Carlos Caralps

Mathematics PhD Student

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I am a PhD student at Universität Bielefeld (Bielefeld, Deutschland) under the supervision of Professor Claudia Alfes and Privatdozent Lennart Gehrmann. I am interested in topics of Algebraic Number Theory and Algebraic Geometry, especially in Heegner Points, p-adic Kudla program, the Birch and Swinnerton-Dyer Conjecture, Brumer-Stark Conjecture, Euler systems, and the use of theorem prover software in mathematical education. In the following lines, you can read my curriculum vitae.

Education

Doctorate in Philosophy *Universität Bielefeld* — Oct 2025 — Present
- **PhD thesis**, *A p-adic approach to the Gross-Kohen-Zagier Theorem for higher weight forms (under the supervision of Professor Claudia Alfes and PD Lennart Gehrmann)*

ALGANT Master *Specialized in Algebra, Geometry and Number Theory* — Jul 2023 — Sep 2025
- **Master of Science**, *Universiteit Leiden* — Jul 2023 — Jul 2024
- **Master of Science**, *Universität Duisburg-Essen* — Aug 2024 — Sep 2025
- **Master thesis**, *Heegner points and periods on products of upper half-planes (under the supervision of Professor Massimo Bertolini).* — Jul 2024 — Sep 2025

Bachelor of Science in Mathematics *(3rd highest GPA)*, *Universitat Autònoma de Barcelona* — Jul 2019 — Jul 2023
- **Exchange Program**, *Concordia University* — Jul 2022 — May 2023
- **Senior Thesis**, *A generalization of a Charollois-Darmon conjecture for certain lattice zeta functions associated to ray class field of ATR fields (fulfilled with honors under the supervision of Professor Hugo Chapdelaine, Professor Patrick Allen, and Professor Marc Masdeu).* — Sep 2022 — Jun 2023

Research Experience

Graduate researcher assistant — **Nov 2025 — Present**
Fakultät für mathematik of Universität Bielefeld — *Bielefeld, Germany*

Graduate researcher assistant — **Jul 2023 — Sep 2023**
Mathematics Institute of Universiteit Leiden — *Leiden, Netherlands*
- In this internship, under the supervision of Professor Marco Streng, I computed examples of lattice zeta function values using the Colmez trick and the generalization of the Charollois-Darmon Conjecture (presented in my senior thesis).

Undergraduate researcher assistant — **May 2023 — Jun 2023**
Mathematics Department of Université Laval — *Québec, Québec, Canada*
- The objective of this internship, supervised by Professor Hugo Chapdelaine, was to finish the formalization of the Charollois-Darmon generalization (presented in my senior thesis) and work on a new algorithm to compute lattice zeta function using a trick proposed by Colmez.

Undergraduate researcher assistant — **Jul 2022 — Sep 2022**
Mathematics Department of Université Laval — *Québec, Québec, Canada*
- The objective of this internship, supervised by Professor Hugo Chapdelaine, was to write Sage programs that computes the Stark number predicted by the range one Stark's conjecture, of a real quadratic number field.

Undergraduate researcher assistant — **Mar 2022 — Jul 2022**
Mathematics Department of Universitat Autònoma de Barcelona — *Barcelona, Catalonia, Spain*
- The main aim of this internship, supervised by Professor Natalia Castellana and Professor Marc Masdeu, was to write and publish a paper that proves a correspondence between semialgebras of filters and topological spaces.

Member of Barcelona LEAN Seminar — **Dec 2020 — Jun 2022**
Universitat Autònoma de Barcelona — *Barcelona, Catalonia, Spain*
- This was a course about LEAN (a theorem prover) conducted by Professor Marc Masdeu. This course evolve into a research group, that formalized topological spaces with LEAN and started to prove the Brouwer fixed point theorem.

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Teaching Experience

Teacher assistant — **Oct 2024 — Aug 2025**
Universität Duisburg-Essen — *Essen, North Rhine-Westphalia, Deutschland*

Associated Researcher — **Jan 2022 — Jul 2022**
Barcelona International Youth Science Challenge, Fundació Catalunya La Pedrera — *Barcelona, Catalonia, Spain*

- BIYSC is a program for high school students, where they can participate in a project of a research center in Catalonia. I was part of the Universitat Autònoma group, directed by Professor Marc Masdeu and Professor Roberto Rubio, where we taught how to use the LEAN prover language (a theorem prover).

Member of the docent innovation group "LEAN in the classroom" — **Jul 2021 — Jun 2022**
Universitat Autònoma de Barcelona — *Barcelona, Catalonia, Spain*

- This docent group, directed by Professor Natalia Castellana and Professor Marc Masdeu, taught how to use LEAN prover to undergraduate students. We met every Wednesday with the students, answered their questions, built an interactive game where they can learn topology through LEAN and formalized the proof of the Descartes rule of signs.

Talks

CM points and periods on products of non-Archimedean upper half-planes, 11 Jun, 2025
The Bielefeld Algebraic and Arithmetic Geometry Seminar SS2025 (organized by Universität Bielefeld)

ABSTRACT: CM points over Shimura curves can be related to periods of a rigid analytic space using the theory of p-adic uniformization. In this talk, we will introduce the key points of this relationship and study a setting where the inverse process can be made explicit. More specifically, following the work of Bertolini, Darmon, and Green, we will show that some periods defined by integrals over products of non-Archimedean upper half-planes are related to CM points of Shimura curves.

Heegner points and integration over $\mathcal{H}_p \times \mathcal{H}_q$, *38th edition of the Barcelona Number Theory Seminar* 6 Feb, 2025
(organized by Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya)

ABSTRACT: Heegner points on Modular curves can be related to periods defined over some concrete integrals defined over the common complex upper half-plane. Using the theory of p-adic measures, p-adic integration, and Drininfled's moduli interpretation of the p-adic upper half-plane $\mathcal{H}_p$, we can get a similar correspondence between Heegner points on Shimura curves and some multiplicative integrals defined over $\mathcal{H}_p$. The main aim of this talk is to present a similar result for integrals defined over the product $\mathcal{H}_p \times \mathcal{H}_q$.

Analytic expressions of Stark Numbers, *37th edition of the Barcelona Number Theory Seminar* 8 Feb, 2024
(organized by Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya)

ABSTRACT: In the 1970s, Harold Stark realized that the first coefficients of the Taylor expansions of some Zeta Functions at s=0 were related to integers in ray class fields, the Stark Numbers. The Stark Conjectures state that this property will be satisfied by all L functions. Since little is known about these coefficients for the Archimedean norm, we are interested in developing algorithms to compute Stark Numbers. The main aim of this presentation is to introduce methods to compute Stark Numbers, especially a new algorithm, developed together with Professeur Hugo Chapdelaine, that uses Eisenstein Series and a trick proposed by Professeur Pierre Colmez.

Computation of values of zeta functions using Eisenstein series, *2022 Québec-Maine Number Theory Conference* 15 Oct, 2022
(organized by Université Laval and the University of Maine)

ABSTRACT: In this talk, we shall explain how Eisenstein Series can be used to compute values of zeta functions using an idea of Colmez. We will start by presenting the computational method, and its related concepts, in the simplest setting namely when the base field is $\mathbb{Q}$ and the corresponding zeta function is the classical Riemann zeta function. Then we shall generalize the procedure to zeta functions of real quadratic fields. In particular, when applied to the value at $s = 1$ of a special class of zeta functions, this provides a way for computing Stark's units over real quadratic fields with the help of the LLL algorithm.

From far-out mystery to a useful tool, *SIMBa Seminar (organized by Universitat de Barcelona,* 16 Feb, 2022
Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya)

ABSTRACT: This talk aims to redefine topological filters in order to obtain a helpful tool that can be used to prove some propositions in topology using semiring theory. In this talk, we will see the first definition of filters provided by Henri Cartan, which is used to define limits in general topological spaces, and we will state some famous theorems about filters and topology. Changing the definition slightly allows us to prove some propositions by using group theory identities, we will show this by solving some topology-undergraduate problems as trivial algebraic identities.

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Organization

Heegner Points Online Seminar, *organized together with Miriam Ni Chobhthaigh* — Apr 2025 — Present
CFT Master Seminar, *organized together with Paolo Bordignon* — Nov 2023 — Jun 2024

Courses

Claudia's Seminar, *Universität Bielefeld* — Oct 2025 — Present
Euler System Seminar, *Universität Duisburg-Essen* — Oct 2024 — Present
Professor Vonk Seminar, *Universiteit Leiden* — Oct 2023 — Dec 2023
Number Theory Montréal's Graduate Student Seminars, *McGill University and Concordia University* — Oct 2022 — Dec 2022
An invitation to p-adic methods in Number Theory, *Barcelona Graduate School of Mathematics* — Mar 2022 — Jun 2022
XIV Edition of the JAE School of Mathematics, *Instituto de Ciencias Matemáticas* — Jul 2021
Workshop about mathematics and COVID-19, *Societat Catalana de Matemàtiques* — Jul 2020
Carnet de Monitor/a d'activitats d'educació en el lleure infantil i juvenil, *Generalitat de Catalunya, Departament de Treballs, Afers Socials i Famílies. Direcció General de Joventut* — Dec 2019 — Jan 2023

Conferences Attended

Arithmetica Transalpina, *Distance Learning University Switzerland* — Oct 2025
Summer school on formulas of Siegel and Weil, *Universität Bielefeld* — Oct 2025
Motives, L-values and Eisenstein series, *Universität Regensburg* — Sep 2025
Modular in Bielefeld, *Univsersität Bielefeld* — Jun 2025
Arithmetica Transalpina, *Università de Genova* — May 2025
Kleine AG - Canonical models of Shimura varieties, *Univsersität Paderborn* — Mar 2025
38th edition of the Barcelona Number Theory Seminar, *Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya* — Feb 2025
School on Hodge Theory and Shimura Varieties, *Univsersität Duisburg-Essen* — Sep 2024
Early Number Theory Researchers Workshop 2024, *Univsersität Duisburg-Essen* — Sep 2024
A Modern Introduction to Number Theory, *Università di Pisa* — Sep 2024
Séminaire Mazur, *Univesiteit Leiden* — Jul 2024
DIAMANT Symposium Spring 2024, *DIAMANT* — Apr 2024
37th edition of the Barcelona Number Theory Seminar, *Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya* — Feb 2024
DIAMANT Symposium Autumn 2023, *DIAMANT* — Nov 2023
Intercity Number Theory Seminar, *Koninklijk Nederlands Wiskundig Genootschap* — Nov 2023 — Present
Numbers in the Universe, *International Centre for Mathematics in Ukraine* — Aug 2023
Machine-Checked Mathematics, *Lorentz Center* — Jul 2023
Number Theory Working Group, *Centre de Recherches Mathématiques du Québec* — Feb 2023 — Mar 2023
MOBIUS Analytic Number Theory Seminar, *Université de Montréal* — Jan 2023 — Mar 2023
Québec-Vermont Number Theory Seminar, *McGill University, Concordia University and Université de Montréal* — Sep 2022 — Apr 2023
Québec-Maine Number Theory Conference, *Université Laval and the University of Maine* — Oct 2022
LEAN in Lyon, *Université Jean Monet* — May 2022
35th edition of the Barcelona Number Theory Seminar, *Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya* — Feb 2022
SIMBa Seminar, *Universitat de Barcelona, Universitat Autònoma de Barcelona & Universitat Politècnica de Catalunya* — Mar 2021 — Jun 2022

Scholarships

ALGANT Leiden Scholarship, *ALGANT Consortium and Universiteit Leiden* — Sep 2023 — Aug 2024
Erasmus+ Traineeship, *European Union* — Jul 2023 — Sep 2023
MOBINT Scholarship, *Generalitat de Catalunya* — Sep 2022 — May 2023
UAB Exchange Programme Scholarship, *Universitat Autònoma de Barcelona* — Sep 2022 — May 2023
ULaval Internship Scholarship, *Centre de Recherches Mathématiques du Québec* — Jul 2022 — Sep 2022
UAB Exchange Programme Traineeships Scholarship, *Universitat Autònoma de Barcelona* — Jul 2022 — Sep 2022

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Languages

Catalan, *as a native language*
Spanish, *as a native language*
English, *Advance Level*

- **TOEFL internet Based Test**, *with a score of 102* — Nov 2024
- **Cambridge Certificate in Advanced English** — Sep 2021

Italian, *Intermediate Level*

- **Bielefeld course: Italienisch / Italiano für leicht Fortgeschrittene, Niveau B1** — Nov 2025 — Present

French, *Introductory Level*

- **Concordia Course FRAN 211: Elementary French Language** — Sep 2022 — Dec 2022

Skills

Tools and Languages	Python, C, LaTeX, SageMath, GitHub, LEAN Theorem Prover, R, Magma, Typst
Operative Systems	Arch Linux, Arcolinux, Windows