Cristóbal Villalobos Guillén
FACTAS team
Office #B204
Centre Inria d'Université Côte d'Azur
2004 route des Lucioles - BP 93
06 902 Sophia Antipolis Cedex FRANCE
cristobal.villalobos-guillen@inria.fr
+33 (0) 4 92 38 71 72

EDUCATION

Vanderbilt University — Nashville, TN, USA
Ph.D. in Mathematics — May 2019
Dissertation: *A Measure Theoretical approach to Geomagnetical Inverse Problems*

Universidad Autónoma de San Luis Potosí — San Luis Potosí, SLP, México
Bachelor's in mathematics — 2012
Thesis: *Algebras de Lie Reductivas sobre campos de característica cero (Reductive Lie Algebras over fields of characteristic zero.)*

RESEARCH INTERESTS

Inverse problems in divergence form. Electromagnetic inverse problems. Both theoretical aspects and numerical approximations of the above.

RESEARCH EXPERIENCE

Centre Inria d'Université Côte d'Azur — December 2021 – Present
Postdoctoral position under the supervision of Laurent Baratchart.

CMAP École Polytechnique — October 2020 – November 2021
Postdoctoral position under the supervision of Houssem Haddar and with funding from the postdoctoral fellowship "Labex Mathématiques Hadamard" in Mathematics in Computational Science and Engineering.

Vanderbilt University — August 2014 – May 2019
Dissertation directed by Douglas P. Hardin, Ph.D.
Worked as part of the Impinge "Associate Inria team".
This was a collaboration between Vanderbilt University, the department of Earth, Atmospheric and Planetary Sciences of the MIT, and the research group FACTAS (formerly APICS) from the inria Inria center at Sophia Antipolis.

Universidad Autónoma de San Luis Potosí
- Thesis under the supervision of Dr. Gil Salgado González. — August 2010 – March 2012
- Summer research for Dr. Gelasio Salazar Anaya together with Dr. Mario Cetina. — Summer 2008

MANUSCRIPTS

- H. Haddar, **C. Villalobos Guillén**, Inverse problems in divergence form for the Helmholtz equation.
- L. Baratchart, D. P. Hardin, **C. Villalobos Guillén**, Numerical setting for the solution of inverse potential problems in divergence form for measures in the plane.

PUBLICATIONS

- L. Baratchart, **C. Villalobos Guillén**, D. P. Hardin, Inverse potential problems in divergence form for measures in the plane. ESAIM: COCV, 27 (2021) 87 DOI: https://doi.org/10.1051/cocv/2021082
- L. Baratchart, **C. Villalobos Guillén**, D. P. Hardin, M. C. Northington, and E. B. Saff. Inverse potential problems for divergence of measures with total variation regularization. Foundations of Computational Mathematics, Nov 2019.
- Laurent Baratchart, **Cristobal Villalobos-Guillen**, Douglas Hardin and Juliette Leblond, Sparse recovery for inverse potential problems in divergence form, to be published in the Proceedings at the 9th International Conference on New Computational Methods for Inverse Problems, May 24, 2019
- G. SALGADO, **C. Villalobos-Guillen**, Algebras de Lie reductivas y semisimples; nuevas caracterizaciones, Aportaciones (Reductive and semisimple Lie Algebras, new characterizations) Mat. Comun. Vol. 52, pags. 3-12, (2017)
- M. Cetina, C. Hernández-Vélez, J. Leaños, **C. Villalobos**, Point sets that minimize ($\leq k$)-edges, 3-decomposable drawings, and the rectilinear crossing number of K_{30}, Discrete Mathematics, Volume 311, Issue 16, 28 August 2011, Pages 1646-1657, ISSN 0012-365X, 10.1016/j.disc.2011.03.030.

PRESENTATIONS

- Inverse problem for the Helmholtz equation and singular sources in the divergence form, at the 2022 WAVES conference help in July 2022
  Discussed an inverse problem where the underlying model is related to sources generated by currents on an anisotropic layer. This problem is a generalization of another motivated by the recovering of magnetization distribution in a rock sample from outer measurements of the generated static magnetic field. The original problem can be formulated as inverse source problem for the Laplace equation with sources being the divergence of the magnetization whereas the generalization comes from taking the Helmholtz equation. Either inverse problem is non uniquely solvable with a kernel of infinite dimension. Presented a decomposition of the space of sources that will allow us to discuss constraints that may restore uniqueness and propose regularization schemes adapted to these assumptions.
- Some measure-theoretic aspects of planar magnetization reconstruction, at the 10th International Conference Inverse Problems: Modeling and Simulation held on May 2022.
  When modeling magnetizations by R^3-valued Borel measures, the kernel of the forward operator, mapping magnetizations supported on the plane {z = 0} to the restriction of the magnetic fields they induce to a sufficiently dense subset of an analytic surface, consist of divergence free measures whose 3rd component is zero. Using this fact as a motivation, showed how any divergence free R^3-valued Borel measure on R^2 can be decomposed into line integrals over Jordan curves. This result has two important implications for the recovery of planar magnetizations. First, that any magnetization supported on sufficiently separated straight lines has minimal total variation, in the measure-theoretic sense, among all other planar magnetizations that induce the same field. Second, that the group LASSO regularization problem in this context, which amounts to total variation regularization, has a unique solution for any value of the regularization parameter.
- Inverse Problem for Singular Sources in the Divergence Form, at the 2022 SIAM Conference on Imaging Science held in March 2022.
  Discussed an inverse problem motivated by the recovering of magnetization distribution in a rock sample from outer measurements of the generated static magnetic field. It can be formulated as

inverse source problem for the Laplace equation with sources being the divergence of the magnetization. It can also be generalized to the Helmholtz equation where the underlying model is related to sources generated by currents on an anisotropic layer.
This was a collaborative work with L. Baratchart, H. Haddar and D. P. Hardin.

- "El número de cruce rectilíneo y pseudolineal de K_{30} es 9726'' (The lineal and pseudo-lineal crossing number of K_{30} is 9726), at the XLI National Congress of the Mexican Mathematical Society (SMM) held in October 2008.
  This was a collaborative work with M. Cetina. Based on the work of J. Leaños, we were able to show that the rectilinear crossing number of K_{30} (that is, the minimal number of edge crossing for the drawing on the plane of a complete graph with 30 vertices where each of the 435 edges is a line segment) actually reached its current upper bound, 9726 .

SUMMER SCHOOLS

- Deep Learning: a hands-on introduction and Computer Vision Crash Course
  Genoa, Italy, from the 12th to the 20th of July 2022
- "Escuela Matemática de América Latina y el Caribe 2010"
  (Mathematical School of Latin Amerca and the Caribbean)
  Villahermosa, México, from the 2nd to the 13th of August 2010.

OTHER EXPERIENCE

Technical proofreader January 2019 – March 2019

Department of Mathematics, Vanderbilt University

Proofread preliminary versions of the book: Borodachov, S. V., Hardin, D. P., and Saff, E. B. (2019). Discrete energy on rectifiable sets. New York, NY: Springer.

Teaching assistant August 2013 – December 2018

Department of Mathematics, Vanderbilt University

- Directed weekly lab on the 2017 Fall term on the basis of Data science with R
- Graded homework and exams
- Directed discussion sessions
- Held office hours to tutored students

Problem Judge of the 25th Mexican Mathematical Olympics (OMM) 13th – 19th of November of 2011

San Luis Potosí, México

This is a contest between highschool and middleschool students where they solve proof-based mathematical problems.