

Bruno PREMOSSELLI

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Curriculum Vitæ October 2017

Current position

2017 - 2020 : “Chargé de Recherche FNRS”, post-doctoral position at the Université Libre de Bruxelles (Belgium), in the Differential Geometry group.

Education and Work Experience

- 2015 – 2017 Postdoctoral position at the Université Libre de Bruxelles under the supervision of J. Fine.
- 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 work follows two main research directions in Geometric Analysis.

In the first direction – at the crossroads of nonlinear analysis on manifolds and mathematical general relativity – I investigated a conformal formulation of the initial-value problem in general relativity, called the *conformal method*. The conformal method allows to determine admissible initial data sets for the Einstein equations by solving a nonlinear critical elliptic system of partial differential equations, called the *conformal constraint system*.

I obtained existence, multiplicity, stability and compactness results for the conformal method (see references [1,2,3,4] below). I then showed the optimality of these stability results by constructing non-compactness examples for the conformal constraint system, first in the decoupled scalar-field case [5], then in the strongly coupled case [6,7]. To deal with a strong coupling I developed a new, promising, constructive method which combines pointwise *a priori* asymptotic analysis techniques with energetic constructive methods.

In [8] I used this new approach in another context to establish new existence and blowing-up results for stationary critical Schrödinger equations in small dimensions.

My second main research direction, developed during my first post-doctoral position in Brussels, deals with the construction of *Riemannian* Einstein metrics. I recently constructed,

see [9] below, a sequence (X_k, g_k) of four-dimensional Riemannian manifolds, where g_k is an Einstein metric with negative scalar and sectional curvature. The specificity of this family of manifolds (X_k) , initially constructed by Gromov and Thurston, is that the X_k never admit a hyperbolic metric (except maybe a finite number of them).

The construction goes through a glueing method where an approximated Einstein metric h_k is deformed, by a suitable version of the inverse function theorem in strong spaces, to a true Einstein metric g_k . Setting up the inverse function theorem requires a delicate understanding of the analytical properties of the Einstein operator in the Bianchi gauge in a neighbourhood of h_k .

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, *Communications in Contemporary Mathematics*, to appear. arXiv:1605.05468
- [7] A pointwise finite-dimensional reduction method for Einstein-Lichnerowicz type systems: the six-dimensional case, 16 pages, 2016, *submitted*.
- [8] Bubbling above the threshold of the scalar curvature in dimensions four and five (with P-D. Thizy), 41 pages, 2017, *submitted*.
- [9] Compact Einstein manifolds with negative curvature (with J. Fine), 2017, *in preparation*.

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

- 2018 Conference “Nonlinear PDEs in Geometry and Physics”, Cortona (11–15 June 2018).
 Joint Mathematics Meetings of the AMS, session “Mathematical Relativity and Geometric Analysis”. University of San Diego (January 12, 2018).
- 2017 Belgium+Chile+Italy conference in PDEs,
 Université Libre de Bruxelles (November 13–17, 2017).
 Conférence “Analyse géométrique à Roscoff” (9–13 Octobre 2017).
 Séminaire MIP, Institut de Mathématiques de Toulouse (June 6, 2017).
 Mathematical General Relativity Seminar, Laboratoire Jacques-Louis Lions, Université Paris 6 (April 10, 2017).
 Mathematical Physics Seminar, Institut Fourier, Grenoble (Feb. 13 2017).
- 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

- 2018 McGill University, Montréal, Two Weeks, January-February 2018.
University of California San Diego, One Week, January 2018.
- 2017 “Geometry and Relativity” programme, Erwin Schrödinger Institute, Vienna
July-August 2017, Three Weeks.
- 2016 Workshop in Geometric Analysis and General Relativity,
BANFF Research Station (July. 17–22, 2016)
Max Planck Institute 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.

Administrative Activities

Organiser of the geometry seminar of the Université Libre de Bruxelles.

Reviewer for the following journals:

Communications in Mathematical Physics (CMP)

Calculus of Variations and PDE (CVPDE)

International Mathematical Research Notices (IMRN)

Classical and Quantum Gravity (CQG)

Journal of Geometry and Physics (JGP)

Teaching experience

- 2017 – 2018 Graduate course “Variational Methods and Partial Differential Equations”, 18h.
- 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: Fluent.

Spanish: Proficient.

FSL (French sign language): Intermediate.