrophysical Fluid Dynamics, 115, 85

26. Silva, L., Gupta, P., MacTaggart, D., Simitev*, R., Effects of shell thickness on cross-helicity generation in convection-driven dynamos 2020, Fluids, 5, 245

25. MacTaggart*, D., Prior, C., Magnetic winding – a key to unlocking topological complexity in flux emergence 2020, Journal of Physics Conference Series, 1730

24. Prior, C., MacTaggart*, D., Magnetic winding - what is it and what is it good for? 2020, Proceedings of the Royal Society A, 476, 20200483

23. Quinn*, J., MacTaggart, D., Simitev, R., The effect of anisotropic viscosity on the nonlinear MHD kink instability 2020, Communications in Nonlinear Science and Numerical Simulation, 83, 105131

22. MacTaggart*, D., Valli, A., Magnetic helicity in multiply connected domains 2019, Journal of Plasma Physics, 85, 775850501

21. MacTaggart*, D., Fletcher, L., The plasmoid instability in a confined solar flare 2019, MNRAS, 486, L96

20. Prior*, C., MacTaggart, D., Interpreting magnetic helicity flux in solar flux emergence 2019, Journal of Plasma Physics, 85, 775850201

19. MacTaggart*, D., The non-modal onset of the tearing instability 2018, Journal of Plasma Physics, 84, 905840501

18. MacTaggart*, D., Stewart, P., Optimal energy growth in current sheets 2017, Solar Physics, 292, 148

17. Dacie*, S., van Driel-Gesztelyi, L., Démoulin, P., Linton, M.G., Leake, J.E., MacTaggart, D., Cheung, M.C.M., The Field Distribution of Magnetograms from Simulations of Active Region Formation 2017, Astronomy and Astrophysics, 606, A34

16. MacTaggart*, D., Vergori, L., Quinn, J., Braginskii MHD for arbitrary magnetic topologies: coronal applications 2017, Journal of Fluid Mechanics, 826, 615

15. MacTaggart*, D., Guglielmino, S.L. Zuccarello, F., The pre-penumbral magnetic canopy in the solar atmosphere 2016, Astrophysical Journal Letters, 831, L4

14. Prior, C., MacTaggart*, D., The emergence of braided magnetic fields 2016, Geophysical & Astrophysical Fluid Dynamics, 110, 432

13. MacTaggart*, D., Gregory, S.G., Neukirch, T., Donati, J.-F., Magnetohydrostatic modelling of stellar coronae 2016, MNRAS, 456, 767

12. MacTaggart*, D., Guglielmino, S.L., Haynes, A.L., Simitev, R., Zuccarello, F., The magnetic structure of surges in small-scale emerging flux regions 2015, Astronomy and Astrophysics, 576, A4

11. MacTaggart*, D., Haynes, A.L., On magnetic reconnection and flux rope topology in solar flux emergence 2014, Monthly Notices of the Royal Astronomical Society, 438, 1500

10. MacTaggart*, D., Elsheikh, A., McLaughlin, J.A., Simitev, R., Non-symmetric magnetohydrostatic equilibria: a multigrid approach 2013, Astronomy and Astrophysics, 556, A40

9. McLaughlin*, J.A., Thurgood, J.O., MacTaggart, D., On the periodicity of oscillatory reconnection 2012, Astronomy and Astrophysics, 548, A98

8. MacTaggart*, D., Finite deformation in ideal magnetohydrodynamics 2012, Astronomy and Astrophysics, 542, A97

7. Vargas Domínguez, S., MacTaggart*, D., Green, L., van Driel-Gesztelyi, L., Hood, A.W., On signatures of twisted magnetic flux tube emergence 2012, Solar Physics, 278, 33

6. Hood*, A.W., Archontis, V., MacTaggart, D., 3D MHD Flux Emergence Experiments: Idealized models and coronal interactions 2012, Solar Physics, 278, 3

5. MacTaggart*, D., Flux emergence within mature solar active regions 2011, Astronomy and Astrophysics, 531, A108

4. MacTaggart*, D., Hood, A.W., Simulating the 'sliding doors' effect through magnetic flux emergence 2010, Astrophysical Journal Letters, 716, L219

3. MacTaggart*, D., Hood, A.W., Multiple eruptions from flux emergence 2009, Astronomy and Astrophysics, 508, 445

2. MacTaggart*, D., Hood, A.W., On the emergence of toroidal flux tubes: general dynamics and comparisons with the cylinder model 2009, Astronomy and Astrophysics, 507, 995

1. MacTaggart*, D., Hood, A.W., Can magnetic breakout be achieved from multiple flux emergence? 2009, Astronomy and Astrophysics, 501, 761

Others:

6. Riello, M., Purgato, M., Bove, C., Tedeschi, F., MacTaggart, D., Barbui, C., Rusconi*, E. 2021, Effectiveness of self-help plus (SH+) in reducing anxiety and post-traumatic symptomatology among care home workers during the COVID-19 pandemic: a randomized controlled trial, Royal Society Open Science, 8, 210219

5. MacTaggart*, D., Review of *Aerospace Dynamics for Aerospace Engineering* by J.J.S. Shang and S.T. Surzhikov 2020, The Aeronautical Journal, 124, 2046

4. Riello, M., Purgato, M., Bove, C., MacTaggart, D., Rusconi*, E., Prevalence of post-traumatic symptomatology and anxiety among residential nursing and care home workers following the first COVID-19 outbreak in Northern Italy 2020, Royal Society Open Science, 7, 200880

3. Bowness*, J., Labrosse, N., Forrest, D., MacTaggart, D., et al., Supporting Students in the Transition to Postgraduate Taught Study in STEM Subjects 2017, Journal of Perspectives in Applied Academic Practice, 5, 3

2. MacTaggart*, D., Twisted flux tube emergence: rigid rise or nonlinear deformation? 2013, Invited UKSP Nugget, http://www.uksolphys.org/uksp-nuggets/

1. Simitev*, R., MacTaggart, D., The mathematics of fluid dynamos 2012, The Commutator, 3, 36