Artur L. Gower

Contact Information

Mechanical Engineering
The University of Sheffield
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Research Interests Wave propagation & scattering, soft solids, industrial mathematics, solid mechanics, optimisation, and random media.

Programming Julia, Mathematica, Python, Matlab, C, and TEX (LATEX, BIBTEX, TikZ).

Academic History

The University of Sheffield, UK

Lecturer in Dynamics, Mechanical Engineering **2019 – present**

University of Manchester, UK

Research associate, Applied Mathematics **2015 – 2018**

- *Ultrasonic propagation in complex media* - EPSRC (EP/M026205/1)
- Responsible for mathematical modelling and numerical implementation. Strong ties with experiments (EP/M026310/1) and simulations (EP/M026302/1)

University of Galway, Ireland

Ph.D. Applied Mathematics **2011 – 2015**

- Thesis title: *Incremental elastic surface waves and static wrinkles*
- Supervisor: Prof. Michel Destrade

University of Campinas, Brazil (QS 2nd best university in Latin America)

M.Sc. Applied Mathematics, Grade 96% **2009 – 2011**
Computational geophysics group

- Thesis: *Nonlinear Elasticity with Radial Symmetry*
- Emphasis in wave scattering and propagation in Geophysics.

B.Sc. Applied Mathematics, Grade 83% **2005 – 2008**

- Emphasis on Mechanics with a minor in Computer Science

Teaching experience

Qualifications

Fellow of the Higher Education Academy (FHEA) **2022**
Teaching and Learning Course - (module) University of Galway **2013**

University of Sheffield

Module leader (avg. faculty teaching score 81%)

- Dynamics I - teaching score 87% , cohort: 70. **2022 – 2023**
- Dynamics II - teaching score 82%, cohort: 125. **2020**

Teach part of module

- Matlab for Engineers, cohort: 150 - 215. **2020 - 2023**
  I develop this coding module around flipped learning (see this Youtube channel) with a series of interactive engineering problems to solve.

Roles

- Transition tutor **2021 – 2023**
  I organise a week of activities for our new cohort (200 students). I helped develop and delivered an activity to increase team working skills, inclusivity, and diversity confidence.
- Outreach officer **2020 – 2023**
  Deliver talks to schools, help improve recruitment in widening participation
- Physics pathway **2019 – 2020**
  This involves organising a few weeks of physics courses for students who did not do A-level physics. One of the goals is to increase diversity in our cohort.

University of Manchester

Supervision **2015 - 2018**

- Supervised 3 final year projects and helped supervise a Ph.D student, Erik Garcia Neefjes, working on thermo-visco-elastic waves.

Tutorials **2015 – 2018**

- Led problem solving classes on calculus, linear algebra, complex analysis for B.Sc. mathematics and B.Sc. engineering 1st to 2nd year students.

University of Galway

Tutorials and substitute lectures **2014 – 2015**

- Taught tutorials and lectures on Fluid Mechanics and Nonlinear Elasticity.

Tutorials **2011 – 2014**

- Led problem solving classes on vector calculus, mathematical modelling, linear algebra, mathematical methods, complex analysis

Drop-in centre **2012 – 2014**

- Taught at the centre for the Support for Undergraduate Mathematics.

University of Campinas

Lectures **2010**

- Lectured on Linear Algebra to B.Sc. engineering 1st year students.

Pas Facamp (Charity) **2009**

- Taught basic finance to the local community.

Funding

I have been instrumental in obtaining a total of £1,028,000 in funding.

Longitudinal Rail Stress Measurement using Ultrasound 2 **2022 - 2023**
Principal Investigators: Robert Dwyer-Joyce, Artur L. Gower, Roger Lewis
Funding Value: £148k
Funder: Federal Railroad Administration (USA)

(unsuccessful) EPSRC-SFI: Ultrasonic Measurement of Stress in Steel **2022 - 2025**
Principal Investigators: Artur L. Gower, Michel Destrade, Rob Dwyer-Joyce, Roger Lewis, Tim Rogers
Funder & Value: £450k - EPSRC & SFI

Sensing Dense Particulate Materials **2021 - 2024**
Principal Investigators: Artur L. Gower
Funding Value: £232k
Funder: EPSRC EP/V012436/1

FAST2 - Fast Analysis of Stress in rail Tracks **2021 - 2023**

Principal Investigators: Robert Dwyer-Joyce, Artur L. Gower, Roger Lewis

Funding Value: £174k - Horizon Shift2Rail & Network Rail Limited

(unsuccessful) Postdoctoral Fellowship (rank 7/35) **2018 - 2021**

Title: Predicting the properties of particulate materials from backscattered waves

Principal Investigators: Artur L. Gower

Funding Value: £256k EPSRC

Video odometry to report rough rides **2021 - 2022**

Principal Investigators: Reliable Data Systems International (www.rdsintl.com), Artur L. Gower

Value & Funder: £70k - Network Rail - Research challenge

Determination of particle attributes via novel active acoustics **2021 - 2025**

Principal Investigators: Artur L. Gower

Partner: Johnson Matthey

Value & Funder:£120k - EPSRC Industrial CASE (ICASE)

FAST - Fast Analysis of Stress in rail Tracks: an ultrasonic method **2020 - 2021**

Principal Investigators: Robert Dwyer-Joyce, Artur L. Gower, Roger Lewis

Value & Funder: £86k - European Commission - Horizon 2020 / H2020, In2Track2, Network Rail Limited

Longitudinal Rail Stress Measurement using Ultrasound **2019 - 2021**

Principal Investigators: Robert Dwyer-Joyce, Artur L. Gower, Roger Lewis

Value & Funder: £115k - Federal Railroad Administration (USA)

(unsuccessful) Postdoctoral Fellowship **2015 - 2018**

Title: Using elastic waves to measure soft tissues

Principal Investigator: Artur L. Gower

Value & Funder: £250k - EPSRC

Irish Research Council, PhD fellowship **2013 - 2015**

Title: Nonlinear modelling of soft matter

Principal Investigator: Artur L. Gower

Value & Funder: €46k - IRC

Hardiman Scholarship, PhD fellowship **2011 - 2013**

Title: Skin deep: the mechanics of skin

Principal Investigator: Artur L. Gower

Value & Funder: €42k - University of Galway

Brazilian Council of Science MSc fellowship (rank 1/45) **2009 - 2011**

Title: Nonlinear elastodynamics with radial symmetry

Principal Investigator: Artur L. Gower

Value & Funder: R$29k (≈ £5.5k) - CNPq

São Paulo Research Foundation Scholarships

Title: Acoustic diffraction with Kirchhoff modelling **2007 - 2008**

Principal Investigator: Artur L. Gower

Value & Funder: R$6k (≈ £1.1k) - FAPESP

Title: Introduction to discrete chaotic dynamics **2006 - 2007**

Principal Investigator: Artur L. Gower

Value & Funder: R$6k (≈ £1.1k) - FAPESP

Open source Software

[S5] TrainView.jl – a package to model and interpret how a camera on a train sees the tracks ahead. The camera is assumed to be fixed on the train, but the train can move relative to the tracks in any direction. GitHub, MIT License. Main author: A.L. Gower.

[S4] ElasticWaves.jl – a package to calculate propagation and scattering of elastic waves. , GitHub, MIT License. Main author: A.L. Gower.

[S3] MultipleScattering.jl – a library for simulating, processing, and plotting multiple scattering of waves. GitHub, MIT License. Main authors: A.L. Gower and J. Deakin.

[S2] EffectiveWaves.jl – a Julia library to calculate the effective wave reflection and transmission in material random materials. GitHub, MIT License. Main author: A.L. Gower

[S1] EntropyGO – a Mathematica package that uses entropy maximisation to calculate the influence on a GO board. GitHub, MIT License. Main author: A.L. Gower

Refereed Journal Papers

Total citations: 488, according to **Google Scholar**.

[21] Z. Zhang, G. Li, J. Yuxan, Y. Zheng, A.L. Gower, M. Destrade, Y. Cao, "Non-invasive measurement of local stress inside soft materials with programmed shear waves", *Science Advances*, (2023)

[20] S. Mukherjee, M. Destrade, A.L. Gower, "Representing the stress and strain energy of elastic solids with initial stress and transverse texture anisotropy", *Proceedings of the Royal Society A*, (2022)

[19] E.G. Neefjes, D. Nigro, A.L. Gower, R.C. Assier, V.J. Pinfield, W.J. Parnell, "A unified framework for linear thermo-visco-elastic wave propagation including the effects of stress-relaxation", *Proceedings of the Royal Society A*, (2022)

[18] G.Y. Li, A.L. Gower, M. Destrade, S.H. Yun, "Non-destructive mapping of stress, strain and stiffness of thin elastically deformed materials", *Communications Physics*, (2022)

[17] A.L. Gower, G. Kristensson, "Effective waves for random three-dimensional particulate materials", New Journal of Physics, (2021)

[16] G.Y. Li, A.L. Gower, M. Destrade, "An ultrasonic method to measure stress without calibration: The angled shear wave method", The Journal of the Acoustical Society of America, (2020)

[15] A.L. Gower, W.J. Parnell, I.D. Abrahams, "Multiple Waves Propagate in Random Particulate Materials", *SIAM Journal on Applied Mathematics*, (2019)

[14] A.L. Gower, I.D. Abrahams, W.J. Parnell, "A proof that multiple waves propagate in ensemble-averaged particulate materials", *Proceedings of the Royal Society A*, (2019)

[13] A.L. Gower, R.M. Gower, J. Deakin, W.J. Parnell, I.D. Abrahams, "Characterising particulate random media from near-surface backscattering: A machine learning approach to predict particle size and concentration", *Europhysics Letters*, (2018)

[12] A.L. Gower, M.J.A. Smith, W.J. Parnell, I.D. Abrahams, "Reflection from a multi-species material and its transmitted effective wavenumber", *Proceedings of the Royal Society A*, (2018)

[11] A. Agosti, A.L. Gower, P. Ciarletta, "The constitutive relations of initially stressed incompressible Mooney-Rivlin materials", *Mechanics Research Communications*, (2018)

[10] A.L. Gower, T. Shearer, P. Ciarletta, "A new restriction for initially stressed elastic solids", *Quarterly Journal of Mechanics and Applied Mathematics*, (2017)

[9] M. Carfagna, M. Destrade, A.L. Gower, A. Grillo, "Oblique wrinkles", *Philosophical Transactions of the Royal Society A*, Invited contribution to the themed issue on *Patterning through instabilities in complex media*, (2017)

[8] P. Ciarletta, M. Destrade, A.L. Gower, M. Taffetani, "Morphology of residually stressed tubular tissues: beyond the elastic multiplicative decomposition", *Journal*

of the Mechanics and Physics of Solids, 90 (2016)

[7] P. Ciarletta, M. Destrade, A.L. Gower, "On residual stresses and homeostasis: an elastic theory of functional adaptation in living matter", *Scientific Reports*, 6 (2016)

[6] R.M. Gower, A.L. Gower, "High order reverse automatic differentiation with emphasis on the third order", *Mathematical Programming SERIES A*, 155 (2016)

[5] A.L. Gower, P. Ciarletta, M. Destrade, "Initial stress symmetry and its application in elasticity", *Proceedings of the Royal Society A*, 471 (2015)

[4] A.L. Gower, "Connecting the material parameters of soft fibre-reinforced solids with the formation of surface wrinkles", *Journal of Engineering Mathematics*, Special Issue on Fibre-Reinforced Materials, 95 (2015)

[3] D.R. Nolan, A.L. Gower, M. Destrade, R.W. Ogden, J.P. McGarry, "A robust anisotropic hyperelastic formulation for the modelling of soft tissue", *Journal of the Mechanical Behavior of Biomedical Materials*, 39 (2014)

[2] A.L. Gower, M. Destrade, R.W. Ogden, "Counter-intuitive results in acousto-elasticity", *Wave Motion*, Special Issue in Honour of V.I. Alshits, 50 (2013)

[1] P. Ciarletta, M. Destrade, A.L. Gower, "Shear instability in skin tissue", *Quarterly Journal of Mechanics and Applied Mathematics*, 66 (2013)

Technical Reports

[6a] A.L. Gower, Chapter: "Generating feasible solutions: part 1", In: Automatic Optimised Design of Umbilicals (ESGI 100), *MIIS Eprints Archive*, 710 (2016)

[3a] A.L. Gower, Chapter: "Elimination of errors from track line detection", In: Train Positioning Using Video Odometry (ESGI 116), *MIIS Eprints Archive*, 672 (2014)

[1b] A.L. Gower, C. Brett, J. Herterich, K. Katterbauer, A. Melnik, J. Thompson, "Modelling of abrasive waterjet etching" (OCCAM 4th Modelling Camp), (2012)

[1a] A.L. Gower, "Detecting Geometric Faults from Measured Data" (ESGI 85), *MIIS Eprints Archive*, 659 (2012)

Academic Services

Reviewer: profile on Web of Science

Proceedings of the Royal Society A |*International Journal of Non-Linear Mechanics* |*Ultrasonics* |*IMA Journal of Applied Mathematics* |*SIAM Journal of Applied Mathematics* | *Journal of Elasticity* |*ZAMP* (Journal of Applied Mathematics and Physics) |*Wave Motion* |*Journal of the Acoustical Society of America* |*Acta Acustica United with Acustica*

Grant reviewer: EPSRC, Royal Society

Guest editor: WAVE motion - special issue on Ultrasonic Measurements (2022)

Outreach

- Online talks to schools. I developed and delivered interactive talks to schools across the UK. Reach: ∼1,000 people **2020-2023**
- New Scientist Live. Help run stand and provide equipment. Reach: >30,000 people, Location: ExCeL London. **11/2022**
- STEM for girls. Organise and run a stand (equipment & people). Reach: 300 people, Location: Octagon Centre, Sheffield. **03/2022**
- Bradford Science Festival. Organise and run a stand (equipment & people). Reach: 10,00 people, Location: Bradford Science Museum. **10/2021**
- 24hr Inspire for Life. A talk on "Sensing the world with sound". These science talks raise money for cancer charities. **03/2020**
- The New Scientist Live. A science festival that attracts over 30,000 visitors. I ran and organised several acoustics stands including acoustic levitation, built structures to survive an earthquake machine, an ultrahaptics device, and medical ul-

trasound device. **10/2019**

- Pint of Science - Sheffield. A talk about science to the general public. **05/2019**
- The New Scientist Live. A science festival that attracts over 30,000 visitors. I demonstrated acoustic levitation and other phenomena over a weekend. **09/2018**
- Science Showdown! *How can we measure the invisible: the mathematics of jiggly waves*. A talk promoting maths to a wider audience in Manchester. **03/2017**
- Science Experience Workshop: on open days we gave potential students a hands on science experience. I ran a stand on maths/physics puzzles. **2011 - 2014**
- Maths Enrichment: Teach two morning sessions preparing students for the Irish and international mathematics Olympiad. **2014**
- School Presentation for the School of Science: Two school visits to engage with students about studying science at university. **2011**

Academic Leadership

- Week long workshop - Isaac Newton Institute (*Organiser*) **2023**
  An international workshop bringing together physics, mathematicians, and engineers working on the Theory of wave scattering in complex and random media.
- A scattering hackathon - Isaac Newton Institute (*Organiser*) **2023**
  I prepared and ran a hackathon for 30 PhD students call the Beam Challenge (see this gist) at the Multiple Scattering Winter School.
- Early Career Group - UK Metamaterials Network (*Coordinator*) **2021–2022**
  Organised a grant writing workshop, and selected and funded early careers to join Metamaterials workshop CISM 2021.
- UK Graduate Modelling Camp (*Mentor*) **2021**
  I set an industrial mathematics problem for a group of students from across the UK Ireland and acted as their mentor for 4 days.
- Mini-symposium on Ultrasonic Waves in Solids (*Organisers*) **2021**
  This mini-symposium was part of the BAMC.
- Early Career Group - UK Acoustics Network (*Coordinator*) **2018–2020**
  Main accomplishments: two summer schools to train early career acousticians and a workshop on academic-industrial collaboration.
- Stokes Modelling Workshop (*Mentor*) **2020**
  I set an industrial mathematics problem for a group of students from across Ireland and acted as their mentor for 4 days.
- Constitutive Behaviour of Soft Tissues (*Co-organiser*) **09/2016**
  A workshop on the state-of-the-art in constitutive modelling of soft tissues.
- Joint Symposium: Irish Mechanics Society and Irish Society for Scientific Engineering & Computation (*Co-organiser*) **11/2014**
  An annual international mechanics conferences
- Irish Applied Maths Research Students' Meeting (*Co-organiser*) **10/2014**
  Organized by the SIAM student chapter, this was the first meeting of postgraduates working in applied mathematics across Ireland.
- Stokes Modelling Workshop (*Co-organiser*) **06/2014**
  A modelling workshop to solve problems brought by industry, in the same style as the European Study Groups with Industry.

Recent Talks

Below are recent invited talks from workshops/conferences/seminars.

- BAMC 2023, "Changing references in non-linear elasticity", Bristol **04/2023**
- Isaac Netwon Institute - Multiple Scattering, "Numerically validating effective waves in random media", Cambridge **03/2023**

- BAMC 2022, "Ultrasonic measurement of stress without material constants", Loughborough **04/2022**
- Wavinar talk, "Ensemble average waves in random materials of any geometry", ICMS **07/2021**
- Acoustical Society of America - session on Acoustics in Polydisperse material, "Ensemble average waves in random materials of any geometry", online **06/2021**
- Modelling showcase, "Ensemble averaging", Metamaterials Network **06/2021**
- Elasticity Day, "Ultrasonic Measurements Without Prior Knowledge", Isaac Newton Institute **04/2021**
- Bristol Eng. Mathematics Seminar, "Ultrasonic Measurements Without Prior Knowledge", Bristol **03/2021**
- Warwick Applied Mathematics Seminar, "Ultrasonic Measurements Without Prior Knowledge", Bristol **02/2021**
- Grant writing workhop, "How to pitch your grant", Acoustics Network **06/2020**
- Wavinar, "Average waves in random materials of different geometries" **06/2020**
- UCL Applied Maths Seminar, "Multiple waves propagate in complex media", London, UK **03/2020**
- Cardiff - Applied and Computational Mathematics Seminar, "Waves in Particulate Materials", Cardiff, UK **02/2020**
- International Congress on Industrial and Applied Mathematics (ICIAM2019), talk in symposium "Waves in multiple-scattering media", Valencia, Spain **06/2019**
- Strathclyde Applied Mathematics Seminar, "Waves in Particulate Materials: Beyond Low Frequencies", Glasgow, UK **05/2019**
- Wave Chaos Seminar, "Waves in complex random media", Wave Modelling Research Group, Nottingham, UK **10/2018**
- I. David Abrahams 30th workshop, "Waves in random particulate materials", Isaac Newton Institute for Mathematical Sciences (INI), Cambridge, UK **09/2018**
- Research seminar, "Using machine learning to characterise complex materials", Malvern Panalytical Ltd, Malvern, UK **08/2018**
- Bremen Workshop on Light Scattering 2018, "Characterising particulate random media from near-surface backscattering, Bremem, Germany **03/2018**
- Meeting of the Acoustical Society of America, 141 (5), 3810-3810, "Characterizing composites with acoustic backscattering: Combining data driven and analytical methods", Boston, USA **06/2017**
- New mathematics for a safer world: wave propagation in heterogeneous materials, "Characterising random composites with acoustic backscattering", International Centre for Mathematical Sciences (ICMS), Edinburgh, UK **06/2017**
- Constitutive behaviour of soft tissues, "Constitutive modelling of initially stressed elastic solids", Manchester, UK **09/2016**