# Jeremy Dalphin

Research Engineer

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# Fields of research

- 1D to 3D modeling related to interdisciplinary issues. Computational quantum chemistry (maximal probability domains), inverse problems (conductivity in a copper converter), resolution of equations coming from fluid mechanics (gas behavior in an industrial network, simulation of surfing waves, KdV), taking into account random uncertainties (Robin Laplacian on thin layers).
- Development and design of computer software written in C language. Architecture and software engineering, efficiency and code performances, parallel computing calculations, exception handling, unit test implementation, software documentation (user guide).
- Simulation and analysis by numerical methods (skills in MATLAB/FREEFEM/C). Adaptive mesh techniques, evolution of surfaces (level-set and phase-field methods), setting up of numerical methods for optimization (gradient, hessian, adjoint), scientific calculus for solving equations, error estimates.
- Shape optimization, optimal design, and calculus of variations. Study and analysis of optimal shapes (existence, uniqueness, regularity, properties), geometric functionals, curvature depending energies (Helfrich, Willmore), maximal probability domains in quantum chemistry.
- Study and analysis of partial differential equations (PDEs).

PDEs in moving geometrical domains (shape derivative, minimizing movement, dynamical control by a shape), stability of solutions to non-linear equations by geometric perturbations of the domain, relaxation of PDEs in non-regular domains,  $\Gamma$ -convergence techniques, inverse problems (approach by Carleman estimates).

• Geometry of points, curves, and surfaces. Differential geometry, geometry of convex bodies (rearrangement techniques, Brunn-Minkowski theory), geometric inequalities, geometric measure theory (varifolds, currents), conformal geometry (Willmore).

# Scientific production

- Jan. 2018 MPD Program, J. Dalphin, development and design of a scientific software for computing maximal probability domains (MPD) in quantum chemistry, currently available at https://github.com/ISCDtoolbox/MPD.
- Jan. 2018 Uniform ball condition and existence of optimal shapes for geometric functionals involving boundary-value problems, J. Dalphin, submitted.
- Jan. 2018 Optimal shape of an underwater moving bottom generating surface waves ruled by a forced KdV equation, J. Dalphin and R. Barros, submitted.
- Dec. 2017 Uniform ball property and existence of optimal shapes for a wide class of geometric functionals, *J. Dalphin*, soon published in Interfaces and Free Boundaries (article accepted).
- Oct. 2016 On the minimization of total mean curvature, J. Dalphin, A. Henrot, S. Masnou, and T. Takahashi, Journal of Geometric Analysis, 26(4) p. 2729-2750.
- Dec. 2014 **PhD Thesis**, Study of geometric functionals depending on curvature by shape optimization methods: applications to the functionals of Willmore and Canham-Helfrich, Jérémy Dalphin, TEL-01097663.
- Sept. 2014 Some characterizations of a uniform ball property, J. Dalphin, ESAIM: Proc., 45 p. 437-446.
- May 2011 **Dealing with CCGT: an explicit dynamic model**, *GDF SUEZ Innovation and Research Division: B. Rossi, J. Dalphin, L. Sinègre, and A. Jacquiau; GRTgaz: T. Renaudie*, PSIG conference paper 1120. Work in progress
  - Existence for domains maximizing the probability to find a number of electrons, J. Dalphin and Y. Privat.
  - A new algorithm for maximal probability domains, B. Braïda, E. Cancès, J. Dalphin, P. Frey, and A. Savin.
  - Simulations of some inverse problems in a copper converter, M. Courdurier, J. Dalphin, and A. Osses.
  - Numerics for the Robin Laplacian on a thin layer of random thickness, J. Dalphin and M. Dambrine.

# Education

- 2017-2018 **Research engineer**, Institut des Sciences du Calcul et des Données, Paris, France. Development of a scientific software. Advisor: P. Frey; collaboration with the math. and chemistry laboratory.
- 2016-2017 **Postdoctorate in Applied Mathematics**, Centro de Modelamiento Matemático, Santiago, Chile. Numerics and inverse problems in a copper converter. Advisor: A. Osses; collaboration with M. Courdurier.

- 2015-2016 **Postdoctorate funded by CALSIMLAB labex**, *Institut du Calcul et de la Simulation*, Paris. Computing maximal probability domains. Advisor: P. Frey; collaboration with the chemistry laboratory.
- 2011-2014 **Research Doctorate in Applied Mathematics**, *Institut Elie Cartan de Lorraine*, Nancy, France. Study of vesicules by shape optimization methods. PhD advisors: A. Henrot and T. Takahashi.
- 2007-2011 Graduated a French engineering school, Ecole Nationale Supérieure des Mines de Nancy, France.
- 2009-2011 Master's degree of Applied Mathematics, Université Henri Poincaré, Nancy, France.
- 2002-2007 Scientific Baccalaureate/Preparatory classes (MPSI, MP\*), Lycée Louis le Grand, Paris.

#### Research activities

- Oct. 2015 **Invited speaker to the Maximal Probability Domains Meeting**, *University of Ghent*, Belgium. Presentation of my ongoing work: computing maximal probability domains with adaptive meshes.
- March 2015 **Invited speaker to the Young French Applied Mathematicians Meeting**, *Saint-Brévin*, France. Presentation of the results obtained during my thesis: study of vesicules by shape optimization methods.
- March 2014 **Invited speaker to the MODE Meeting**, *Institut National des Sciences Appliquées*, Rennes, France. Presentation of my thesis results during a session about shape optimization.
  - Oct. 2013 **Invited speaker to the Federation Charles Hermite**, *Institut Elie Cartan*, Nancy, France. Presentation of my thesis work during a scientific day Shapes and Numerical Geometry.
- May 2013 **Participation to the SMAI Congress**, *Seignosse*, France. Presentation of two posters: one about my thesis results and one about the work done at the SEME5.
- 2012-2016 Member of the ANR project Optiform, Nancy, Rennes, Rhône-Alpes, Paris, France. Regular talks given during these trimestrial events about the theoretical/numerical study of optimal shapes.

#### Formative activities

- Nov. 2016 Attended the international colloquium on shape optimization, isoperimetric and functional inequalities, Centre International de Rencontres Mathématiques, Luminy, France.
- Jan. 2016 Attended a mini-colloquium on inverse problems and the control of partial differential equations, Universidad Técnica Federico Santa María, Valparaíso, Chile.
- Aug. 2015 Attended the international workshop on partial differential equations, optimal design, and numerics (short talk given), Centro de Ciencas de Benasque Pedro Pascual, Benasque, Spain.
- June 2015 Attended the courses given at the summer school, *Institut Fourier*, Grenoble, France. Geometric measure theory and calculus of variations: theory and applications.
- June 2012 Attended the courses given at the summer school, Centro di Ricerca Matematica, Pisa, Italy. Geometric and Analytic Techniques in Calculus of Variations and Partial Differential Equations.
- May 2012 Attended the international colloquium about shape optimization and spectral theory, Centre International de Rencontres Mathématiques, Luminy, France.

### Collaboration with companies

- Aug. 2016 **Collaborative reunion with Codelco**, *Instituto de Innovación en Minería and Metalurgia*, Santiago, Chile. Numerics and inverse problems in a copper converter. Collaborators: A. Osses and M. Coudurier.
- Feb. 2013 Attended the event Semaine d'Etude Maths-Entreprises (SEME5), Ecole des Mines, Nancy, France. Reconstruction of geological layers from sparse discrete data. Advisor: G. Caumon (Gocad consortium).
- Mar.-Aug. Internship in a foreign research center, Basque Center for Applied Mathematics, Bilbao, Spain.
- 2010 2010 Shape optimization of an underwater moving bottom generating waves. Advisors: E. Zuazua and R. Barros.
- Sept.-Feb. Assignment for the company GDF SUEZ, Innovation and Research Division (CRIGEN), Paris, France.
- 2009 2010 Modeling of the influence of new combined cycles in the network of gas. Advisors: L. Sinegre and N. Castellan.
- Feb. 2008 Internship, Billon SAS, six weeks spent on a punching-unit in this manufacturing company of Paris, France.

# Teaching activities

- July 2015 Invited teacher at a summer school, Scientific Trends at the Interfaces Mathematics, Chemistry, and High Performance Computing, Roscoff, France.
- Lectures (2x3h) + MATLAB sessions (2x3h): shape optimization, level-set methods, and adaptative meshes. 2011-2014 **Teaching Assistant**, Ecole Nationale Supérieure d'Electricité et de Mécanique, Nancy, France.
- Complex analysis (1x10h), distributions and PDEs (2x12h), numerical analysis and introduction to scientific calculus (MATLAB sessions 1x12h), numerical methods for optimization (MATLAB sessions 3x6h).

# Administrative responsibilities

- 2012-2014 Member of the research laboratory council, Institut Elie Cartan de Lorraine, Nancy, France.
- 2013 Reviewer for an international scientific journal, ESAIM: Proceedings and Surveys.
- 2011-2013 Member of the committee for scientific mediation and computer literacy, INRIA, Nancy, France.