

Anthony Bordg, PhD

Curriculum Vitae

Positions

- Mar.2022–present **Senior Research Associate**, Department of Computer Science and Technology, University of Cambridge (UK)
- 2018–Feb.2022 **Research Associate**, Computer Laboratory, University of Cambridge (UK), 5-year position as Research Associate on the ALEXANDRIA project, €2,5M ERC-funded project led by Lawrence C. Paulson
- 2015–17 **Research Fellow**, Eduard Čech Institute for Algebra, Geometry and Physics, Mathematical Institute, Charles University (Prague, Czech Republic)
- 2012–15 **Research Assistant**, CNRS (UMR 7351) & Université Nice-Sophia Antipolis

Qualifications

- 2021 **Qualification aux fonctions de Maître de Conférences**, *section 25 Mathématiques*, credential ID 21225291921, Conseil National des Universités (CNU)
- 2016 **I have obtained my French Qualification aux fonctions de Maître de Conférences**, *section 25 Mathématiques*, credential ID 16225291921, Conseil National des Universités (CNU)

Education

- 2015 **PhD in Mathematics**, Université Nice Sophia Antipolis
awarded with Distinction, advisor: André Hirschowitz, laboratoire J.A. Dieudonné, team Algebra, Topology and Geometry
- 2012-13 **Visiting graduate student**, Institute for Advanced Study, School of Mathematics, Princeton
- 2012 **Master's degree in Mathematics**, Université Paris Diderot, Paris
pure mathematics and theoretical computer science, Magna Cum Laude (I was in the top 5 students)
- 2010 **Licence degree in Mathematics**, Université Pierre et Marie Curie, Paris
major in mathematics, minor in physics
- 2006 **Maîtrise degree in Philosophy**, Master 1 at Université Paris-Sorbonne & Magister at École Normale Supérieure Paris
- 2005 **Licence degree in Philosophy**, Université Paris-Sorbonne

Awards and Distinctions

- 2019 **Royal Academy of Engineering (RAEng) internal selection**, winner of the internal selection at the Department of Computer Science and Technology of the University of Cambridge for a RAEng Fellowship (selection conducted by the Head of Department, Ann Copestake)
- Sept. 2017 **Heidelberg Laureate Forum**, *invited young researcher*
"Only the 200 most qualified Young Researchers can be given the opportunity to enrich and share the unique atmosphere of the Heidelberg Laureate Forum." – Scientific Committee of the Foundation
- 2015 **Laureate of an Eole grant**, (French-Dutch award of excellence, 500€)

- 2014 **Laureate of a Fulbright grant**, (\$10 000) As a Fulbright Fellow I was invited for 3 months to Carnegie Mellon University (CMU) in Steve Awodey and Jeremy Avigad's group and for 3 additional months to the Department of Mathematics of the University of San Diego (USD) to visit Michael Shulman and present my work there
- 2013 **Notable Computing Books and Articles of 2013**, the collective book *Homotopy Type Theory: Univalent Foundations of Mathematics* was among the "Notable Computing Books and Articles of 2013" of *Computing Reviews*

Preprints & Publications

Mathematics research

Algebra

- 2021 **The Interpretation Lifting Theorem for C-Systems**, Theory and Applications of Categories, Vol. 38, 2022, No. 7, <http://www.tac.mta.ca/tac/volumes/38/7/38-07abs.html>
In this work we prove a conjecture of Vladimir Voevodsky published in the same journal.

Homotopy theory

- 2019 **On a Model Invariance Problem in Homotopy Type Theory**, Applied Categorical Structures. <https://doi.org/10.1007/s10485-019-09558-w>, arXiv:1712.03409
In this work we disprove the model invariance conjecture of Michael Shulman.

- 2015 **On the Inadequacy of the Projective Structure with Respect to the Univalence Axiom**, arXiv:1712.02652
submitted

- 2013 **Homotopy Type Theory: Univalent Foundations of Mathematics**, The Univalent Foundations Program, Institute for Advanced Study, Princeton
This book is the standard reference on the Univalent Foundations of Mathematics and it is available online <http://homotopytypetheory.org/book/>.

Expository writing in mathematics

- 2021 **What is a Scheme in Algebraic Geometry? A Problem-Oriented Approach**, <https://bit.ly/3y07Akt>
draft

Computer science research

Journal articles

- 2022 **Simple Type Theory is not too Simple: Grothendieck's Schemes without Dependent Types**
Experimental Mathematics <https://doi.org/10.1080/10586458.2022.2062073>. Kevin Buzzard wrote a nice Twitter thread to give the gist of our work <https://bit.ly/3Std00Z>

- 2020 **Certified Quantum Computation in Isabelle/HOL**
Journal of Automated Reasoning 65(5) 691-709 <https://doi.org/10.1007/s10817-020-09584-7>

- 2019 **Comment on Quantum Games and Quantum Strategies**, arXiv:1911.09354
this work uncovered an error in the pioneering, highly cited, article of quantum game theory published in Physical Review Letters, a high-profile journal, and it led to the publication of an erratum in the same journal

Workshop and conference refereed articles

- 2023 **Modular Functions and Dirichlet Series in Isabelle/HOL**, in preparation
- 2022 **Encoding Dependently-Typed Constructions into Simple Type Theory**, CPP 2023
article available at <https://dl.acm.org/doi/10.1145/3573105.3575679>
- 2022 **A Parallel Corpus for Natural Language Machine Translation to Isabelle**, CICM 2022,
article available in the following proceedings <https://bit.ly/3Y5kHM1>

2021 **Elements of Differential Geometry in Lean**, CEUR Workshop Proceedings of the Fifth Workshop on Formal Mathematics for Mathematicians (part of CICM 2021), <https://bit.ly/3Iyf6I1>

[Refereed extended abstracts](#)

2022 **A Parallel Corpus of Natural Language and Isabelle Artefacts**, AITP 2022, abstract available at http://aitp-conference.org/2022/abstract/AITP_2022_paper_8.pdf

[Refereed book chapters](#)

2019 **Univalent Foundations and the UniMath library**, in *Reflections on the Foundations of Mathematics: Set Theory, Univalent Foundations and General Thoughts*, Synthese Library, vol 407, Springer, arXiv:1710.02723

[Computer code](#)

2022 **Strict Omega Categories**, Archive of Formal Proofs
<https://www.isa-afp.org/entries/StrictOmegaCategories.html>

2021 **Grothendieck's Schemes in Algebraic Geometry**, Archive of Formal Proofs
https://www.isa-afp.org/entries/Grothendieck_Schemes.html

2020 **Isabelle Marries Dirac: a Library for Quantum Computation and Quantum Information**, Archive of Formal Proofs
https://www.isa-afp.org/entries/Isabelle_Marries_Dirac.html

2018 **The Localization of a Commutative Ring**, Archive of Formal Proofs
https://www.isa-afp.org/entries/Localization_Ring.html

2018 **Projective Geometry**, Archive of Formal Proofs, this work is a contribution to Freek Wiedijk's epoch-making online list "Formalizing 100 Theorems" (*cf.* item 87 for Desargues's Theorem and the additional list for Hessenberg's theorem, <https://www.cs.ru.nl/~freek/100/>)
https://www.isa-afp.org/entries/Projective_Geometry.html

[Things with ideas](#)

2022 **A Tale of Duality**, Letter to the Editor, Notices of the American Mathematical Society, 69(1), January 2022
<https://www.ams.org/journals/notices/202201/rnoti-p4.pdf>

2021 **Hypercriticality, Hypocriticality and Hyperempathy**, Letter to the Editor, Communications of the ACM, 64(12), December 2021
<https://cacm.acm.org/magazines/2021/12/256941-common-ails/fulltext>

2021 **A Replication Crisis in Mathematics?**, Math Intelligencer <https://bit.ly/3xPLxx7>
At some point this article was in the top 5% of all research outputs ever tracked by Altmetric (21,525,176 research outputs across all sources).

[Textbooks](#)

2016 **L'épreuve de mathématiques à Sciences Po**, Ed. Ellipses, collection Optimum
maths textbook (in French)

[Translations](#)

2010 **L'Ecole de New Haven de droit international**, Ed. Pedone, collection Doctrine(s), Paris, 2010, translation in French, led by Julien Cantegreil, of ten papers of Michael Reisman (Myres S.McDougal Professor of International Law at Yale Law School)
International Law

[Some Invitations to International Workshops](#)

- May 2023 *Formalization of Cohomology Theories* workshop, Banff International Research Station for Mathematical Innovation and Discovery, organisers: Matthew Ballard, Adam Topaz, Johan Commelin, Heather Macbeth, Anne Baanen.
- June 2022 *Workshop Schlumberger 2022: Dependent Types and Formalisation of mathematics*, IHES, organiser: Thierry Coquand.
- Dec. 2019 *The Mathematics of Quantum Computation: The 4th Winter School in Computer Science and Engineering*, Israel Institute for Advanced Studies, organisers: Moshe Vardi, Dorit Aharonov, Zvika Brakerski, Or Sattath and Amnon Ta-Shma.
- May 2019 *Big Proof*, International Centre for Mathematical Sciences, Edinburgh, organisers: Ursula Martin and Natarajan Shankar.
- Aug.-Sep. 2018 project *Homotopy Type Theory and Univalent Foundations* (<https://bit.ly/41ran3T>), Centre for Advanced Study at the Norwegian Academy of Science and Letters, project organisers: Marc Bezem and Bjorn Ian Dundas.
- Feb. 2016 *Homotopy Type Theory* workshop, part of the programme "Higher structures in geometry and physics", Max-Planck Institute in Bonn, workshop organiser: Richard Garner.
- 2012-13 *Special Year on the Univalent Foundations of Mathematics*, IAS, Princeton, organisers: Steve Awodey, Thierry Coquand and Vladimir Voevodsky. During the special year I raised an issue with the experimental implementation of higher inductive types in the COQ language. This issue was later fixed by Yves Bertot, see <https://bit.ly/3EEemZLi>.

My Work in the Wild

- July 2022 I was featured in the Scientific American, see John Horgan's article "Should Machines Replace Mathematicians?" <https://bit.ly/3StHUGC>
- June 2022 "Game over for mathematicians?" on the Silicon Reckoner Substack of Michael Harris, see <https://siliconreckoner.substack.com/p/game-over-for-mathematicians>
- 2022 Our work on the certification of quantum algorithms and protocols was featured in the Magazine MaSciProûve, vol.1, no.2 (see in particular Section 3.2 "Isabelle dans la matrix" <https://masciprouve.caf-rmsa2p.be>).

Computer Code

- 2021 **Some graduate level number theory**, with Manuel Eberl, Wenda Li and Larry Paulson https://github.com/AnthonyBordg/Number_Theory
- 2020 **Geometry in Lean**, differential geometry in the Lean theorem prover, joint work with Nicolò Cavalleri https://github.com/AnthonyBordg/Geometry_in_Lean
- 2019 **Lie**, Lie groups in the Isabelle proof assistant, pilot study with Michael R. Douglas <https://github.com/AnthonyBordg/Lie>
- 2017 **UniLab**, mathematical formalizations based on the Univalent Foundations of mathematics. I formalized (with the Coq proof assistant) comma categories, the univalent category of modules over a ring, monoidal categories, algebras over a commutative ring, types and groups with operators. Part of my work was integrated in Vladimir Voevodsky's UniMath library who cited my work during his talk at the Isaac Newton Institute for Mathematical Sciences in Cambridge as an example of a reformulation of a piece of mathematics using the univalent point of view (see p. 15 of Voevodsky's slides <https://bit.ly/3ZoBSsU>) <https://github.com/AnthonyBordg/UniLab>

Supervisions

- July-Aug 2022 supervision of Adrián Doña Mateo, a Part III student of the Mathematical Tripos at the University of Cambridge, grant awarded by the Cambridge Mathematics Placements Programme
- Apr-Aug 2021 supervision of Nicolò Cavalleri's Master 2 thesis (École Normale Supérieure, Paris)
- Apr-Aug 2021 supervision of Zibo Yang (Master I MPRI) from École Polytechnique, Paris
 - June-Aug 2020 I supervised the internships of Nicolò Cavalleri, a Part III student of the Mathematical Tripos (St. Edmund's College, University of Cambridge), and Jiaqi Qiao, a 4th year student in mathematical physics at the University of Edinburgh. We worked on the formalization of mathematical physics in the Lean theorem prover. Nicolò and I were awarded a grant from the Cambridge Mathematics Placements Programme of the Department of Pure Mathematics and Mathematical Statistics, while Jiaqi was supported by the University of Edinburgh.
 - 2019–20 Supervising Xiao Ma's Part II Dissertation on deep learning (Gonville and Caius College, University of Cambridge).
 - June-Aug 2019 I supervised the internship of Hanna Lachnitt, the second recipient of the Helmut Veith Prize awarded annually to an outstanding female Master's Student in computer science at TU Wien (Austria). Our project was awarded an Erasmus+ grant.
 - June-Aug 2019 I supervised the internship of Yijun He, a 2nd-year student from the Mathematical Tripos (St. John's College, University of Cambridge). Yijun and I were awarded a grant from the Cambridge Mathematics Placements Programme.
- Apr-Aug 2018 I co-supervised (with Larry Paulson) the internship of two students (Master I), Martin Baillon and Paulo Emilio de Vilhena, from École Polytechnique (Paris, France). One can read their work on GitHub <https://github.com/DeVilhena-Paulo/GaloisCVC4>.
- Apr 2018 I was invited to take part in the MPhil project focus group of Andreas Theodorou (MPhil student, University of Cambridge) on Speedith, a diagrammatic reasoner for spider diagrams.

Academic Responsibilities

- Jan. 2023 Assessor. I was in charge of assessing the applications of students and of interviewing them for admissions to the MPhil in Advanced Computer Science at the University of Cambridge (Department of Computer Science and Technology).
- July 2021 programme committee member of the *Fifth Workshop on Formal Mathematics for Mathematicians* associated with the *14th Conference on Intelligent Computer Mathematics*
- 2021–present Member of UKRI Early Career Researcher Forum that gives researchers a voice in UKRI's strategy, policy development and decision making.
 - 2019 Referee for *Internal Junior Fellowships*, Freiburg Institute for Advanced Studies.
- 2019–present Administrator of the Zulip chat that I initiated for the research community working on the proof assistant Isabelle, <https://isabelle.zulipchat.com/>.
- 2019–2023 Each year I organized and led interviews of students of the Mathematical Tripos applying for the Cambridge Mathematics Placements (CMP) programme.
- 2017–present Reviewer for scientific journals and conferences
 - 2014–15 I was elected to the Council of my Doctoral School (Ecole Doctorale Sciences Fondamentales et Appliquées, Université Nice Sophia Antipolis).

Teaching

2010–12 **Head teacher & educational engineer**, private school ADMISUP, Paris

I was responsible for the maths option of “Préparation Sciences Po Paris” for our senior high school students. I developed the syllabus and material for the preparation of this competitive exam and from the course I taught I wrote and published a maths textbook with two colleagues, [link](#). I was also in charge of the preparation for the TAGE MAGE (French test for business and management studies, corresponding to the GMAT exam in English-speaking countries, to assess verbal, problem-solving and logical reasoning skills), I developed the syllabus and course material and coached our students.

Computer Skills

Mathematica, Isabelle, COQ, Lean, L^AT_EX, git, emacs, Linux, OCAML, Scheme, Scilab, VBA.

Online Profiles

Math <http://math.stackexchange.com/users/346996/anthony-bordg?tab=profile>
Physics <https://physics.stackexchange.com/users/144508/anthony-bordg>
GitHub <https://github.com/AnthonyBordg>

Community Services

- Feb. 2023 collected 1,500 litres of plastic and glass waste in the woods at the boarder between Guerville and Mézières (Yvelines, France)
- Jan. 2023–present member of *Les Shifters* supporting the think tank *The Shift Project* which aims to limit climate change and our dependence on fossil fuels. I am a writer for *La Gazette du Carbone* (team Energy), a weekly analysis of French legal news on global warming and our dependence on fossil fuels.
- 2020–21 mentor of a senior high school student with the French organization *Chemins d'avenirs*
- 2020–21 blogger at francedoctorat.fr and okaydoc.fr for the valorisation of doctorate in France
- 2020–21 Due to the COVID-19 pandemic the 2020-21 academic year at the University of Cambridge took place online. To help students cope with this unprecedented situation, I launched an online chat, the *Schrödinger's Chat* (<https://cam-mathphys.zulipchat.com>).

Languages

- French: mothertongue
- English: full professional proficiency

Learned Societies

- 2021-present member of the International Society for Quantum Gravity (ISQG)
- 2021-present member of the European Research Network on Formal Proofs (EuroProofNet)
- 2018-20 member of the Cambridge University Physics Society
- 2015-present member of the French Fulbright alumni association
- 2014 member of the Association for Symbolic Logic