

# Josh Walton

FINAL YEAR PHD STUDENT

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## Personal Statement

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A final year PhD student, with 4 years of programming experience using Magma, researching maximal subgroups and representation theory of finite groups of Lie type through the means of the computational algebra. I aspire to further my career with a post-doctoral research role involving the development and implementation of computational algebra to solve open problems in algebra, group theory and representation theory. I am an articulate and clear communicator of mathematics with a strong university level teaching portfolio.

## Education

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### The University of Manchester, Pure Mathematics PhD 2021-Present

- Thesis Title: Potential Maximal Subgroups of  $E_8(3)$ ,  $E_8(2)$  and The Maximal Tori of Finite Exceptional Groups of Lie Type.
- Supervisor: Professor Peter Rowley
- Brief Synopsis: Maximal subgroups have been of great interest for decades. In this thesis, I work with the finite Lie group  $E_8(3)$  and attempt to identify possible maximal subgroups. In particular, I look at groups of the form  $L_2(3^n)$ ,  $n=3,4,5,6,7$ , and others such as  $L_2(11)$ ,  $Sz(8)$ ,  $L_3(5)$ ,  $L_2(32)$  (and more). Other work and supporting code is also included, such as identifying whether  $L_2(8)$  can be maximal in  $E_8(2)$  and a comprehensive paper on maximal tori.
- Specialize in computational algebra using the software package Magma.

### The University of Manchester, MMath (Integrated Masters) 2017-2021

- Course Title: Mathematics
- Awarded first class honors (87%) including 91% in extended master's dissertation.

### Runshaw College, A-levels 2015-2017

- Mathematics (A\*), Further Mathematics (A), Physics (A), European Modern History (A)

## Research Interests

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- Drive research in computational pure mathematics, in particular algebra and group theory, through the development of Magma by designing and implementing new algorithms and modifying existing code to improve efficiency, functionality and ease of use. As part of this development, expand the current database stored in Magma by incorporating known data not yet stored and integrating new data sets as current knowledge expands.
- Matrix representations of finite exceptional groups of Lie type (especially those of high dimension) and their maximal subgroups and root systems. The complex structure and size of such groups make this computationally challenging yet rewarding.
- Formalising new developments in Magma and surrounding theory in computational algebra into talks and research papers to present the research in a clear way, thus making Magma feel more accessible and easier to use.
- Learning new techniques and theory for solving problems using computational algebra and Magma. I am very open to expanding my current knowledge and learning about new areas of computational algebra and how such computations and algorithms are or could be implemented into Magma.

## Research Skills

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- 4 years programming experience with the computational algebra package Magma, ran on Linux machines, including (but not limited to) working with large matrix representations of groups and subsequent subgroups, group modules of high dimension, maximal tori, root systems and subsystems, groups of Lie type and parabolic subgroups, irreducible modules over finite fields and their projective covers.
- Designing and modifying mathematical algorithms in algebra, group theory, representation theory and Lie group theory and then implementing them to run efficiently in Magma. This includes writing, modifying and testing code for constructing centralisers, normalisers, parabolic subgroups and their subsequent Levi-complements, maximal tori, maximal and non-maximal proper subgroups and group modules.
- Good knowledge of present Magma functions and identifying the appropriate function to use in a particular situation. This includes investigating how the original Magma functions were written in the source code.
- Experienced at handling vast amounts of data produced from code output whilst working with a limited storage capacity. This includes how to store data efficiently and organise it to ensure easy use and access in the future.
- Experience using other languages and applications such as Python, C++ and MATLAB.
- Experience working in a lively research environment and collaborating with other mathematicians on larger projects; this is exhibited in the joint work conducted in my thesis, my publication with Professor Peter Rowley and Joe Parkin and my extended research project for my master's dissertation.
- Clear and strong communicator of mathematics with 7+ years experience using LaTeX.

## Conferences & Workshops

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- Two workshops funded by the Heilbronn Institute for Mathematical Research, both in 2022, working with a small group of fellow mathematicians identifying potential maximal subgroups of  $E_8(3)$ .
- Postgraduate Group Theory Conference Edinburgh 2023.
- Postgraduate Group Theory Conference Birmingham 2024.
- Nikolaus Conference Aachen 2024 (upcoming).

## Publications

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- Javed, M., Parkin, J., Rowley, P., & Walton, J. (2024). The maximal Tori of finite exceptional groups of Lie type. *Communications in Algebra*, 52(11), 4806–4833. <https://doi.org/10.1080/00927872.2024.2358418>
- Parkin, J., Rowley, P., & Walton, J. The maximal subgroups of  $E_8(3)$  - Part 1. Unpublished manuscript.

## Funding and Awards

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- Fully funded PhD by EPSRC.
- Awarded the School of Mathematics Entrance Scholarship by the University of Manchester in 2017.
- Awarded 3rd place in 2019 in a Python coding competition sponsored by the N Brown Group. This competition was based on coding an AI opponent that the player could play against in the game 'Othello'.

## University Teaching Experience

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- Leading a class on fundamental skills in pure mathematics such as set theory, elementary logic and proof by induction to 30 first year students.
- Linear algebra tutorial leader to a group of approximately 20 first year students, including weekly marking on submitted homework and marking exams at the end of the semester.

- Teaching assistant for fourth year course Galois theory, working alongside Professor Peter Rowley to help a group of 15 master's students with weekly problem sheets. Student feedback described the classes as 'informative and engaging'.
- Lab assistant for large 50+ student class on solving mathematical problems using Python.
- Led two first year engineering groups with approximately 25 students each on fundamental applied mathematics, including weekly marking for both groups and exam marking at the end of the semester.
- Tutorial leader to small group of first year mathematicians teaching the foundations of pure mathematics, including weekly marking.
- Teaching assistant to large class on project-based course on mathematical problem solving, including monthly marking on submitted group projects.
- Taught medium sized group of approximately 20 first year students the principles of real analysis, including weekly marking.
- Volunteered to mentor graduate students by listening to short talks and offering feedback.
- Exam assessment marker for many courses, including introductory work on ordinary differential equations, probability and the fundamentals of pure mathematics.

## **Outreach Work / Other Teaching Experience**

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- Workshop leader to class of approximately 15 young adults teaching the mathematics of card shuffling in 2022, 2023 and 2024. This was part of an outreach event called Mathematical Modelling Day hosted by the University of Manchester and Professor Louise Walker.
- Co-leading a workshop alongside a fellow PhD student to talented young adults at the 'Problem Solving Matters' event held at the University of Manchester in 2022.
- Teaching assistant for the enrichment event 'Maths in the Real World' hosted at the University of Manchester in 2022.
- Privately tutored a GCSE student on all areas of GCSE mathematics in 2022.

## **References**

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- Professor Peter Rowley, The University of Manchester, [peter.j.rowley@manchester.ac.uk](mailto:peter.j.rowley@manchester.ac.uk)
- Dr Richard Webb, The University of Manchester, [richard.webb@manchester.ac.uk](mailto:richard.webb@manchester.ac.uk)
- Dr Marianne Johnson, The University of Manchester, [Marianne.Johnson@manchester.ac.uk](mailto:Marianne.Johnson@manchester.ac.uk)
- Professor Louise Walker, The University of Manchester, [louise.walker@manchester.ac.uk](mailto:louise.walker@manchester.ac.uk) (teaching reference)