

SACHA CARDONNA

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Current position

Ph.D. candidate in Mathematics.

10/2023 – Present

Institut Montpellierain Alexander Grothendieck, Montpellier.

Thesis. Numerical study of free-border problem and wave-structure interaction.

Advisors. François Vilar & Fabien Marche.

Funding. French ministry fellowship, ranked 1st at I2S Doctoral School admission exam.

Research interests

Theoretical analysis of PDEs

Modeling & coupling

Fluid mechanics

Discontinuous Galerkin schemes

Finite-Volume schemes

ALE approaches

Shallow-Water equations

Hyperbolic PDEs

Scientific computing

Education

Faculty of Sciences, Montpellier.

09/2020 – 06/2023

M.Sc. in Theoretical and Numerical Analysis of PDEs (*with honours*).

M.Sc. in Fundamental Mathematics.

Ranked 1st of promotion.

Faculty of Sciences, Montpellier.

09/2017 – 05/2020

B.Sc. in Pure and Applied Mathematics (*with honours*).

A.Sc. in Mathematics & Physics (*with honours*).

Work experiences

Teaching assistant.

10/2023 – Present

Department of Mathematics, Faculty of Sciences, Montpellier.

Tutor in Sciences and Humanities.

07/2017 – 05/2023

Salon-de-Provence & Montpellier.

Internships

Finite-Volume Subcells correction on discontinuous Galerkin schemes.

03 – 07/2023

Abstract. Building and implementing a new strategy for stabilizing discontinuous Galerkin numerical methods using a Finite-Volume subcells type approach for the Nonlinear Shallow-Water equations. We consider here an a priori approach, more precisely a monolithic subcell dG/FV convex property preserving scheme.

Advisors. François Vilar & Fabien Marche.

Asymptotic analysis of PDEs sequences and homogenization theory.

02 – 05/2022

Abstract. We consider two problems, including a Dirichlet problem on a variable open set. Ice fog forms when water vapour, mainly resulting from human activities, enters the atmosphere. This vapor condenses into droplets which quickly freeze, giving rise to particles of ice without a well-defined crystalline form. The objective is to model it as a homogenization problem.

Advisor. Michel Bellieud.

From differential geometry to mathematical billiards.

03 – 05/2021

Abstract. Studying one of the simplest dynamical system, the mathematical billiard where we characterize the periodic trajectories by their initial angle of shot.

Advisor. Daniel Massart.

Proof of Dirichlet Prime Number theorem.

01 – 04/2020

Abstract. Demonstrating that, for $a, b \in \mathbf{N}^*$, such that $\gcd(a, b) = 1$, the arithmetic progression $\{an + b\}_{n \in \mathbf{N}}$ contains an infinity of prime numbers. Such a proof needs various theories, like complex analysis or group theory.

Advisor. Sylvain Brochard.

Computer skills

Programming	C/C++, Python, notions of Fortran.
Mathematics softwares	FreeFEM++, Matlab, Scilab, gnuplot, Maple, Mathematica.
Markup languages	HTML, CSS, PHP.
Typesetting systems	L ^A T _E X, Beamer, Microsoft Office (<i>Word & PowerPoint</i>).
Operating systems	Linux (<i>Kali & Debian</i>), Windows, macOS.
Creation softwares	Adobe Creative Cloud, Audacity, Final Cut Pro X.

Projects

- Hybrid High-Order method on Leray-Lions operators.** 12/2022
Advanced Numerical Analysis, introduction to Hybrid High-Order method.
Studying a new non-conform finite-element method called Hybrid High-Order and its main discrete functional analysis results on Leray-Lions operators.
Advisor. Daniele Di Pietro.
- Müller's SPH C++ implementation for fluid dynamics.** 11/2022
A Posteriori Estimates & Mesh Adaption.
Building and implementing Smooth Particle Hydrodynamics method for a C++ simulation.
Advisor. Bijan Mohammadi.
- Some results about measure theory.** 05 – 09/2022
Personal project lead during summer break.
Proving measure theory results, including differentiation of Radon measures, Besicovitch & Vitali covering theorems, Tietze & Lusin's theorems.
Advisor. Michel Bellicud.
- Finite-element resolution and FreeFEM++ simulation.** 05 – 04/2022
Numerical Analysis, introduction to Finite-Element method.
Studying and implementing a Dirichlet problem with mixed boundary conditions on FreeFEM++.
Advisor. Vanessa Lleras.
- Machine Learning code for database analysis.** 10/2021
Machine Learning & Convex Optimization.
Database analysis and programming regression methods for machine learning on Python.
Advisor. Bijan Mohammadi.
- Numerical interpolation and its limits.** 01 – 12/2018
Personal project lead during summer break.
Studying polynomial interpolation and Runge's phenomenon.
Advisor. Sylvain Brochard.

Courses taken

Fundamental courses. Theoretical Analysis of PDEs – Functional Analysis & Distribution Theory – Differential Geometry – Measure and Integration Theory – Topology of Metric Spaces – Galois Theory – Category Theory – Ring & Group Theory – Differential Equations & Calculus – Probability Theory – Euclidian Geometry – Linear & Bilinear Algebra – Calculus.

Applied and specialized courses. Numerical Analysis of PDEs – Numerical Modeling – Homogenization for Navier-Stokes – Scientific Computing – Machine Learning & Convex Optimization – *A Posteriori* Estimates & Mesh Adaption – Fourier Transform & Convolution for Inverse Problems – Deterministic & Stochastic Modeling.

Physics courses. Solid & Fluid Mechanics – Electromagnetism – Electrostatics & Magnetostatics – Thermodynamics – Wave & Geometrical Optics – Electrohydrodynamics – Experimental Physics.

Languages

French (*native*), **English** (*fluent*), **Spanish** (*intermediate*).