Sacha Cardonna

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Current position

Ph.D. candidate in Mathematics. *10/2023 – Present*
Institut Montpelliérain Alexander Grothendieck, Montpellier.
Thesis. Numerical study of free-border problem and wave-structure interaction.
Advisors. François Vilar & Fabien Marche.
Funding. French ministry fellowship, ranked 1^{st} 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 1^{st} 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

Ph.D. candidate with teaching activities. *10/2023 – Present*
IMAG & 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 contains various fields, 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	LaTeX, Beamer, Microsoft Office (*Word* & *PowerPoint*).
Operating systems	Linux (*Kali* & *Debian*), Windows, macOS.
Creation softwares	Adobe Creative Cloud, Audacity, Final Cut Pro X.

Projects

Hybrid High-Order method on Leray-Lions operators. *12/2022*
Goal. Studying a new non-conform finite-element method called Hybrid High-Order and its main discrete functional analysis results on Leray-Lions operators.
Course. Advanced Numerical Analysis, introduction to Hybrid High-Order method.
Advisor. Daniele Di Pietro.

Mller's SPH C++ implementation for fluid dynamics. *11/2022*
Goal. Building and implementing Smooth Particle Hydrodynamics method for a C++ simulation.
Course. *A Posteriori* Estimates & Mesh Adaption.
Advisor. Bijan Mohammadi.

Some results about measure theory. *05 – 09/2022*
Goal. Proving measure theory results, including differentiation of Radon measures, Besicovitch & Vitali covering theorems, Tietze & Lusin's theorems.
Advisor. Michel Bellieud.

Finite-element problem and FreeFEM++ simulation. *05 – 04/2022*
Goal. Studying and implementing a Dirichlet problem with mixed boundary conditions on FreeFEM++.
Course. Numerical Analysis, introduction to Finite-Element method.
Advisor. Vanessa Lleras.

Machine Learning code for database analysis. *10/2021*
Goal. Database analysis and programming regression methods for machine learning on Python.
Course. Machine Learning & Convex Optimization.
Advisor. Bijan Mohammadi.

Numerical interpolation and its limits. *01 – 12/2018*
Goal. Studying polynomial interpolation and Runge's phenomenon. Personal project lead during associate's degree.

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*).

Last update. Friday 16th June, 2023.