# BARINDER SINGH BANWAIT

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## RESEARCH INTERESTS

Algebraic Number Theory | Arithmetic Geometry | Abelian Varieties | Modular Forms

## ACADEMIC APPOINTMENTS

### Postdoctoral researcher in Mathematics

**Boston University**

Sep 2022 – present — Boston, USA

Mentor: Prof. Jennifer Balakrishnan

### Postdoctoral researcher in Mathematics

**Ruprecht-Karls-Universität Heidelberg**

Oct 2021 – Apr 2022 — Heidelberg, Germany

Mentor: Prof. Dr. Gebhard Böckle

### Postdoctoral researcher in Mathematics

**Harish-Chandra Research Institute**

Feb – Sep 2021 — Prayagraj, India

### Visiting Scientist

**Max-Planck-Institut für Mathematik**

Oct 2016 – Nov 2016 — Bonn, Germany

Host: Prof. Alex Bartel

### Postdoctoral researcher in Mathematics

**Universität Duisburg-Essen**

Jan 2015 – Jan 2017 — Essen, Germany

Mentor: Prof. Dr. Ulrich Görtz

### Postdoctoral researcher in Mathematics

**Institut national de recherche en informatique et en automatique (INRIA)**

Jan – Dec 2014 — Bordeaux, France

Mentor: Dr. Andreas Enge

## PAPERS AND PREPRINT

- **Towards strong uniformity for isogenies of prime degree**, with M. Derickx. Preprint 2023, *arXiv:2302.08350*.
- **Computing nonsurjective primes associated to Galois representations of genus $2$ curves**, with A. Brumer, H. J. Kim, Z. Klagsbrun, J. Mayle, P. Srinivasan and I. Vogt. *arXiv:2301.02222*. To appear, *LMFDB, Computation, and Number Theory (LuCANT) 2023*.
- **Modularity over $\mathbb{C}$ implies modularity over $\mathbb{Q}$**. *arXiv:2212.14412*. To appear, *Modularity and the Generalised Fermat Equation*, 2022.
- **Explicit isogenies of prime degree over number fields**, with M. Derickx. *arXiv:2203.06009*. 2022, submitted.
- **Cyclic isogenies of elliptic curves over fixed quadratic fields**, with O. Adascalitei and F. Najman. *arXiv:2206.08891*. 2022, submitted.
- **Explicit isogenies of prime degree over quadratic fields**. *International Mathematics Research Notices*. (2022)
- **Examples of abelian surfaces failing the local-global principle for isogenies**. *Research in Number Theory*. 7(55) (2021)

- **Del Pezzo surfaces over finite fields and their Frobenius traces**, with F. Fité and D. Loughran. *Mathematical Proceedings of the Cambridge Philosophical Society.* 167(1) (2019) 35-60.
- **Tetrahedral Elliptic Curves and the local-global principle for isogenies**, with J. Cremona. *Algebra and Number Theory.* 8:5 (2014) 1201-1229.

# INDUSTRY EXPERIENCE

### Quantitative Analyst

**Quantile**

Sep 2019 – Mar 2020 | London, UK

- Linear, mixed-integer, and multi-objective optimisation for compression of interest-rate derivative portfolios using Gurobi.
- Visualisation of FX trading datasets across several client investment banks.
- Modelling of reset risk and PV01 for swaptions.
- Git code management with Bitbucket.

### Research Engineer

**CMR Surgical**

Jan 2018 – Sep 2019 | Cambridge, UK

- Research and optimisation of robotic control algorithms, including inverse kinematics and mass-spring-damper models.
- Mathematical modelling in Matlab, with Robotics and Control Systems toolboxes.
- Writing production-level, safety-critical embedded C code, compliant with MISRA C and International Standard IEC 62304.
- Time-series telemetry processing in Python, using pandas, numpy, and matplotlib.
- Analysis and visualisation of system log messages with Elasticsearch and kibana.
- Development with Amazon Web Services, including Lambda, S3, and Athena.
- Implementing machine learning algorithms for robot arm condition monitoring, using scikit-learn and Tensorflow.
- Unit and Regression tests in C, C++, and Matlab, including Google Test framework, continuously integrated with TeamCity.
- Agile software development with SVN and Git.

# EDUCATION

### PhD Mathematics

**University of Warwick**

Jan 2010 – Sep 2013 | Coventry, UK

Supervisor: Prof. John Cremona
Thesis: On some local to global phenomena for abelian varieties

### BA and MMath Mathematics

**University of Cambridge - Christ's College**

Oct 2005 – June 2009 | Cambridge, UK

MMath (*Part III of the Mathematical Tripos*) - Distinction
Part III Essay: Class Field Theory (Cohomological Approach), supervised by Dr. Tim Dokchitser

# INVITED TALKS

*(recent)*

- Modular curves and Galois representations, Zagreb, Croatia, Sep 2023
- Rational Points, Schney, Germany, Jul 2023
- MIT Number Theory Seminar, Cambridge MA, Nov 2022
- Boston University Number Theory Seminar, Boston MA, Nov 2022
- Séminaire de Théorie des Nombres, Université de Strasbourg, France, Apr 2022
- Séminaire de Théorie des Nombres, ENS de Lyon, France, Apr 2022
- Séminaire de Théorie des Nombres, Université Blaise-Pascal, Clermont-Ferrand, France, Apr 2022
- Bhaskaracharya Pratishthana, Pune (online), Feb 2022

- Atelier PARI/GP 2022, Besançon, France (online), Jan 2022
- Arithmetic Geometry Seminar, Universität Bayreuth (online), July 2021
- VaNTAGe Seminar (online), June 2021
- Effective Methods in Algebraic Geometry (online conference), June 2021
- Algebra Seminar, Rijksuniversiteit Groningen (online), June 2021
- Mathematics Colloquium, Indian Institute of Technology, Hyderabad (online), June 2021
- University of Washington Number Theory Seminar (online), June 2021
- Séminaire de Théorie Algorithmique des Nombres, Bordeaux (online), May 2021
- Stat-Math Unit, Indian Statistical Institute, Delhi (online), Apr 2021
- Mathematics Colloquium, Indian Institute of Science Education and Research, Mohali (online), Apr 2021
- Joining Seminar, Harish-Chandra Research Institute, Prayagraj (online), Feb 2021
- Zagreb Number Theory Seminar (online), Jan 2021
- Number Theory Seminar, Indian Institute of Science Education and Research, Pune, Jan 2020

## ACADEMIC MEMBERSHIPS

Member of the *$L$-functions and Modular Forms Database*. 15 pull requests merged since October 2020 across the codebase, including Classical and Bianchi Modular Forms, Testing utilities, and Dirichlet Characters.

## OPEN SOURCE SOFTWARE CONTRIBUTIONS

### Absolutely simple endomorphism rings - Sage

2021

- First functionality to check for geometric simplicity of Jacobians of genus 2 curves over $\mathbb{Q}$.
- Scheduled for inclusion into sage-9.5.

## TEACHING EXPERIENCE

### Course Lecturer

**Computational Number Theory**

Oct 2021 - present — Heidelberg, Germany

Masters course covering algorithmic and computational topics in elliptic curves, modular forms, and algebraic number theory.

**Vertiefung Zahlentheorie**

Apr - July 2016 — Essen, Germany

Representability of primes via quadratic forms - from Fermat, Euler, Gauss, and to Artin Reciprocity. Three hours per week for 15 weeks. Lectures given in German.

**Einführung in das Computer-Algebra-Paket *Sage***

Sep 2015 — Essen, Germany

Introductory week-long course on *Sage* aimed at final year undergraduates. Course given in German.

**Algebraic Number Theory**

July 2009 — Linyi, China

Introductory course at summer school aimed at second year undergraduates.

### Seminar Organiser

**Abelian Varieties**

Oct 2021 - present — Heidelberg, Germany

Masters level seminar organised with Prof. Böckle.

**Algebraic Surfaces**

Oct 2015 - Jan 2016 — Essen, Germany

Masters level seminar organised with Prof. Görtz.

### Teaching Assistant

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| **Linear Algebra** | Apr - July 2015 | Vytautas Paškūnas | Universität Duisburg-Essen |
| **Modular Forms** | Oct - Dec 2012 | Mehmet Haluk Şengün | University of Warwick |
| **Algebraic Number Theory** | Jan - Mar 2012 | Johan Bosman | University of Warwick |
| **Elliptic Curves** | Oct - Dec 2011 | Lassina Dembélé | University of Warwick |
| **Algebraic Number Theory** | Jan - Mar 2010 | William Hart | University of Warwick |

### Undergraduate Supervisor

Oct 2010 - Apr 2013 — University of Warwick

Holding supervisions of groups of 5 undergraduates.

### STEP Mentor

Apr 2007 – 2009 — University of Cambridge

Coaching groups of 10 A-Level students in the STEP mathematics entrance exams to increase diversity and access at Cambridge.

## REFEREE DUTIES FOR JOURNALS

Mathematics of Computation | International Journal of Number Theory | Algebra and Number Theory | Research in Number Theory | Acta Arithmetica

## AWARDS

### Engineering and Physical Sciences Research Council, UK

Jan 2010

- Full funding for PhD studies.

### Institute for Advanced Study, Princeton NJ, USA

Jul 2008

- Full funding to attend Undergraduate Summer School Program of Park City Mathematics Institute on Algebraic Geometry in 2008.

### Whelan Prize

Oct 2007

- Awarded by Christ's College, University of Cambridge, for outstanding examination performance (top of college in mathematics).

### Nuffield Trust, UK

Jul 2007

- Undergraduate Research Bursary to conduct summer research project.
- Supervisor: Dr. Jon Bevan, University of Surrey, UK.

## LANGUAGES

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| **English** | ●●●●●● | **Python** | ●●●●●○ |
| **ਪੰਜਾਬੀ (Punjabi)** | ●●●●●● | **Sage** | ●●●●○○ |
| **Deutsch** | ●●●●○○ | **C** | ●●●○○○ |
| **हिंदी (Hindi)** | ●●●○○○ | **PARI/GP** | ●●●○○○ |
| **Français** | ●●●○○○ | **Magma** | ●●●○○○ |