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Paul Druce's CV

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Updated January 2020

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Education

PhD in Mathematical Sciences, University of Nottingham, UK: 2015 - Passed Viva 13/11/2019

Title: Spectral Geometry of Fuzzy Spaces

Supervisor: Prof. John Barrett

For my PhD I worked on an area of mathematics called non-commutative geometry and how it might be useful in the theory of quantum gravity. My research was to investigate the use of called fuzzy spaces as candidates for quantum spacetimes. I investigated the dimension and volume of these spaces by analysing the spectrum of the Dirac operator. I also investigated the role of Lie group symmetries in restricting the possible fuzzy spaces possible.

First Class Masters in Mathematics and Physics, University of Warwick, UK: 2011-2015

Masters Dissertation: Multiferroicity Emerging from Frustrated Spin Interactions

Supervisors: Prof J Staunton and Dr J Lloyd-Hughes

During my time at Warwick, I studied a wide range of mathematics and physics topics. My interests were in both the abstract mathematics and the physics of matter and its constituents. Here is a list of topics I studied during my time at Warwick: Real Analysis, Differential Equations, Groups and Rings, Complex Analysis, Classical Mechanics, Statistical Physics, General Relativity, Solid State Physics, Fluid Dynamics and many more. I managed to maintain an average grade of 81% throughout my course achieving one of the best marks in the year.

2009-2011: King Edward Vi Sixth Form - A Levels: Maths: A*, Physics: A, Chemistry: A. I also completed the AQA baccalaureate during my A levels.

2004-2009: Birley Community College. GCSEs: 9 A's, 2 B's and one C.

Teaching Experience

Undergraduate Masters seminar: During my PhD I organised and delivered a two-semester long seminar on the topics surrounding my research to masters students at the University of Nottingham. The seminar was not for credit but was popular and regularly attended by around 10 students. The seminar course resulted in two students choosing noncommutative geometry as the subject of their masters dissertation and one choosing to undertake a PhD with my supervisor. The course resulted in the beginnings of a set of lecture notes being developed.

PhD Demonstrating and Marking: Alongside my PhD, I am employed to help students with their questions for various undergraduate mathematics modules for Engineering students, Physics students and Mathematics students. This includes courses such as Introduction to Mathematical Physics (2nd year), Differential Equations and Fourier Analysis (2nd year), Applied Mathematics (1st year) and more. I also mark the mid-term exams and coursework for various modules.

GCSE and A Level Tutoring: I am an experienced tutor in mathematics, further mathematics and physics at both GCSE and A-level standards for various exam boards. I have experience in both face-to-face tutoring and online tutoring via a shared whiteboard such as BitPaper. I also possess an Enhanced DBS check and I am trusted by schools to give one-to-one tutorials to their students via the company MyTutor.

Undergraduate Revision Classes (2012-2015): As part of Warwick Physics Society, I organised and ran revision lectures on various topics including first year Classical Mechanics, Waves, Electricity and Magnetism courses. As well as 2nd-year Quantum Mechanics, Electromagnetic Theory and Optics and Physics of Fluids courses. For the 2nd year Physics course in C programming, the Warwick Physics Society provided workshops to help, generally, first time programmers, get to grips with the language and the general programming mentality. I

also updated and maintained the revision guides the society had and created a revision guide for the second year physics module Thermal Physics II.

Academic Activities

Research Interests

My research interests span a wide area within Mathematical Physics. I am deeply interested in the mathematical description of the universe with emphasis on the precise nature of spacetime. With my recent work investigating the use of noncommutative geometry to model spacetimes with a high energy cutoff. I am also interested in the use of topology and algebraic methods in condensed matter studies.

Outreach

I am an enthusiastic advocate for mathematics and science. I was on the organisational committee for the international festival Pint of Science 2019. I helped organise the Nottingham branch where academics from the University of Nottingham go to the pubs of Nottingham to explain their current research to the public in an understandable manner. I am always looking for ways to bring mathematics and science out of the universities and into public view.

Past Research Projects

PhD Research Project - Spectral Geometry of Fuzzy Sapce 2015-2019

My PhD research was concerned with the use of finite noncommutative geometries as candidates for quantum spacetimes. These so-called <u>fuzzy spaces</u> possess an energy cutoff whilst retaining Lie group symmetries. My PhD research was to investigate the dimension and volume of these spaces by analysing the spectrum of the Dirac operator. I also investigated the role of Lie group symmetries in restricting the possible fuzzy spaces possible.

Masters Research Project - Multiferroicity Emerging from Frustrated Spin Interactions 2014-2015

During the Masters' year of my undergraduate degree, I undertook a research project, supervised by Prof. J. Staunton and Dr. J Lloyd-Hughes, in which we investigated the various spin structures of materials with a multiferroic phase. We aimed to identify what was special about these materials spin structures that caused them to possess a multiferroic phase. This project was conducted with the aim of aiding the design of high temperature multiferroic devices. We specifically studied Cupric Oxide (CuO) which has a multiferroic phase between 213K and 230K using a mean field model. This project resulted in a function model which predicted a multiferroic phase at a temperature which is in reasonable agreement with the experimental values.

Undergraduate Summer Research - Knotted Nematics August 2014-September 2014

This was funded under the Undergraduate Research Scholarship Scheme and was supervised under G P Alexander at The University of Warwick. The main aim of this research was to develop a construction for describing knotted liquid crystals, specifically knotted nematics. We improved upon existing ideas that used Milnor's Fibration Theorem and a way to construct an appropriate complex polynomial from a given knot.

Publications

<u>Spectral estimators for finite non-commutative geometries</u>. Barrett,J., Druce,P., Glaser, L.: J Phys Math Theor. 52, 275203 (2019). doi:10.1088/1751-8121/ab22f8

Talks

<u>Noncommutative Geometry and Gravity Models</u> Talk given at Collabor8.2 meeting at Lancaster University, UK, May 2018.

<u>Fuzzy Geometries and Spectral Zeta Functions.</u> Invited by Lisa Glaser at Radboud University, Netherlands, April 2017.

<u>Algebraic Knots and Liquid Crystals</u>. At the Warwick Imperial Autumn Meeting, 2014 (University of Warwick, UK, November 2014).

Poster presented at Quantum Gravity on the Computer conference March 2018.

Conferences Attended

- Gauge Theories and Noncommutative Geometry - Nijmegen, April 2016, http://www.noncommutativegeometry.nl/ncg2016/
- Quantum Structure of Spacetime - Belgrade, August 2016, http://qssg16.ipb.ac.rs/
- Quantum Spacetime - Porto, January 2017, https://www.fc.up.pt/quantumspacetime17/
- Talking Maths in Public - Bath, September 2017, http://talkingmathsinpublic.uk/
- Quantum Spacetime and Physics Models - Corfu, September 2017, http://www.physics.ntua.gr/corfu2017/qg.html
- Quantum Structure of Spacetime - Sofia, February 2018, http://theo2.inrne.bas.bg/~dobrev/QST-18.htm
- Quantum Gravity on the Computer - Stockholm, March 2018, https://agenda.albanova.se/conferenceDisplay.py?confId=6242
- Collabor8.2 - Lancaster, May 2018, http://www.collabor8research.com/
- Physical Applications of Fuzzy Spaces - Brussels, January 2019

Previous Employment

GCSE and A Level Tutor (August 2017-September 2019)

I am a self employed academic tutor for mathematics and physics for all levels of schooling. I prepare lessons and question sheets at appropriate levels for my tutees. My role is to build the confidence and the abilities of my students and provide them with a comfortable environment to ask any questions they may have. I have an Enhanced DBS check and I am trusted by schools to give one-to-one tutorials to their students via the company MyTutor.

Postgraduate Demonstrator at the University of Nottingham (September 2015 - July 2019)

Throughout my PhD I was an assistant in many of the courses ran by the School of Mathematical Sciences. I was entrusted to run small group tutorials (typically around 10 people) for courses in mathematical physics as well as aiding in the running of problems classes for many of the courses. I also helped mark coursework for the courses as well as marking the end of year exams of some of the courses.

University of Warwick Open Day Assistant (September 2012 - July 2015)

Throughout my undergraduate degree I was part of the open day team for the Physics department at Warwick university. My role included taking the prospective students on tours of the campus, informing them of important and interesting aspects of the university. I was also given the responsibility to present experiments to prospective students, engaging them with thought provoking questions. I was also part of the team to inform the prospective students about the courses available by the Physics department and answer any questions they may have about life at university.

Full time Administrative Worker at Split The Bills Ltd. (Aug-September 2012)

Split The Bills is a student bill management service, who aim to take the hassle out of setting up new bill accounts every year when students move from house to house. My roles was to communicate with the student registering for the service and then contact utility providers to setup the new accounts. Handling any issues that would arise in a timely and professional manner.

Part time warehouse operative at River Island (2010-2011)

I was part of the team that unpackaged new deliveries of clothes and prepare clothing to be presented on the store floor. This required adaptability as each delivery changed in size. As well as good team work and communication as the unpacking procedure was split in to various stages, with a separate person per stage. As well as working in an efficient manner. I was also responsible for searching and retrieving clothing requested by the store front.

Voluntary Sale Assistant at British Heart Foundation (2010-2011)

My role at the British Heart Foundation included assisting customers in finding items, informing them about the charity and maintaining the store. As the British Heart Foundation has a wide range of customers and staff, I had to quickly learn to adapt my communication and sales approach to fit their needs and situation.

Qualifications and Skills

I am fluent in the programming languages Python and C, and very familiar with the software Mathematica. I know how to use Linux, macOS and Windows systems to a high level. I am currently learning basic web development including HTML/CSS and I use Markdown and LaTeX extensively for my note taking. My hobbies

include rock climbing and photography/videography usually combining the two. I therefore know how to use photo and video editing software.

I have a valid First Aid Certificate (2017-2020) and an Enhanced DBS check (2017-2020). I also have a clean full drivers licence and motorcycle licence. "