

# Francesco Bonaldi

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## Curriculum Vitæ

Last update: November 19, 2023

### Personal information

Work address **Laboratoire de Modélisation Pluridisciplinaire et Simulations (LAMPS)**  
**Université de Perpignan Via Domitia**  
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### Keywords

continuum mechanics, partial differential equations, contact mechanics, multiphysics linear and nonlinear couplings, wave propagation in heterogeneous media, mechanics of fractured porous media, high-order discretizations (HHO, DG), polytopal meshes, finite element exterior calculus, finite volume methods, asymptotic methods, advanced implementation techniques

### Career path

- 2022–now **Maître de conférences (Assistant/Associate Professor, permanent position) in Applied Mathematics**, *Laboratoire de Modélisation Pluridisciplinaire et Simulations*, Université de Perpignan, France
- 2021–2022 **Postdoctoral researcher**, *Institut Montpelliérain Alexander Grothendieck*, Université de Montpellier, France  
Collaboration with Daniele A. Di Pietro.  
Polytopal exterior calculus and Discrete De Rham (DDR) complexes. Projet MUSE (Montpellier Université d'Excellence, <https://muse.edu.umontpellier.fr/>).
- 2019–2021 **Postdoctoral researcher**, *Inria Sophia Antipolis & Laboratoire J.A. Dieudonné*, Université Côte d'Azur, Nice, France  
Collaboration with Roland Masson, Jérôme Droniou (Monash University), Konstantin Brenner, and Laurent Monasse.  
Numerical simulation of two-phase flow and hydro-mechanical coupling in heterogeneous fractured porous media. Research project funded by Andra.
- 2017–2019 **Postdoctoral researcher**, *MOX, Dipartimento di Matematica*, Politecnico di Milano, Italy  
Collaboration with Paola F. Antonietti.  
Development and analysis of a high-order discontinuous Galerkin method on polygonal and polyhedral grids for elasto-acoustic wave propagation. Project *PolyPDEs*, funded by the Italian Ministry of Research and Education.

- 2016–2017 **Postdoctoral researcher**, *Institut Montpellierain Alexander Grothendieck*, Université de Montpellier, Montpellier, France  
Collaboration with Daniele A. Di Pietro.  
Development and implementation of a nonconforming, hybrid high-order numerical method for Kirchhoff-Love plate bending problems (project *HHOMM* funded by Agence Nationale de la Recherche).

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## Education

- 2013–2016 **Ph.D. in Applied Mathematics**, *Institut Montpellierain Alexander Grothendieck*, Université de Montpellier, France
- Defense date: **July 6, 2016**
  - Advisor: Françoise Krasucki. Co-advisor: Marina Vidrascu
  - Dissertation title: *Mathematical and numerical modeling of structures in the presence of multiphysics linear couplings*
  - Funding: 50% doctoral school of the University of Montpellier, 50% ANR project *ARAMIS* («Analysis of robust asymptotic methods in numerical simulation in mechanics»)
  - **Committee members**: Virginie Bonnaillie-Noël (ENS Paris, chair), Frédéric Hecht (UPMC, referee), Annie Raoult (Paris Descartes, referee), Daniele A. Di Pietro (Montpellier, examiner), Giuseppe Geymonat (Ecole Polytechnique, examiner), Grégory Vial (EC Lyon, examiner), Françoise Krasucki (Montpellier), Marina Vidrascu (Inria de Paris)

### Pre-doctoral studies

- 2012 **M.Sc. in Mathematical Engineering**, *Università di Roma TorVergata*, Rome (Italy).  
Final grade: 110 summa cum laude
- Advisor: Paolo Podio-Guidugli (Rome TorVergata). Co-advisor: Chandrajit Bajaj (UT Austin)
  - Dissertation title: *A continuum theory for the natural vibrations of spherical virus capsids*
- 2009 **B.Sc. in Mathematical Engineering**, *Università di Roma TorVergata*, Rome (Italy).  
Final grade: 110 summa cum laude
- Advisor: Paolo Podio-Guidugli
  - Dissertation title: *Statics of cylindrical shells in membrane regime*

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## Teaching experience

- 2023–2024 **192 hours, Université de Perpignan**  
Instructor of the following classes: Analyse et Calcul Numérique (L3 Maths), Outils Mathématiques pour le Numérique (M1 HPC), Modélisation et Approximation (M1 HPC), Éléments de Mécanique des Milieux Continus (M1 HPC), Initiation à la Modélisation (L3 Maths).
- 2022–2023 **160 hours, Université de Perpignan**  
Instructor of the following classes: Analyse et Calcul Numérique (L3 Maths, M1 HPC), Outils Mathématiques pour le Numérique (M1 HPC), Modélisation et Approximation (M1 HPC).
- 2021–2022 **23 hours, Université de Montpellier**  
Exercise classes for the course *Outils mathématiques pour les sciences de l'ingénieur 3* for first-year undergraduate students (L1) in Electronic and Automation Engineering, and lab sessions for the course *Algèbre linéaire numérique* for second-year graduate students (L2) in Mathematics, 23 hours overall.
- 2019–2021 **48 hours, Université Côte d'Azur**  
Tutoring classes for the course *Résolution numérique de systèmes d'équations linéaires et non linéaires*, Mathematics and Computer Science students, second-year undergraduate students (L2), 40 hours.

## 2013–2016 **190 hours, Université de Montpellier**

- 2013–2014: exercise classes for the course *Analyse L3* (36 hours, L3 Mathematics); lab sessions for the course *Modélisation Mathématique en Mécanique* (30 hours, L3 Mathematics, Mechanics, Mechanical Engineering).
- 2014–2015: exercise classes for the course *Calcul Différentiel et Équations Différentielles* (37,5 hours, L3 Mathematics); lab sessions for the course *Modélisation Mathématique en Mécanique* (24 hours, L3 Mechanics and Mechanical Engineering).
- 2015–2016: exercise classes for the course *Calcul Différentiel et Équations Différentielles* (39 hours, L3 Mathematics); lab sessions for the course *Modélisation Mathématique en Mécanique* (24 hours, L3 Mechanics and Mechanical Engineering).

## Student supervision

- 10/2023–11/2024 **Zhizhuo Zang**, PhD student at Southeast University, Nanjing (China). Dissertation title: “A layer decomposition method for multi-layer elastic systems with interlayer Tresca friction”.
- 02–07/2023 **Christina Mahmoud**, second-year Master’s student of the University of Montpellier, intern at LAMPS. Dissertation title: “*Une formulation mathématique et numérique de problèmes hyperélastiques pour la modélisation des tissus biologiques mous*”.

## Scientific responsibilities

**Deputy director**, CNRS Research Federation “OcciMath”, bringing together researchers in Mathematics from Montpellier, Perpignan, and Toulouse, Starting in January 2024  
Director: Matthieu Hillairet (IMAG, Univ. Montpellier). Second deputy director: Laurent Manivel (IMT, Univ. Paul Sabatier, Toulouse)

**Correspondant AMIES (Agence pour les Mathématiques en Interaction avec l’Entreprise et la Société)**, LAMPS, Université de Perpignan

## Teaching responsibilities (in French)

**Responsable** de la première année du Master en “Calcul Haute Performance et Simulation” (CHPS), Université de Perpignan

**Responsable** de la mineure de réorientation en Mathématiques pour la formation L1 PASS (Parcours Accès Spécifique Santé), Université de Montpellier

**Membre** de la commission pédagogique chargée de l’examen des dossier des étudiants du Master CHPS pour la rentrée 2022–2023, Université de Perpignan

**Membre** du comité de sélection pour un poste d’ATER (Attaché(e) Temporaire d’Enseignement et Recherche), Section 26 (Mathématiques Appliquées), Université de Perpignan

## Popularization (in French)

Participation à la “**Journée Portes Ouvertes**” de l’Université de Perpignan (15 février 2023), référent pour la Licence de Mathématiques et pour le Master CHPS (Calcul Haute Performance et Simulation)

Participation à la “**Journée d’Accueil post-bac**” de l’Université de Perpignan (8 février 2023), référent pour la Licence de Mathématiques.

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## Distinctions and awards

- 2023 **BQR 2023 (Bonus Qualité Recherche)**, *Organization of the conférence JOMA (Journées d'Occitanie en Mathématiques Appliquées)*, June 8 and 9, 2023, Université de Perpignan, in collaboration with Mikäel Barboteu (LAMPS, Université de Perpignan)  
Funding: 2000 €
- 2017 **Qualification aux fonctions de Maître de conférences**, Sections 26 (Applied Mathematics) and 60 (Mechanics)
- 2014 **ECCOMAS Scholarship**, *ECCOMAS*, Barcelona (Spain)  
Scholarship for participation to the 11th World Congress on Computational Mechanics.
- 2012 **National Initiative for Modeling and Simulation (NIMS) Fellowship**, *Institute for Computational Engineering and Sciences*, The University of Texas at Austin, Austin, TX (United States)  
Fellowship for the Ph.D. Program in *Computational Sciences, Engineering and Mathematics*.

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## Organization activities

- 2023 **Journées de Lancement d'OcciMath**, *Apr 4–5, 2024*, Perpignan, co-organizer  
Opening conference of the CNRS research federation “OcciMath” (Fédération Occitane de Recherche en MATHématiques) bringing together researchers from Montpellier, Perpignan, and Toulouse.  
**Journées d'Occitanie en Mathématiques Appliquées (JOMA)**, *June 8–9, 2023*, Perpignan, co-organizer  
This conference is thought of as a pre-opening of the CNRS research federation “OcciMath” (Fédération Occitane de Recherche en Mathématiques) bringing together researchers from Montpellier, Perpignan, and Toulouse. The general theme of the workshop is “Variational and numerical analysis of partial differential equations and their applications in mechanics”.
- 2022 **Minisymposium “Advances in structure-preserving methods and applications”**, *ECCOMAS 2022*, Oslo (Norway), in collaboration with J. Aghili (Université de Strasbourg).

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## Referee activity

I am **Review Editor** for the journal **Frontiers in Applied Mathematics and Statistics**.

I was appointed as a referee for the following journals:

- **Mathematics of Computation**
- **Journal of Computational Physics**
- **ESAIM: Mathematical Modelling and Numerical Analysis**
- **Nonlinear Analysis: Real World Applications**
- **Journal of Elasticity**
- **Applied Numerical Mathematics**
- **International Journal for Numerical Methods in Engineering**
- **SIAM Journal on Scientific Computing**
- **Numerical Algorithms**
- **Advances in Computational Mathematics**
- **Calcolo**
- **International Journal of Numerical Analysis and Modeling**
- **Mathematical Reviews**

## Research interests

From a general viewpoint, I am interested in

- Numerical and theoretical aspects of PDEs
- Multiphysics problems
- Applications in Continuum (Solid or Fluid) Mechanics

Current research topics include:

- Finite element exterior calculus and discrete De Rham complexes
- Poroelasticity with fractures in the presence of two-phase flows
- Gradient Discretization Method
- Discretization methods on polytopal grids (Hybrid High-Order, Discontinuous Galerkin)

## Proposed research projects

- 2019 *New mathematical and numerical models for plate-like smart structures*, Project submitted for a renewable fixed-term research contract, having obtained the **second best evaluation (28,5/30)** among all the research proposals of *shortlisted candidates* in all scientific domains, including medical science.

## Participation to research projects

- 2018 *Metodi numerici avanzati per lo studio di problemi differenziali multifisica/multiscala alle derivate parziali* (Advanced numerical methods for multiphysics/multiscale partial differential problems), GNCS (National Group of Scientific Computing), INdAM, P.I.: Ilario Mazziere. Funding: 4 k€

## Memberships

- 2019 Member of the *Groupe de Recherche MANU* (Mathematics for Nuclear)
- 2018 GNCS–*Gruppo Nazionale per il Calcolo Scientifico* (National Group of Scientific Computing), INdAM–Istituto Nazionale di Alta Matematica (*National Institute for Higher Mathematics*)

## Publications

### Preprints

3. M. Barboteu, F. Bonaldi, S. Dumont, and C. Mahmoud. An energy-consistent discretization of hyper-viscoelastic contact models for soft tissues. Submitted. Preprint [hal-04291073](#), 2023.
2. F. Bonaldi, D. A. Di Pietro, J. Droniou, and K. Hu. An exterior calculus framework for polytopal methods. Submitted. Preprint [hal-04037653](#), [arXiv:2303.11093](#), 2023.
1. F. Bonaldi, J. Droniou, and R. Masson. Numerical analysis of a mixed-dimensional poromechanical model with frictionless contact at matrix–fracture interfaces. Submitted, 2022. Preprint [hal-03541096](#).

## Refereed journal papers

11. M. Barboteu, F. Bonaldi, D. Danan, and S. El-Hadry. An improved normal compliance method for dynamic hyperelastic problems with energy conservation property. *Commun. Nonlinear Sci. Numer. Simul.*, 2023. To appear. Preprint [hal-03955591v2](#), [arXiv:2301.10471](#).
10. F. Bonaldi, J. Droniou, R. Masson, and A. Pasteau. Energy-stable discretization of two-phase flows in deformable porous media with frictional contact at matrix–fracture interfaces. *J. Comput. Phys.*, page 110984, 2022. DOI: [10.1016/j.jcp.2022.110984](#).
9. F. Bonaldi, K. Brenner, J. Droniou, R. Masson, A. Pasteau, and L. Trenty. Gradient discretization of two-phase poro-mechanical models with discontinuous pressures at matrix fracture interfaces. *ESAIM Math. Model. Numer. Anal.*, 55:1741–1777, 2021. Preprint [hal-02997396v2](#), [arXiv:2011.05576](#). DOI: [10.1051/m2an/2021036](#)
8. F. Bonaldi, K. Brenner, J. Droniou, and R. Masson. Gradient discretization of two-phase flows coupled with mechanical deformation in fractured porous media. *Comput. Math. with Appl.*, 98:40–68, 2021. Preprint [hal-02454360](#), [arXiv:2004.09860](#).
7. P.F. Antonietti, F. Bonaldi, and I. Mazzieri. Simulation of 3D elasto-acoustic wave propagation based on a Discontinuous Galerkin Spectral Element method. *Internat. J. Numer. Methods Engrg.*, 2020. DOI: [10.1002/nme.6305](#).
6. P.F. Antonietti, F. Bonaldi, and I. Mazzieri. A high-order discontinuous Galerkin approach to the elasto-acoustic problem. *Comput. Methods Appl. Mech. Engrg.* 358, 2020. DOI: [10.1016/j.cma.2019.112634](#).
5. F. Bonaldi, D.A. Di Pietro, G. Geymonat, and F. Krasucki. A Hybrid High-Order method for Kirchhoff–Love plate bending problems. *ESAIM Math. Model. Numer. Anal.*, 52:393–421, 2018. Preprint [arXiv:1706.06781](#).
4. F. Bonaldi, G. Geymonat, F. Krasucki, and M. Vidrascu. Mathematical and numerical modeling of plate dynamics with rotational inertia. *J. Numer. Math.*, 26:21–33, 2017.
3. F. Bonaldi, G. Geymonat, F. Krasucki, and M. Serpilli. An asymptotic plate model for magneto-electro-thermo-elastic sensors and actuators. *Math. Mech. Solids*, 22:798–822, 2017.
2. F. Bonaldi, G. Geymonat, and F. Krasucki. Modeling of smart materials with thermal effects: dynamic and quasi-static evolution. *Math. Models Methods Appl. Sci.*, 25:2633–2667, 2015.
1. F. Bonaldi and M. Frémond. Collision, damage, smooth evolution of an articulation. The “tennis elbow”. *Meccanica*, 48:1117–1126, 2013.

## Book chapters

1. F. Bonaldi, K. Brenner, J. Droniou, and R. Masson. The gradient discretisation method for two-phase discrete fracture matrix models in deformable porous media. In Robert Klöforn, Eirik Keilegavlen, Florin A. Radu, and Jürgen Fuhrmann, editors, *Finite Volumes for Complex Applications IX - Methods, Theoretical Aspects, Examples*, pages 295–303, Cham, 2020. Springer International Publishing.

## Conference proceedings

2. F. Bonaldi, K. Brenner, J. Droniou, R. Masson. Two-Phase Darcy Flows in Fractured and Deformable Porous Media, Convergence Analysis and Iterative Coupling. *Conference Proceedings, ECMOR XVII, Volume 2020*, 1–20, DOI: [10.3997/2214-4609.202035013](https://doi.org/10.3997/2214-4609.202035013).
1. F. Bonaldi, G. Geymonat, F. Krasucki, and M. Serpilli. Temperature influence on smart structures: a first approach. In A. Huerta, E. Onate, and X. Oliver, editors, *11th World Congress on Computational Mechanics, WCCM 2014*, 3357–3368. International Center for Numerical Methods in Engineering, 2014.

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## Talks

- SISSA mathLab Seminar, Trieste (Italy), November 2023
- 29th French-Polish Seminar of Mechanics, Gdansk (Poland), September 2023
- ENUMATH 2023, Lisbon (Portugal), September 2023
- Nonsmooth Problems with Applications in Mechanics, Bedlewo (Poland), June 2023
- CFC 2023, Cannes (France), April 2023
- ECCOMAS 2022, Oslo (Norway), June 2022
- FRAME2020+2 (Fractured media: numerical methods for fluid flow and mechanics), Politecnico di Torino, May 2022
- Séminaire de l'équipe Inria M3DISIM, Inria Saclay, December 16, 2021
- Séminaire du LAMPS, Université de Perpignan Via Domitia, December 9, 2021
- Séminaire ACSIOM, IMAG, Université de Montpellier, October 26, 2021
- Mathias Days 2021, Minisymposium "Reservoir simulation", October 6, 2021
- SIMAI 2020+1, Minisymposium "Advances in polygonal and polyhedral methods", August 30, 2021
- SIAM GS 2021, Minisymposium "Mathematical and numerical methods for coupled interface-driven mixed-dimensional problems", June 22, 2021
- Interpore 2021, Minisymposium "Flow, transport and mechanics in fractured porous media", June 1, 2021
- Séminaire EDP & Analyse Numérique, LJAD, Université Côte d'Azur, February 25, 2021
- Séminaire Mécanique des Solides, Institut Jean Le Rond d'Alembert, February 9, 2021
- The Gradient Discretisation Method for Two-phase Discrete Fracture Matrix Models in Deformable Porous Media, Algoritmy 2020, online conference, September 14, 2020
- The Gradient Discretisation Method for Two-phase Discrete Fracture Matrix Models in Deformable Porous Media, Finite Volumes for Complex Applications IX, online conference, June 16, 2020
- Séminaire EDP & Analyse Numérique, LJAD, Université Côte d'Azur, December 12, 2019
- 5th ECCOMAS Young Investigators Conference, mini-symposium "Recent advances in numerical methods for seismic wave propagation", Krakow, September 2019.
- MAFELAP 2019 Conference, mini-symposium "Numerical methods in structural mechanics and for higher order problems", June 20, 2019.

- Séminaire de Mécanique, Laboratoire de Mathématiques Nicolas Oresme, Université de Caen, March 18, 2019
- Séminaire d'Analyse Numérique et Calcul Scientifique, Laboratoire de Mathématiques de Besançon, March 14, 2019
- Seminar at DISMA (Excellence Project), Politecnico di Torino, March 5, 2019
- Séminaire Mécanique des Fluides, Institut Jean Le Rond d'Alembert, Sorbonne Université, February 19, 2019
- Séminaire Equations aux dérivées partielles, IRMA de Strasbourg, January 29, 2019
- *A discontinuous Galerkin approach to the elasto-acoustic problem on polytopic grids*, SIMAI Conference, Rome (Italy), July 3, 2018.
- *Une approche Galerkin discontinue au problème élasto-acoustique sur des maillages polyédriques*, CANUM 2018, Cap d'Agde (France), May 29, 2018.
- *Une approche Galerkin discontinue d'ordre élevé au problème élasto-acoustique*, Journées Jeunes EDPistes 2018, Nancy, March 22, 2018.
- *A Hybrid High-Order method for Kirchhoff–Love plate bending problems*, MOX NuMeth Seminar, Politecnico di Milano, November 16, 2017.
- *Une méthode hybride d'ordre élevé pour les plaques en flexion*, Séminaire de Mathématiques Appliquées, Laboratoire de Mathématiques Jean Leray, Université de Nantes (France), October 19, 2017.
- *Coupling elastodynamics and acoustics: a Discontinuous Galerkin approach*, POEMS 2017 Workshop, Milan (Italy), July 6, 2017.
- *A Hybrid High-Order method for Kirchhoff–Love plate bending problems*, ARAMIS Workshop, Pau (France), Jun. 13, 2017.
- *Numerical modeling of Kirchhoff–Love plates with rotational inertia*, Journées FreeFEM++, Paris (France), Dec. 16, 2015.
- *Temperature influence on smart structures: a first approach*, Journées ARAMIS, Compiègne (France), Sep. 11, 2014.
- *Temperature influence on smart structures: a first approach*, 11th World Congress on Computational Mechanics, Barcelona (Spain), July 22, 2014.
- *Mathematical modeling of linear thermo-electromagnetoelastic Materials*, Ph.D. students seminar, Montpellier (France), Apr. 30, 2014.
- *Mechanical modeling of virus capsids–Part II*, Computational Visualization Center seminars, UT Austin (United States), Mar. 28, 2012.
- *Mechanical modeling of virus capsids–Part I*, Computational Visualization Center seminars, UT Austin (United States), Jan. 18, 2012.

## Research visits

- 2023 **Scuola Internazionale Superiore di Studi Avanzati (SISSA), Trieste (Italy)**, invited by Andrea Cangiani, Nov 15–17.
- 2019 **Laboratoire J.A. Dieudonné, Université Côte d'Azur, Nice**, invited by Roland Masson, June 13–14

- 2016 **Erwin Schrödinger International Institute for Mathematics and Physics (ESI)**, Vienna (Austria), thematic programme *Nonlinear Flows*, invited by Ulisse Stefanelli, May 31–June 8 and July 10–July 15
- 2014 **Laboratoire de Mathématiques et de leurs Applications**, *Université de Pau et des Pays de l'Adour*, Pau (France), invited by Marc Dambrine and Victor Péron, June 1–June 8
- 2012 **Institute for Computational Engineering and Sciences**, *The University of Texas at Austin*, Austin, TX (United States), invited by Chandrajit Bajaj, Jan.–Mar. (three months)

## Language skills

English fluent  
French fluent  
Italian native

## Computer skills

Fortran and C++ programming. Advanced knowledge of MATLAB, Mathematica, FreeFEM++, L<sup>A</sup>T<sub>E</sub>X.

## Other experiences

- 2019 **ENUMATH Conference (participation as an attendee)**, *Egmond Aan Zee (Netherlands)*, Sep. 30–Oct. 4
- 2016 **Workshop: Industry and mathematics (participation as an attendee)**, *Institut Henri Poincaré*, Paris, Nov. 21–23
- 2015 **CEA-EDF-Inria summer school *New Trends in Compatible Discretizations* (participation as an attendee)**, *Inria de Paris-Rocquencourt*, Rocquencourt (France), June 29–July 2
- 2014 **Semaine d'Étude Maths-Entreprises**, *Centre International de Rencontres Mathématiques*, Marseille (France), Apr. 14–18  
Exchanges between industrial and academic environments through a week of work on problems posed by industrialist and requiring innovative mathematical and computational approaches.