

Curriculum Vitæ December 2016

Current position

2015 - 2018 : Post-doctoral position under the supervision of Joel Fine,
Differential Geometry group, Université Libre de Bruxelles (Belgium).

Education

2012 – 2015 Allocataire moniteur normalien, Université de Cergy-Pontoise, France.
2014 Ph.D. thesis, University of Cergy-Pontoise, France.
Advisors: Olivier Druet (University of Lyon) and Emmanuel Hebey
(University of Cergy-Pontoise).
Title: “Constraint equations in a scalar-field theory”.
Defended December the 5th, 2014.
2011 Agrégation de Mathématiques (French teaching diploma). Rank: 15.
2008 – 2011 Studies at the ENS Lyon.
2006 – 2008 Classes préparatoires MPSI/MP*, Lycée du Parc, Lyon (two-year
undergraduate intensive course in mathematics preparing for national
competitive examination for admission to the French “Grandes Ecoles”).

Research area

My research area stands at the crossroads of nonlinear analysis on manifolds and General Relativity. More specifically, I am interested in a conformal formulation of the initial-value problem in the 3+1 formalism in General Relativity (and more generally in the $n+1$ formalism for $n \geq 3$). In this formulation, finding initial data that evolves into a physically realistic space-time solution of the Einstein equations amounts to solving a nonlinear, highly coupled elliptic system of equations, called the *conformal constraints system*.

I investigated stability and compactness properties for the conformal constraints system (references [2,3,4] below). These stability results admit a reformulation in terms of the physical relevance of the conformal formulation of the initial-value problem. I also obtained existence and multiplicity results (see references [1,2,5,6] below) using both topological methods, applications of the stability results and constructive methods.

More recently, I investigated constructive method to prove the optimality of the above-mentioned stability results. In reference [5] a non-compactness result for the Einstein-Lichnerowicz equation in dimensions larger than 6 in the delicate case of non-trivial non-gravitational physics data was obtained. In references [6] and [7] I extended this non-compactness construction to the full system and investigated the role played by the strong nonlinear coupling in the appearance of blowing-up families of solutions, again in dimensions $n \geq 6$. The blowing-up

constructions in references [5,6,7] imply in particular the existence of an infinite number of solutions to the conformal constraint system as soon as the stability conditions are not satisfied.

Articles

- [1] The Einstein-scalar field constraint system in the positive case, *Communications in Mathematical Physics* **326** (2014), no. 2, 543-557. arXiv:1301.5792
- [2] Effective multiplicity for the Einstein-scalar field Lichnerowicz equation, *Calculus of variations and Partial Differential Equations* **53** (2015), no.1, 29-64. arXiv:1307.2416
- [3] Stability of the Einstein-Lichnerowicz constraints system (with Olivier Druet), *Mathematische Annalen* **362** (2015), no.3, 839-886. arXiv:1312.6574
- [4] Stability and instability of the n -dimensional Einstein-Lichnerowicz constraints system, *International Mathematical Research Notices*, Vol. 2016 no.8, 1951-2025. arXiv:1502.04233
- [5] Non-compactness and infinite number of conformal initial data sets in high dimensions (with Juncheng Wei), *Journal of Functional Analysis* no. 270 (2016), 718-747. arXiv:1505.02806
- [6] A pointwise finite-dimensional reduction method for a fully coupled system of Einstein-Lichnerowicz type, 57 pages, 2016, *preprint*. arXiv:1605.05468
- [7] A pointwise finite-dimensional reduction method for Einstein-Lichnerowicz type systems: the six-dimensional case, 16 pages, 2016, *preprint*.

Conference Proceedings

- [1] A pointwise finite-dimensional reduction method for Einstein-Lichnerowicz type systems, Proceedings of the BruTo PDE's Conference (Torino, 2–5 May 2016). To appear in the *Rendiconti del Seminario Matematico - Università e Politecnico di Torino*.

PhD Thesis

Equations de contraintes en théorie de champ scalaire, 182 pages, 2014.

Invited Talks

- 2016 Workshop “General Relativity: from geometry to amplitudes”,
Isaac Newton Institute for Mathematical Sciences (June 27 – July 1st).
Bruxelles-Torino seminars in PDEs, Università di Torino (Mai 2–5, 2016).
Analysis seminar, University of Nancy (March 8, 2016).
Analysis seminar, Max Planck Insitut für Mathematik, Leipzig (Jan. 29, 2016)
- 2015 Journée de Géométrie, Université Paris-Est Créteil (Nov. 23, 2015)
Séminaire Analyse non linéaire et EDP,
Université Libre de Bruxelles (Oct. 16, 2015)
Séminaire Analyse Numérique et EDP,

- Laboratoire de Mathématiques d’Orsay (Oct 8, 2015)
- IHP Seminar in the three-months program in
Mathematical General Relativity (Oct 7, 2015)
- Thematic School: Geometric aspects in General Relativity,
Université de Montpellier (Sep 30, 2015).
- Séminaire Commun d’Analyse Géométrique, CIRM (Sep 4, 2015).
- Differential Geometry seminar, Université Libre de Bruxelles ULB (July 7, 2015).
- Meeting “Mini-courses in Mathematical Analysis”,
University of Padova (June 22–26, 2015).
- Working group in Statistical Physics, University of Nancy (June 11, 2015).
- 5th Central European Relativity Seminar (CERS5), Budapest (Feb. 26–28, 2015).
- General Relativity seminar, Laboratoire Jacques-Louis Lions,
Paris 6 University (Feb. 11, 2015).
- Conference “Mathematical Physics” of the thematic semester “Partial Differential
Equations and large time asymptotics”, Centre Henri Lebesgue, Nantes
(February 2 – 6, 2015).
- 2014 Nonlinear PDEs seminar, Laboratoire LAGA, Paris 13 University (Nov 28, 2014).
- Differential Geometry seminar, Institut Elie Cartan, University of Nancy
(Nov 18, 2014).
- Differential geometry, Mathematical Physics and PDE seminar,
University of British Columbia, Vancouver (Nov 11, 2014)
- Geometry seminar, University of Nantes (Oct 2, 2014).
- Geometry seminar, Institut Mathématique de Jussieu, Paris 7 University (Sep 29, 2014).
- Geometry and Analysis seminar, University of Nice, (Sep 11, 2014).
- Conference: “Nonlinear PDEs in geometry and physics”, Notre-Dame University, IN,
(Jun 17, 2014).
- Geometry, PDEs and Mathematical Physics seminar, Laboratoire AGM,
Cergy-Pontoise University (Apr 7, 2014).

Research Invitations

- 2016 Workshop in Geometric Analysis and General Relativity,
BANFF Research Station (July. 17–22, 2016)
- Max Planck Insitut für Mathematik, Leipzig, Two weeks, January 16–30, 2016.
- 2014 Notre-Dame University, IN, Three Weeks, June 2014.
- University of British Columbia, Vancouver, One week, November 2014.

Referee for peer-reviewed journals

Communications in Mathematical Physics, Calculus of Variations and PDE
Classical and Quantum Gravity.

Teaching experience

- 2014 – 2015 Exercise classes for the Agrégation
 (French teaching examination requiring a Master’s degree).
 Undergraduate exercise sessions “Calculus and Real analysis”
 (First-year Mathematics degree).
 Undergraduate exercise sessions “Mathematics for biologists”
 (First year Biology degree).
- 2013 – 2014 Exercise classes for the Agrégation
 (French teaching examination requiring a Master’s degree).
 Graduate exercise sessions “Functional Analysis and PDEs”
 (First-year Mathematics Master’s degree).
 Undergraduate exercise sessions “Mathematics for biologists”
 (Second year Biology degree).
- 2012-2013 Exercise classes for the Agrégation
 (French teaching examination requiring a Master’s degree).
 Graduate exercise sessions “Functional Analysis and PDEs”
 (First-year Mathematics Master’s degree).

Languages Spoken

French: Native.

Italian: Native.

English: Proficient.

Spanish: Intermediate.

FSL (French sign language): Intermediate.

Dutch: Learning.