# Curriculum Vitae

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## Employment

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| 2013 - Present | Heilbronn Research Fellow, University of Bristol |
| 2012 - 2013 | Teaching Fellow, University of Leicester |
| 2011 - 2012 | Lecturer in Pure Mathematics, Lincoln College, Oxford |
| 2011 | PhD+ Postdoctoral Research Fellow, University of Birmingham |

## Education

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| 2006 - 2010 | PhD at the University of Birmingham, supervised by Professor Sergey Shpectorov, funded by EPSRC |
| 2001 - 2005 | MMath at the University of Warwick<br>1st class (Hons), degree percentage 84% |
| 1994 - 2001 | Scholarship to Christ's Hospital, Horsham, Sussex<br>A Levels: 4As (Maths, Further Maths, Physics, Chemistry) |

## Research Interests

I am an algebraist with broad interests throughout algebra, geometry and combinatorics. A common theme in my work involves exploring the links between an automorphism group and the structure of the object it acts on, such as a geometry or algebra. Recently, my work has focused on axial algebras, which are a new class of non-associative algebra with a strong natural link to groups. The prototypical example is the Griess algebra, but they also generalise features of vertex operator algebras (VOAs) and most recently links have been found elsewhere in maths, for example with non-linear PDEs and the algebra of Ricci flows. My early research was in classical groups and finite geometry, linking topological and combinatorial properties of discrete geometries with algebraic properties of their automorphism groups using techniques such as the amalgam method. I am also interested in combinatorics, designs, coding theory, Clifford algebras, VOAs, buildings, fusion systems and cluster algebras. I have extensive experience programming in both MAGMA and GAP and some in Python.

## Publications and Preprints

16. From forbidden configurations to a classification of some axial algebras of Monster type, with Sergey Shpectorov, *arXiv*:2107.07415, 41 pages, Jul 2021.

15. Split spin factor algebras, with Sergey Shpectorov, *arXiv*:2104.11727, 17 pages, Apr 2021.

14. 3-generated axial algebras with a minimal Miyamoto group, *arXiv*:2004.11773, 11 pages, Apr 2020.

13. Enumerating 3-generated axial algebras of Monster type, with Sanhan Khasraw and Sergey Shpectorov, *J. Pure Appl. Algebra* **226** (2022), no. 2, 21 pages, DOI: 10.1016/j.jpaa.2021.106816.

12. Miyamoto groups of code algebras generated by small idempotents, with Alonso Castillo-Ramirez, *J. Pure Appl. Algebra*, **225** (2021), no. 6, 19 pages,
DOI: 10.1016/j.jpaa.2020.106619.

11. An expansion algorithm for constructing axial algebras, with Sergey Shpectorov, *J. Algebra* **550** (2020), 379–409.

10. On the structure of axial algebras, with Sanhan Khasraw and Sergey Shpectorov, *Trans. Amer. Math. Soc.* **373** (2020), 2135–2156.

9. Code algebras which are axial algebras and their $\mathbb{Z}_2$-gradings, with Alonso Castillo-Ramirez, *Isr. J. Math.* **233** (2019), 401–438.

8. Code algebras, axial algebras and VOAs, with Alonso Castillo-Ramirez and Felix Rehren, *J. Algebra* **518** (2019), 146–176.

7. Axial algebras, 30 pages, lecture notes and survey, May 2018, `https://people.maths.bris.ac.uk/~jm13603/docs/Axial_algebras.pdf`.

6. Vahlen groups over commutative rings, *Math. Z.* **284** (2016), no. 3, 901–917.

5. On Sidki's presentation for orthogonal groups, with Sergey Shpectorov, *J. Algebra* **434** (2015), 227–248.

4. An amalgam uniqueness result for recognising $q^6{:}SU_3(q)$, $G_2(q)$, or $3{\cdot}M_{10}$ using biaffine polar spaces, *J. Algebra* **400** (2014), 105–122.

3. New flag-transitive geometries for the groups $Sp_4(K)$ and $SU_5(K)$, with Harm Pralle and Sergey Shpectorov, *Geom. Dedicata* **173** (2014), no. 1, 65–82.

2. Biaffine polar spaces, *Adv. Geom.* **13** (2013), no. 3, 449–469.

1. On the simple connectedness of hyperplane complements in dual polar spaces, II, with Sergey Shpectorov, *Discrete Math.*, **310** (2010), no. 8, 1381–1388.

## In preparation

5. Quotients of the highwater algebra, with Clara Franchi and Mario Mainardis.

4. Varieties of axial algebras, with Simon Peacock.

3. Expansions of axial decomposition algebras, with Simon Peacock and Michiel Van Couwenberghe.

2. Axial decomposition algebras for the pariah groups $J_3$ and $Ly$, with Simon Peacock and Michiel Van Couwenberghe.

1. Computations with algebras of Jordan type, with Sergey Shpectorov.

## Theses

- *A family of biaffine geometries and their resulting amalgams*, PhD, University of Birmingham, 2010.

- *On the simple connectedness of hyperplane complements in dual polar spaces*, MPhil(Qual), University of Birmingham, 2008.

## Computer Code

- Partial axial algebras – a MAGMA package, with Sergey Shpectorov, `https://github.com/JustMaths/AxialAlgebras`.

- Decomposed $G$-modules – a MAGMA package, with Sergey Shpectorov and Dima Pasechnik, `https://github.com/JustMaths/DecomposedGModules`.

- Fusion Laws – a MAGMA package, with Simon Peacock and Michiel Van Couwenberghe, `https://github.com/JustMaths/FusionLaws`.

- Decomposition algebras – a MAGMA package, with Simon Peacock and Michiel Van Couwenberghe, `https://github.com/SimonMaths/DecompAlgs`.

- Fundamental groups of geometries, GAP code, `https://people.maths.bris.ac.uk/~jm13603/docs/fundamentalgroup.g`.

## Teaching Experience

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| Invited | *Introduction to Axial Algebras*, 5 lecture series, Invited Lecturer, CIMPA School: Non-associative Algebras and their Applications, Madagascar (online), Aug/Sep 2021. |
| | *Code algebras, axial algebras and VOAs*, 5 lecture series, Invited Lecturer, CIMPA-African Mathematical School on Algebras, Geometries and Permutation Groups, KwaZulu-Natal, (2 weeks) Dec 2019. |
| Bristol | *Axial algebras*, Postgraduate mini-course, designed and lectured. Full lecture notes produced and one assessment for PhD credit. May 2018. |
| | *Topics in Discrete Mathematics* (permutation groups), $3^{rd}/4^{th}$ year, jointly designed and lectured. I chose to do my part on permutation groups, covering primitive and imprimitive groups and multiply transitive actions. Full lectures notes produced and example sheets and exam set and marked. |
| Leicester | *Plane Geometry*, $1^{st}$ year, course adapted from a previous year. Lectured, lecture notes written. Assessed via group work assignments, group posters and a class test (exam). |
| | *Curves and Surfaces*, $3^{rd}/4^{th}$ year, extended previous lecture course adding new material, lecture notes updated and expanded from previous year. Assessed via computerised tests, group work on visualisation via models and videos, and an exam. |
| | *Reading module* (knot theory), $3^{rd}$ year, I chose to do this on knot theory, selecting a suitable book and other texts. I ran the course so that the students learned the material independently and lectured to their fellow students, giving them an opportunity to develop their presentation skills and confidence. Assessment by participation in the lecturing, group presentations and a class test (exam). |
| | *Mathematics Project*, $3^{rd}$ year, two students. Designed three mini-projects and then guided students choice of main project. Assessment by written thesis and presentations. |
| Oxford | College tutor for $1^{st}$ year *Real Analysis* and $2^{nd}$ year *Complex Analysis* and *Measure Theory*. |
| | Class tutor for $3^{rd}$ year *Group Theory and an Introduction to Character Theory*. |

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| Birmingham | Class tutor for various maths courses including group theory, ring theory, character theory, real and complex analysis, measure theory, metric spaces, linear algebra and programming. |
| | Also taught maths courses for scientists, engineers and economists and game theory for economists. |

## Selected Talks

- *The Structure of Axial Algebras*
  Majorana, Axial, Vertex Algebras and the Monster Seminar, Apr 2021.
  Algebra Seminar, Novosibirsk State University, Mar 2021.
  Algebra Seminar, Catholic University of the Sacred Heart, Milan, Jan 2021.
  Algebra Seminar, Guadalajara, Nov 2020.
  Algebra and Geometry Seminar, Bristol, Jan 2020.
  Algebra Seminar, Birmingham, Nov 2019.

- *Axial Algebras: Beyond the Monster*, Plenary Speaker, International Workshop on Non-associative Algebras, Porto, May 2019.

- *Constructing axial algebras*, Focused Workshop on Axial Algebras, Bristol, May 2018.

- *The Classification of Finite Simple Groups: A Very Short Introduction*, Research Seminar in Physics and Mathematics, Guadalajara, Mexico, Sep 2017.

- *Majorana algebras and axial algebras*, joint with Alonso Castillo-Ramirez, Seminar of the MSc in Mathematical Physics, Guadalajara, Mexico, Sep 2017.

- *Code algebras, axial algebras and VOAs*
  Invited speaker, Workshop on Non-associative Algebras and Applications, Lancaster, Jul 2018.
  Algebra Seminar, Birmingham, Mar 2018.
  Pure Mathematics Colloquium, Lancaster, Dec 2017.
  All Kinds of Mathematics Remind me of You (Peter Cameron's birthday conference), FCUL, Lisbon, Portugal, Jul 2017.
  Groups St Andrews, Birmingham, Jul 2017.

- *Presentations for orthogonal groups?*
  Mathematical Sciences Seminar, Birkbeck, Mar 2016.
  Algebra and Geometry Seminar, Newcastle, Feb 2016.
  Pure Mathematics Colloquium, Southampton, Nov 2015.
  Algebra Seminar, Nottingham, Nov 2015.
  Algebra Seminar, Universidade de Braslia, Brazil, Sep 2015.

- *Sidki's Conjecture; showing finiteness of presentations using amalgams*
  Algebra and Geometry Seminar, Bristol, Mar 2014.
  Groups St Andrews, St Andrews, Aug 2013.
  Pure Seminar, Leicester, Nov 2012.

- *Biaffine geometry, amalgams and group recognition*
  Algebra Seminar, Oxford, Nov 2011.

- *Triality, two geometries and one amalgam non-uniqueness result*
  Junior Algebra Seminar, Cambridge, Nov 2011.
  Algebra and Geometry Seminar, Bristol, Feb 2011.
  Algebra Colloquium, Technische Universität Clausthal, Germany, Nov 2010.

## Professional Activities

### Grants

- Heilbronn Focused Research Grant (£7500) for a 5-day *Focused Research Workshop on Algebras of Jordan type and groups*, Birmingham, Sep 2021.

- Heilbronn Collaboration Grant (£1000) in 2019 to support a 1-week research trip to visit Bernardo Rodrigues in South Africa.

- Heilbronn Focused Workshop Grant (£7500) for a 5-day *Focused Research Workshop on Axial Algebras*, Bristol, May 2018.

- LMS Scheme One Grant (£7000) to support the *Workshop on Non-associative Algebras and Applications*, Lancaster, Jul 2018.

- Heilbronn Conference Grant (£7000) to support the *Workshop on Non-associative Algebras and Applications*, Lancaster, Jul 2018.

- Mexican Academy of Sciences Newton Fund Mobility Grant (£2525) in 2017 for a 5-week research trip to visit Alonso Castillo-Ramirez in Mexico.

- Heilbronn Collaboration Grant (£1300) in 2015/16 for research visits of Said Sidki.

- Heilbronn Collaboration Grant (£1200) in 2015/16 for research visits of Alonso Castillo-Ramirez and Felix Rehren.

- LMS Scheme Four Grant (£1200) in 2015 for a 3-week research trip to visit Said Sidki in Brazil.

### Conference and Seminar Organisation

- Co-organiser of a 5-day *Focused Research Workshop on Algebras of Jordan type and groups*, Birmingham, Sep 2021.

- Organiser of Bristol Algebra Reading Group, 2018–19.

- Co-organiser of a 5-day *Focused Research Workshop on Axial Algebras*, Bristol, May 2018.

- Member of the Scientific Committee for the *Workshop on Non-associative Algebras and Applications*, Lancaster, Jul 2018.

- Co-organiser of Bristol Algebra & Geometry Seminars, 2014–16.

- Co-organiser of a one day conference, *Bristol Algebra Day*, Apr 2014.

- Co-organiser of Birmingham Postgraduate Pure Mathematics Seminars, 2007–08.

### General Activities

- External thesis examiner:

  - PhD, University of Ghent, Belgium.
  - PhD, University of KwaZulu-Natal, South Africa.
  - MRes, University of Birmingham, UK.

- Member of the London Mathematical Society since Feb 2015.

- Interviewed candidates for undergraduate admissions at Lincoln College, Oxford.

- Jointly responsible for the pastoral care and academic progress of the mathematics students at Lincoln College, Oxford.

- Wrote reference letters for undergraduate project students.

- Organised reading groups on several topics, including VOAs (via zoom), representation theory of $S_n$, buildings, Kac-Moody groups, profinite groups, $p$-groups and fusion systems.

- Refereed for Transactions of the AMS, Journal of Algebra, European Journal of Combinatorics, Algebra Colloquium and the Arabian Journal of Mathematics.

- Refereed a grant proposal for the National Research Foundation, South Africa.

- Outreach activities in both primary and secondary schools. Gave undergraduate maths research seminars. Participated in a maths and music event for the general public.

## Selected Conferences and Visits

2021    Organiser, *Focused Research Workshop on Algebras of Jordan type and groups*, Birmingham.
Invited Lecturer, *CIMPA School: Non-associative Algebras and their Applications*, Madagascar (2 weeks, online).

2020    Research trip visiting Simon Peacock, Manchester (3 days).
Research trips visiting Dima Pasechnik and Sergey Shpectorov, Oxford (3 days) and Birmingham (3 days), CoDiMa grant.

2019    Invited Lecturer, *CIMPA-African Mathematical School on Algebras, Geometries and Permutation Groups*, KwaZulu-Natal (2 weeks).
*Groups and Representation Theory*, a Conference in Memory of Kay Magaard, Warwick.
Plenary Speaker, *International Workshop on Non-associative Algebras*, Porto.
Research trip to visit Tom De Medts and Michiel Van Couwenberghe, Ghent (2 weeks).

2018    *Groups, Geometry and Representations*, Oxford.
*Simple Groups: New Perspectives and Applications*, Bristol.
Organiser, *Focused Research Workshop on Axial Algebras*, Bristol.
Invited Lecturer, *Workshop on Non-associative Algebras and Applications*, Lancaster.

2017    Research trip visiting Alonso Castillo-Ramirez, Mexico (5 weeks), Mexican Academy of Sciences grant.
*Groups St Andrews*, Birmingham.
*All Kinds of Mathematics Remind me of You* (Peter Cameron's birthday conference), FCUL, Lisbon, Portugal.

2016    *British Mathematical Colloquium*, Bristol.
Visit of Alonso Castillo-Ramirez (1 week), Heilbronn Collaboration Grant.
Visit of Said Sidki (2 weeks), Heilbronn Collaboration Grant.

2015    Research trip visiting Said Sidki, Brazil (3 weeks), LMS Scheme Four Grant.
*Conference on Finite Simple Groups and Related Topics* – in honour of Richard Lyons, Warwick.

*Simple groups, representations, and related topics* – in honour of Martin Liebeck and Jan Saxl, Cambridge.

2014    *Birthday Colloquium for Gernot Stroth*, Halle, Germany.

2013    *Summer School on Finite Groups and Related Geometrical Structures*, Venice.
*Groups St Andrews*, St Andrews.
*Peter Cameron: Combinatorics, Algebra, and More*, Queen Mary, University of London.

2010    Research trip visiting Harm Pralle, Technische Universität Clausthal, Germany.