Curriculum Vitae

Ryan Stewart McWilliams

Professor
Personal Chair in Mineral Physics
University of Edinburgh, UK

ADDRESS: School of Physics and Astronomy
James Clerk Maxwell Building
University of Edinburgh
Peter Guthrie Tait Road
Edinburgh EH9 3FD, UK
TELEPHONE: +44 0(131) 650 5273
EMAIL: rs.mcwilliams@ed.ac.uk
WEBSITE: http://www2.ph.ed.ac.uk/~rmcwilli/
CITIZENSHIP: United States
LANGUAGES: English (Native), Spanish (Basic)

EDUCATION:

PhD, Earth and Planetary Science, Department of Earth and Planetary Science, University of California Berkeley, 2008

BS, Physics, BS, Astronomy, *summa cum laude*, Departments of Physics and Astronomy, University of Massachusetts Amherst, 2001.

PROFESSIONAL POSITIONS:

8/2023 – :	Professor, Personal Chair in Mineral Physics, School of Physics and Astronomy, University of Edinburgh, Edinburgh, UK.
8/2018 – 7/2023:	Reader (Associate Prof.), School of Physics and Astronomy, University of Edinburgh, Edinburgh, UK.
9/2013 – 8/2018:	Chancellor's Fellow, School of Physics and Astronomy, University of Edinburgh, Edinburgh, UK.
1/2010 – 12/2016:	Visiting Scientist, Geophysical Laboratory, Carnegie Institution of Washington, Washington, DC, USA.
11/2011 –12/2014:	Visiting Researcher, Departamento de Física, Universidad de los Andes, Bogotá, Colombia.
1/2010 – 11/2011:	Postdoctoral Research Associate, Howard University, Washington, DC, USA.
10/2008 – 9/2009:	Postdoctoral Research Associate, Institute for Shock Physics, Washington State University, Pullman, WA, USA.
9/2002 – 9/2008:	Graduate Student Fellow, Lawrence Livermore National Laboratory, Livermore, CA, USA.
5/1998 – 9/2001:	Research Assistant, Depts. of Physics and Astronomy, University of Massachusetts Amherst, Amherst, MA, USA.

HONORS, FELLOWSHIPS, and AWARDS:

Mercator Fellow, DFG Research Unit Grant, Germany, 2022.
Student Employee Graduate Research Fellowship (SEGRF), LLNL, 2002-2007
Graduated *summa cum laude* (highest honors), University of Massachusetts, 2001
Field Scholarship, University of Massachusetts, for academic excellence in the sciences, 2000
Hasbrouck Scholarship, University of Massachusetts, to exceptional junior physics major, 2000
Commonwealth Scholarship, University of Massachusetts, 1997-2001 (full academic scholarship)

GRANTS:

Principal Investigator

Mercator Fellowship, DFG Research Unit, €8.1k, 2022.

ERC Consolidator Grant "TRIREME (Transport in the Interior of the Earth from Modelling and Experiments)", €2M, 2021-2026.

Daiwa Foundation Small Grant. £3k, 6/17.

EPSRC First Grant "Frontier Experiments in Dynamic Extreme Conditions: The Case for Light Elements." £125k, 5/17-4/20.

Carnegie Trust U.K., Research Incentive Grant for proposal "Measuring flow and viscosity at extreme pressure and temperature." £7.5k, 06/2015 - 05/2016.

British Council, Researcher Links Travel Grant for proposal, "Geophysical fluid transport at high pressure and temperature: from computer simulations to experiments to natural systems." £12.9k, 3/14–3/15. With co-P.I. N. Gomez, Universidad de los Andes, Colombia.

Co-Investigator

DOE National Ignition Facility Time Award, for proposal "Dense Hydrogen: New Quantum States of Matter on NIF." PI: R. Jeanloz. Beamtime award, 12/17, 3 days/~$1m per day.

EPSRC 'Underpinning multi-user equipment' grant "Cryo-FIB-SEM-CT: a 'three-in-one' imaging facility for opaque soft matter". P.I. L. Yellowlees, University of Edinburgh. £1.3M, 3/17-3/18.

ERC Advanced Grant "HECATE: Hydrogen at Extreme Conditions: Applying Theory to Experiment". P.I. G.J. Ackland, University of Edinburgh. €2.5m, 8/16-8/21.

DOE National Ignition Facility Time Award, for proposal "Structural studies of electride phases in Mg." P.I.: M.I. McMahon, University of Edinburgh. Beamtime award, 11/15, 3 days/~$1m per day.

NSF Major Research Instrumentation (MRI) Grant for proposal "Development of an Ultrafast Laser Instrument for Creating and Probing Matter under Extreme Pressures, Temperatures, and Strain Rates." PI: A.F. Goncharov, Carnegie Institution of Washington. $554k, 12/10-11/13.

DOE National Ignition Facility Time Award, for proposal "Optical Studies of Methane and Hydrogen at Ultra-High pressures using ramp compression at the National Ignition Facility." PI: R.J. Hemley, Carnegie Institution of Washington. Beamtime award, 5/10, 4 days/~$1m per day.

U.S. Army Research Office High School Apprenticeship Program. PI: M.F. Mahmood, Howard University. $20k, 4/10-9/11.

U.S. Army Research Office Basic Research Grant, for proposal "Probing of Fast Chemical Dynamics at High Pressures and Temperatures using Pulsed Laser Techniques." PIs: M.F. Mahmood, Howard University; A.F. Goncharov, Carnegie Institution of Washington. $367k, 09/09-08/12.

Institute for Laser Science and Applications (ILSA) grant for academic use of Lawrence Livermore National Laboratory High-Energy-Density Facilities. P.I. Raymond Jeanloz, UC Berkeley. $40k, 6/07-6/08.

TEACHING EXPERIENCE:

Physics of Fields and Matter & Physics of Matter (year 2, sem. 2) – Lecturer ('15,'16,'17,'18,'19,'20,'21,'22,'23)

Physics of Extreme Environments / Advanced Materials Physics (year 4/5, sem. 1) – Course Creator, Organiser, Lecturer (15,'16,'17,'20,'21,'22,'23,'24,'25)

Experimental Physics 2 (EP2) / Practical Physics (year 2, sem. 2) – Course Organiser ('25,'26), Laboratory leader ('16,'17,'18,'19,'20,'21,'25,'26)

Experimental Physics 3 (EP3) / Experimental Physics (year 3, sem. 1) – Laboratory leader ('16,'17,'18,'19,'20)

Physics 1A (year 1, sem. 1) - Workshop leader ('14,'15,'16,'17,'18,'19)

MPhys Project (year 5) – Supervisor ('15-'16,'18-'19,'19-'20x2, '20-'21,'21-'22, '22-'23,'23-'24x2,'25)

Senior Honours Project (year 4) – Supervisor ('15,'18,'19,'20,'21,'22,'24,'25x3,'26)

Geophysics Project (year 4) – Supervisor ('22-'23)

Group Project (year 4/5) – Supervisor ('17-'18,'18-'19,'19-'20,'20-'21,'22-'23,'23-'24,'24-'25,'25-'26), Marker ('16)

OTHER EXPERIENCE:

- AIRAPT Organizing Committee (2023 Meeting in Edinburgh); organisation of Satellite Meeting for Transport (TRIREME); organiser of remote conference, "Conference for Science at Extreme Conditions" (2021) in original AIRAPT time slot.
- GSCCM Technical Committee (APS Conference) ('23)
- Proposal Review Panel (PRP), LCLS MEC Instrument ('22)
- Facility Management Committee, Cryo-FIB-SEM facility (Focused Ion beam / Electron microscope) University of Edinburgh ('17-)
- Member, Technical Advisory Committee, HIBEF user consortium at European XFEL, Germany ('18)
- Panel Member, Research Unit proposals, Deutsche Forschungsgemeinschaft (DFG), Germany ('16)
- External Examiner, PhD viva, Department of Earth Sciences, University College London ('15)
- Internal Examiner, PhD viva, University of Edinburgh ('17)
- Organiser of Centre for Science at Extreme Conditions international seminar series ('15,'16,'17)

PROFESSIONAL ORGANIZATIONS:

Member, American Geophysical Union & American Physical Society

EARLY CAREER SUPERVISION:

Postdoctoral fellows **A. Patsoukis-Dimou** ('24-) **N. Jaisle** ('24-), **B. Massani** ('22-) (supervisor), **J. McHardy** ('24-), **M. Duff** ('20-'23), **E. Pace** ('18-'20), **R. Briggs** ('13-'17), **M. Gorman** ('17), **A. Coleman** ('18) (co-supervisor) (School of Physics and Astronomy, University of Edinburgh).

PhD students **Z. Younes** ('22-'26) **O. Ball** ('18-'23), **H. Bartlett** ('16-'20) (direct supervisor), **R. Cao** ('20-'24), **J. McHardy** ('19-'23), **A. Coleman** ('15-'18), **L. Kelsall** ('16-'20), (co-supervisor) (School of Physics and Astronomy, University of Edinburgh), **J. Rodriguez** ('11-'14) (Departamento de Fisica, Universidad de los Andes, Colombia)

Masters students **D. Hall** ('24-'25), **S. Meakin** ('23-'24), **T. Jenkins** ('23-'24), **L. McConnell** ('22-'23), **S. Millen** ('21-'22), **L. Berman** ('20-'21), **A. Spray** ('19-'20), **A. Hurley** ('19-'20), **A. Millar** ('18-'19), **H. Bartlett** ('15-'16), (direct supervisor MPhys @ School of Physics and Astronomy, University of Edinburgh, UK), **J. Meza** ('17) (visiting Edinburgh from UNAM México, 6 mo. project).

Senior Honours (4th year research project) students **G. Parry** ('15), **O. Sharpe** ('18), **A. Gunn** ('20), **S. Prokopovic** ('21), **T. Prokopova** ('22), **X. Wang** ('24), **J. Grey** ('25), **S. Desai** ('25), **Y. Wu** ('25), **H. Liang** ('26) (School of Physics and Astronomy, University of Edinburgh), **A. Holley** ('22-'23) (School of GeoSciences, University of Edinburgh)

Summer students **C. Grune** ('23), **S. Meakin** ('23), **A. Marshall** ('18), **H. Bartlett** ('15) (University of Edinburgh), **J. Chang** ('11), **Y. Kadry** ('10), **T. Hittinger** ('10) (Carnegie Institution of Washington).

PUBLICATIONS:

Liang, A., et al. High-pressure formation and characterization of a boron carbide polymorph featuring bent C--B--C chains. Physical Review B 113(10): 104108, 2026.

Ginestet, H., et al. Metrology for femtosecond pulsed x-ray heating in diamond anvil cell experiments at the European XFEL: Revisiting the iron phase diagram up to 150 GPa. Journal of Applied Physics 139(4), 2026.

Heighway, P. G., et al. X-ray thermal diffuse scattering as a texture-robust temperature diagnostic for dynamically compressed solids. Journal of Applied Physics 138(15), 2025).

Frost, M., et al. Synthesis of Gold Hydride at High Pressure and High Temperature. Angewandte Chemie International Edition 64(38): e202505811, 2025.

Descamps, A., et al. Calibration and characterization of the line-VISAR diagnostic at the HED-HIBEF instrument at the European XFEL. Review of Scientific Instruments 96(7), 2025.

Kraus, D., et al. The structure of liquid carbon elucidated by in situ X-ray diffraction. Nature 642(8067): 351–355, 2025.

Konopkova, Z., et al. Observation of body-centered cubic iron above 200 gigapascals. arXiv preprint arXiv:2505.15397, 2025.
Wark, J. S., et al. Femtosecond temperature measurements of laser-shocked copper deduced from the intensity of the x-ray thermal diffuse scattering. Journal of Applied Physics 137(15), 2025.
Ehrenreich-Petersen, E., et al. X-ray phase contrast imaging and diffraction in the laser-heated diamond anvil cell: A case study on the high-pressure melting of Pt. Results in Physics 69: 108132, 2025.
Husband, R. et al. Phase transition kinetics of superionic H2O ice phases revealed by Megahertz X-ray free-electron laser-heating experiments. Nature Communications 15(1): 8256, 2024.
Ball, O.B. et al. Measurement bias in self-heating x-ray free electron laser experiments from diffraction studies of phase transformation in titanium. Journal of Applied Physics 136(11), 2024.
Edmund, E. et al. The Thermal Conductivity of Bridgmanite at Lower Mantle Conditions Using a Multi-Technique Approach. Journal of Geophysical Research: Solid Earth 129(6): e2024JB028823.
Liang, A. High-Pressure Synthesis of Ultra-Incompressible, Hard and Superconducting Tungsten Nitrides, Advanced Functional Materials, 2313819, 2023.
Gorman, M. G. et al. Shock compression experiments using the DiPOLE 100-X laser on the high energy density instrument at the European x-ray free electron laser: Quantitative structural analysis of liquid Sn. Journal of Applied Physics 135(16), 2024.
Frost, M., et al., Diamond Precipitation Dynamics from Hydrocarbons at Icy Planet Interior Conditions, Nature Astronomy, 2024.
Koller, T.J. et al. Simple Molecules under High-Pressure and High-Temperature Conditions: Synthesis and Characterization of α- and β-C(NH)2 with Fully sp3-Hybridized Carbon. Angewandte Chemie Int. Ed., e202318214, 2024.
Jaisle, N. et al. MHz Free electron laser X-ray diffraction and Modelling of pulsed laser heated diamond anvil cell, Journal of Applied Physics 134, 095904, 2023.
Dresselhaus-Marais, L.E., et al., Simultaneous Dark-and Bright-Field X-ray Microscopy at X-ray Free Electron Lasers, Scientific Reports 13:17573, 2023.
Ball, O., et al., Dynamic optical spectroscopy and pyrometry of static targets under optical and x-ray laser heating at the European XFEL, Journal of Applied Physics 134(5), 2023.
Husband, R.J., et al., A MHz X-ray diffraction set-up for dynamic compression experiments in the diamond anvil cell, Journal of Synchrotron Radiation 30(4), 2023.
Duff, M.J., et al. Atomistic investigation of cavitation and ablation in tantalum foils under irradiation with x-rays approaching 5 keV. Physical Review B 106(2): 024107, 2022
Husband, R. J., et al. X-ray free electron laser heating of water and gold at high static pressure. Communications Materials 2(1): 61, 2021.
Hwang, H., et al. X-ray Free Electron Laser-Induced Synthesis of ε-Iron Nitride at High Pressures. The Journal of Physical Chemistry Letters 12(12): 3246-3252, 2021.
Liermann, H. P., et al. (2021). Novel experimental setup for megahertz X-ray diffraction in a diamond anvil cell at the High Energy Density (HED) instrument of the European X-ray Free-Electron Laser (EuXFEL). Journal of Synchrotron Radiation 28(3), 2021.
Ball, O.B., et al. Proceedings of the APS Topical Group on Shock Compression of Condensed Matter, Portland, Oregon, 2019, *AIP Conference Proceedings* 2272, 100001, 2020.
Meza-Galvez, J., et al. Thermomechanical response of thickly tamped targets and diamond anvil cells under pulsed hard x-ray irradiation. Journal of Applied Physics127, 195902, 2020.
Bartlett, H.B., et al. Viscosity measurement from microscale convection at high pressure and temperature. Physical Review B, 101, 144202, 2020.
Pace, E.J., et al. Intense Reactivity in Sulfur-Hydrogen Mixtures at High Pressure under X-ray Irradiation. The Journal of Physical Chemistry Letters, 11, 1828, 2020.
Jiang, S., et al. A Spectroscopic Study of the Insulator–Metal Transition in Liquid Hydrogen and Deuterium. Advanced Science 7, 1901668, 2019.
Coleman, et al. Identification of Phase Transitions and Metastability in Dynamically Compressed Antimony Using Ultrafast X-Ray Diffraction. Physical Review Letters 122(25): 255704, 2019.

Gorman, M.G., et al. Recovery of metastable dense Bi synthesized by shock compression. Applied Physics Letters 114(12), 120601, 2019.
Gorman, M.G., et al. (2018). Femtosecond diffraction studies of solid and liquid phase changes in shock-compressed bismuth. Scientific Reports 8(1), 16927, 2018
Celliers, P.M., et al. Insulator-metal transition in dense fluid deuterium. Science 361, 677–682, 2018.
Jiang, S., et al. Metallization and molecular dissociation of dense fluid nitrogen. Nature Communications 9(1): 2624, 2018.
Gomez Perez, N., et al. Finite element modeling of melting and fluid flow in the laser-heated diamond-anvil cell. Journal of Applied Physics, 121, 145904, 2017.
Briggs, R., et al. Ultra-fast X-ray Diffraction Studies of the Phase Transitions and Equation of State of Scandium Shock-Compressed to 82 GPa. Physical Review Letters, 118(2): 025501, 2017.
McMahon, M.I., McWilliams, R.S. Dynamic times for ESRF–EBS. ESRF News, 73:21, 2016.
McWilliams, R.S., et al. Physical Review Letters, 116(25): 255501, 2016.
Konôpková, Z., et al. Direct measurement of thermal conductivity in solid iron at planetary core conditions. Nature, 534: 99-101, 2016.
McWilliams, et al. Opacity and conductivity measurements in noble gases at conditions of planetary and stellar interiors. Proceedings of the National Academy of Sciences, 112(26):7925, 2015.
McWilliams, et al. A flash heating method for measuring thermal conductivity at high pressure and temperature: Application to Pt. Physics of the Earth and Planetary Interiors, 247: 17-26, 2015.
McWilliams, R.S. cover photo of The Analytical Scientist, Issue # 0514 "The full spectrum…past, present, and bright future of spectroscopy", 2014.
McWilliams, R.S., et al. Phase Transformations and Metallization of Magnesium Oxide at High Pressure and Temperature. Science 338(6112), 2012.
McWilliams, R.S., et al. Structural and chemical properties of the nitrogen-rich energetic material Triaminoguanidinium 1-methyl-5-nitriminotetrazolate (TAG-MNT) under pressure. Journal of Chemical Physics 137: 054501, 2012.
Ojwang, J.G.O., et al. Melting and Dissociation of Ammonia at High Pressure and High Temperature. Journal of Chemical Physics 137: 064507, 2012.
Spaulding, D.K., et al. Evidence for a phase transition in silicate melt at extreme temperature and pressure conditions. Physical Review Letters 108: 065701, 2012.
Goncharov, A.F., et al. Development of ultrafast spectroscopic techniques to study rapid chemical and physical changes in materials under extreme pressure and temperature conditions. Materials Research Society Symposium Proceedings 1405, 2012.
Celliers, P.M., et al. Insulator-to-Conducting Transition in Dense Fluid Helium. Physical Review Letters, 104(18): 184503, 2010.
McWilliams, R.S., et al. Strength effects in diamond under shock compression from 0.1 to 1 TPa. Physical Review B, 81(19): 014111, 2010.
Eggert, J.H., et al. Melting temperature of diamond at ultra-high pressure. Nature Physics, 6:40, 2009.
Eggert, J.H., et al. Shock Experiments on Pre-Compressed Fluid Helium. Atomic Processes in Plasmas - 16th International Conference on Atomic Processes in Plasmas, 2009.
Martel, P., et al. Nuclear targets for a precision measurement of the neutral pion radiative width. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 612(1): 46, 2009.
McWilliams, R.S., "Elastic and Inelastic Shock Compression of Diamond and Other Minerals", Doctoral Thesis, University of California, Berkeley, May 2008.
Hicks, D. G., et al. High-precision measurements of the diamond Hugoniot in and above the melt region. Physical Review B, 78(17): 174102, 2008.
Eggert, J.H., et al. Hugoniot data for helium in the ionization regime. Physical Review Letters, 100(12): 124503, 2008.
Jeanloz, R., et al. Achieving novel states through shock-wave loading of pre-compressed samples. Proceedings of the National Academy of Sciences, 102 (22): 9172, 2007.

Spaulding, D.K., et al. New optical diagnostics for equation of state experiments on the Janus laser. Proceedings of the APS Topical Group on Shock Compression of Condensed Matter, Waikoloa, Hawaii, 2007.

Celliers, P. M., et al. Using laser-driven shocks to study the phase diagrams of low-Z materials at Mbar pressures and eV temperatures. Atomic Processes in Plasmas - 15th International Conference on Atomic Processes in Plasmas, 2007.

Eggert, J.H., et al. Anisotropic Shock Propagation in Single Crystals. Joint 20th AIRAPT - 43th EHPRG, 2005.

INVITED TALKS:

"Long Timescale Processes Relevant to Twin Bunch Operation", DESY/EuXFEL User Meeting, Hamburg, Germany (Workshop on Two Bucket Mode), 2026.

"Thermal conductivity of matter under high pressures at EuXFEL: Outlook for HXS, from lessons learned at HED", HXS Workshop, Hamburg, Germany, 2025.

"Static High-Pressure Experiments at X-ray Free Electron Lasers", Nature Conference on Frontiers of High-Pressure Research, Shenzhen, China & ICMRE Conference, Xi'an, China, 2025.

"White dwarf photospheres on the benchtop", Workshop on Current Challenges in the Physics of White Dwarf Stars. Santa Fe NM USA, 2023.

"New Windows on Transport Properties of Deep Planetary Interiors." 11th Joint Workshop on High Pressure, Planetary, and Plasma Physics, Rostock, Germany, September 2023.

"Design of Static High Pressure Experiments at Free Electron Lasers", AIRAPT/EHPRG, Edinburgh, UK 2023.

"Pioneering a New Generation of Static High Pressure Experiments at Free Electron Lasers", Gordon Conference on High Pressure Research, New Hampshire USA, 2022 (originally 2020, reinvited)

Mercator Fellowship Talks, Germany, 2022. 1 month stay in Germany for talks and collaborative meetings, with associated funding.

"X-ray heating of pressurized samples @ HED", 14th International Conference on Synchrotron Radiation Instrumentation (SRI2021), Hamburg Germany, August 2021.

"Static High Pressure Experiments at European XFEL", European XFEL Meeting, Hamburg, 2020 (**Plenary Speaker**) + invitation to satellite session.

"Static High Pressure Experiments at Free Electron Lasers: Results and Prospects." IUCr High Pressure Meeting, Vienna, Austria, August 2019. (**Plenary Speaker**)

"Thermal Conductivity Measurements at Static High Pressure and Dynamic High Temperature." APS Shock Compression of Condensed Matter Conference, Portland OR, USA, June 2019.

"Static high pressure experiments using high intensity, high frequency pulsed x-rays: models and first experiments." Satellite session of European XFEL Meeting, Hamburg, Germany, January 2019.

"Optical measurements of transport properties in molecular, metal and oxide materials at deep planetary interior conditions." 6th Joint Workshop on High Pressure, Planetary, and Plasma Physics, University Gottingen, September 2017.

"Phase transformations and transport properties at high pressure and temperature from dynamic measurements under static compression." 55th European High Pressure Research Group (EHPRG) International Meeting on High Pressure Science and Technology, Poznan, Poland, September 2017.

"Optical measurements of the electronic and transport properties of molecular and metallic systems at deep planetary interior conditions", Core-Mantle Coevolution International Frontier Seminar, Ehime University, Japan, June 2017.

"Direct thermal conductivity measurements on metals at high pressure and temperature: From the usual to the unusual." American Geophysical Union Fall Meeting, San Francisco, USA, 12-16 December 2016.

"Dynamic high temperatures in the diamond cell: pump-probe measurements of optical and transport properties at extremes." 54th European High Pressure Research Group (EHPRG) International Meeting on High Pressure Science and Technology, Bayreuth, Germany, 4 – 9 September 2016.

"Warm dense matter in the diamond cell: Toward first light at European XFEL." European XFEL Meeting, Hamburg, January 2016.

"Warm dense matter on the desktop: Miniaturizing dynamic extremes experiments." 4th Joint Workshop on High Pressure, Planetary, and Plasma Physics, University Bayreuth, 23-25 September 2015.

"Phase Transformations and Metallization of Magnesium Oxide at High Pressure and Temperature." 7th International Workshop on Warm Dense Matter, Saint-Malo, France, June 2013.

"Ultra-High Pressure Phase Transformations in Planetary Mantle Materials using Laser-Driven Shock Compression." International Conference on High Energy Density Sciences, Yokohama, Japan, April 2013.

"Bridging the gap between static and dynamic compression: an inertial confinement approach to laser-heating experiments in the diamond-anvil cell." Gordon Conference on High Pressure Research, Biddeford, ME, USA, June 2012.