Curriculum vitæ

Daniele A. Di Pietro

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Contents

1 Personal information

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1.1 Education

6/12/2010 **Habilitation** (*Habilitation à Diriger des Recherches*), École des Ponts (ENPC), Université Paris-Est, *Nonconforming methods for PDEs with diffusion*

28/3/2006 **PhD Thesis**, Università di Bergamo, *Discontinuous Galerkin methods for the incompressible Navier–Stokes equations*. Part of my PhD thesis was carried out at École Polytechnique Fédérale de Lausanne (EPFL)

11/7/2002 **Master in Engineering**, Università di Bergamo, 110/110 with honors (lode)

1.2 Current positions

2021–pres. **Director of Institut Montpelliérain Alexander Grothendieck (IMAG)**, Université de Montpellier (UM). IMAG is a joint research unit of University of Montpellier and Centre National de la Recherche Scientifique (CNRS), and one of the hubs of mathematical research in the South of France with over 170 researchers (∼100 of which holding permanent positions). Its former members include the Fields medalist Alexander Grothendieck (who graduated and later served as professor at University of Montpellier). Research at IMAG covers a wide range of topics, from fundamental developments to industrial applications.

1/9/2012–pres. **Full professor** (*Professeur des Universités Classe Exceptionnelle*) at IMAG

1.3 Previous positions

2019–2020 **Deputy director of IMAG**

2014–2020 Head of the *Analyse, Calcul Scientifique Industriel et Optimisation de Montpellier* (ACSIOM) research team (∼40 members, ∼20 of which holding permanent positions). The research activities of ACSIOM focus on the theoretical and numerical analysis of partial differential equations with applications to environmental, biological, and biomedical problems.

1/4/2007–31/8/2012 **Senior researcher** at the Department of Applied Mathematics of IFP Energies Nouvelles (IFPEN), Rueil-Malmaison (France)

1/2/2006–31/3/2007 **Post-doctoral researcher** at the Centre d'Enseignement et de Recherche en Mathématiques et Calcul Scientifique (CERMICS), ENPC, Paris (France)

1/1/2005–30/6/2005 **Visiting PhD assistant**, CMCS, EPFL, Lausanne (Switzerland)

1.4 Fellowships, awards, and distinctions

2019–2020 CNRS professor appointment (*délégation CNRS*, 1 year half time) at IMAG

4–5/2018 STaRs invited professor (*Supporting Talented Researchers*) at Università di Bergamo

2016–2017 CNRS professor appointment (1 year half time) at Institut Henri Poincaré (Paris)

2016 ITALY (*Italian TALented Young researchers*) fellowship, Università di Bergamo, Italy

2012–pres. French national award for Doctoral Supervision and Research

1.5 Memberships

2015–pres. Member of *Société de Mathématiques Appliquées et Industrielles* (SMAI)
2016–pres. Member of *European Mathematical Society* (EMS)
2015–pres. Member of the French Research Network MaNu (*Mathématiques pour le Nucléaire*)

2 Research activities

My main research topics include: advanced numerical methods for partial differential equations (PDEs), a priori and a posteriori error analysis, efficient implementation algorithms. I have worked on problems in several branches of fluid- and solid-mechanics, porous media flows, and electromagnetism, mostly issued from applications in the field of energy and environment. In this section, I will briefly discuss my main contributions and provide a citation overview.

2.1 Some contributions

From the mathematical viewpoint, my research activity focuses on the design and analysis of advanced computer simulators for challenging PDE problems. A summary of my main contributions in this field is provided below.

2.1.1 Hybrid High-Order methods

In [56, 61] I have introduced Hybrid High-Order (HHO) methods, a paradigm for the design and analysis of nonconforming/mixed methods supporting general polytopal meshes (i.e., meshes including elements of general shape, nonmatching interfaces, etc.) and arbitrary order. The support of polytopal meshes is a distinctive advantage in applications involving complex geometries (to reproduce fine details with fewer elements than, say, matching simplicial meshes), local mesh adaptation (which can be performed in a nonconforming manner, thus avoiding to trade mesh regularity for size), or in the presence or embedded or moving interfaces (where the additional flexibility simplifies the matching of 2D and 3D meshes). Such features are encountered, e.g., when modeling nuclear waste storage (where the storage site has several details on a much smaller scale than the surrounding subsoil) or CO_2 storage (where one must account for geological features such as faults).

In their original flavor, HHO methods hinge on unknowns that are polynomials of a given degree $k \geq 0$ located at mesh elements and faces. From such unknowns, one can reconstruct higher-order functions mimicking a Stokes formula inside each element, and use them to formulate consistency and stabilization terms. Crucially, stabilization is conceived so as to vanish for polynomial functions of degree up to $k + 1$, leading to methods that converge faster than, say, hybridized versions of discontinuous Galerkin (DG) methods [50]. With a suitable discretization of forcing terms, HHO schemes additionally verify local balances with equilibrated numerical fluxes [17, 57].

The HHO paradigm has been adopted and developed by several research groups around the world, and has made its way into industrial codes developed by EDF (Code_Saturne and Code_Aster). Applications of HHO methods on which I have worked include, among others, incompressible flows [26, 39, 51, 53], poromechanics [14, 84, 93, 48], flows in fractured porous media [28, 35]. My recent monograph [1] covers several aspects concerning the design and analysis of HHO methods, and is a perfect introduction to the subject for students and young researchers.

2.1.2 Numerical analysis of problems featuring nonlinear physics

I have given major contributions to the numerical analysis of problems featuring real-life physics with highly nonlinear behaviors. Examples of such problems include, e.g., flows governed by the Navier–Stokes equations (and possibly including other physical phenomena, such as electromagnetism) or viscous processes governed by Leray–Lions type problems (like glacier motion).

An original point in my approach to nonlinear problems is the combined use of different advanced analysis techniques, including error estimates and convergence by compactness. Compactness techniques enable convergence proofs under very general assumptions on the regularity of both the data and the problem solution, representative of real-life situations. They hinge on key discrete functional analysis tools such as Poincaré-type inequalities and Rellich-like compactness results, whose proof at the discrete level is often very challenging. In [76] I proved such results for DG spaces built upon general polytopal meshes. I later extended these results to hybrid spaces in [44], where they were used to derive the first convergence analysis of HHO methods for Leray–Lions problems. Such problems display additional difficulties linked to the fact that they are posed in a non-Hilbertian setting. This work, along with the error estimates derived in [43] (see also the improved version of [19]), was the starting point to tackle more complex problems. We can cite, in particular, nonlinear elasticity [42] and poromechanics [23], and incompressible flows of non-Newtonian fluids [15], possibly including generalizations of the convective term encountered in optimal transport [16].

2.1.3 Robustness with respect to the problem data

Another field where I have given major contributions is the robust discretization, and corresponding analysis, of problems featuring large variations of the problem data (possibly involving singular limits). Handling such variations in a robust manner is key to the ensure the accuracy of their numerical approximations.

For linear problems featuring singular limits, the general idea consists in linking the regime (depending on the possibly degenerate coefficients) to a locally defined dimensionless number, then precisely tracking the dependence on such number in the error estimates. For instance, in the locally degenerate diffusion-advection-reaction problems considered in [55] (see also [78]), the convergence rates are expressed in terms of the meshsize and of local Péclet numbers involving diffusion, advection, and length scales characteristic of a given element. This technique has been applied in [30] to estimate the convergence rates of HHO discretizations of linearized versions of the Navier–Stokes equations. Another example is the Brinkman problem considered in [34], where the (Darcy- or Stokes-dominated) regime is expressed in terms of a local coefficient of friction.

Another class of problems where the variations of physical coefficients can be problematic are those affected by locking phenomena. A classical example encountered in solid mechanics is quasi-incompressible linear elasticity. In [56], the robustness of HHO methods in such situations is shown leveraging commutation properties of reconstructed differential operators. A more subtle set of properties is required in plate problems. In [17], I have proposed a polygonal method which achieves robustness with respect to the plate thickness by leveraging the properties of a discrete de Rham sequence. A less classical example of locking phenomenon is encountered in the discretization of incompressible flows with large irrotational body forces. In this case, erratic numerical behaviors result from the failure to reproduce a Hodge-type decomposition at the discrete level. In [24, 51], I have proposed HHO methods that circumvent this problem leveraging projections on $\boldsymbol{H}(\mathrm{div})$-conforming spaces in the right-hand side.

2.1.4 Discrete de Rham methods

The stability of numerical methods and their robustness with respect to problem data often hinge on deep mathematical structures that involve analytical, homological and algebraic aspects. In problems of practical interest, like those encountered in electromagnetism, such structures are expressed by the cohomology of Hilbert complexes (the most famous of which is the de Rham complex). Numerical methods that reproduce the complex structure at the discrete level are referred to as *compatible*.

A research avenue that I have been exploring very recently [25] concerns the construction and analysis of discrete complexes on polytopal meshes. This is a very promising subject, as it will enable to merge two very successful and timely research streams: polytopal methods and Finite Element Exterior Calculus. Preliminary results show that polytopal methods can lead to leaner constructions with fewer degrees of freedom, particularly so for certain complexes and/or element shapes. In [17], I have been able to obtain what appears to be the first complete set of results for polyhedral discretizations of the de Rham sequence, including not only complex and stability properties (available also for other methods, such as Virtual Elements), but also very general primal and adjoint consistency results. Obtaining the latter results is very challenging, with major mathematical difficulties grounded in the fact that polytopal methods are nonconforming (as demonstrated by the need for stabilization terms).

Despite being very recent, the discrete de Rham (DDR) paradigm has already been applied to derive stable and robust discretizations of model problems including the equations of magnetostatics [18] and, very recently, Reissner–Mindlin plate problems [8].

2.1.5 Other contributions

Concerning older contributions, for the sake of brevity I will discuss a selection of highlights.

The monograph [2] is the first book where a rigorous analysis of DG methods is carried out on general polytopal meshes. This work has over 400 citations on MathSciNet and is an essential reference in the field. Preliminary ideas that have lead to this monographs are contained in [76] (discrete functional analysis results for DG methods), [68] (DG on agglomerated meshes), and [79–81] (DG methods for incompressible flows).

Another stream of research that I have been following is a posteriori error analysis by flux equilibration. This topic has been developed in the framework of industrial collaborations with IFPEN and EDF. The major outcomes are contained in [47] (poroelasticity), [60, 62, 64] (multiphase Darcean flows) and, more recently, [11] (contact problems).

2.2 Bibliometrics

As of 3 September 2022, my **93 works in Scopus** have been **cited 2218 times by 1036 documents** and my **h-index is 27**; see `https://www.scopus.com/authid/detail.uri?authorId=6603444428`. My ten most cited publications in Scopus have 203 / 184 / 153 / 118 / 110 / 94 / 89 / 81 / 61 / 51 citations.

At the same date, my **86 works in MathSciNet** have been **cited 2127 times by 1417 authors**; see `http://www.ams.org/mathscinet/search/author.html?mrauthid=790640`. My ten most cited publications in MathSciNet have 491 / 164 / 117 / 90 / 90 / 82 / 78 / 64 / 53 / 53 citations.

Finally, according to Google Scholar, at the same date I have collected **5046 citations** (3738 since 2017), corresponding to an **h-index of 35** (30 since 2017) and an **i10-index of 67** (55 since 2017); see `https://scholar.google.fr/citations?user=KFd4Jm8AAAAJ&hl=en`.

3 Scientific outreach

3.1 Evaluation of the research

I have acted as referee for all the major international journals in Numerical Analysis and Scientific Computing (*Numer. Math.*, *SIAM J. Numer. Anal.*, *Math. Comp.*, *Math. Models Meth. Appl. Sci.*, *SIAM J. Sci. Comput.*, *J. Comput. Phys.*,*Comp. Math. Appl.*, etc.)

I have also served as referee for several national research agencies and institutions (ANR France, CONACYT Chile, FWF Austrian Science Found, PRIN Italy, The Royal Swedish Academy of Science, NWO Netherlands, Los Alamos National Labs, POR FSE Regione Friuli-Venezia-Giulia, etc.)

I have been member of evaluation panels for ANR (details omitted owing to the confidentiality agreement).

3.2 Editorial activity

- *2022–pres.* Associate Editor of Frontiers in Applied Mathematics and Statistics
- *2020–pres.* Associate editor of Numerical Algorithms, Springer
- *2020* Editor for the volume *Polyhedral methods in geosciences* of the SEMA-SIMAI Springer series [3]
- *2016* Editor for the volume *Numerical methods for PDES: State of the Art Techniques* of the SEMA-SIMAI Springer series [4]

3.3 Organization of scientific meetings

- *2022* Member of the Scientific Committeee of the POEMS 2022 conference (Milan, Italy). See `https://mox.polimi.it/POEMS2022/`
- *2021* Organizer of the NEMESIS virtual workshop, `https://imag.umontpellier.fr/~di-pietro/NEMESIS.html`
- *2020* Organizer of the mini-symposium *Polyhedral discretization methods for geomechanical simulation*, SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS21), June 21–24, 2021 (Milan, Italy)
- *2020* Organizer of the mini-symposium *Low and high-order polytopal methods: developments and applications*, ALGORITHMY 2020 conference (Vysoke Tatry, Podbanske). Conference switched to hybrid mode after the COVID-19 crisis

2020 Organizer of the mini-symposium *Numerical Methods for Polygonal and Polyhedral Meshes*, WCCM XIV-ECCOMAS 2020 conference (Paris, France). Conference moved to January 2021 in fully virtual mode owing to the COVID-19 crisis

2019 Organizer of the POEMS 2019 conference at CIRM (29 Apr.– 3 May 2019). See https://imag.umontpellier.fr/~di-pietro/poems2019.html, where slides and posters from the conference can be found

2019 Organizer of the mini-symposium *Theoretical and computational advances in polygonal and polyhedral methods*, MAFELAP 2019 (Brunel University, London)

2019–pres. Co-organizer of the *Numerical Algebraic Geometry and Algebraic Numerical Analysis (NAGANA)* workgroup at IMAG. See https://imag.umontpellier.fr/~di-pietro/nagana.html

2017 Organizer of the mini-symposia *Polyhedral Methods and Applications* and *Recent advances on polyhedral discretizations*, ENUMATH 2017 international conference (Bergen, Norway)

2016 Coordinator of the **IHP thematic quarter** *Numerical Methods for PDEs*. The quarter included one summer school and three international conferences:

- Introductory school (IESC, Corse, 5–9 Sept. 2016)
- *Advanced numerical methods: recent developments, analysis, and applications* (IHP, 3–7 Oct. 2016)
- *Recent developments in numerical methods for model reduction* (IHP, 7–10 Nov. 2016)
- *Industry and mathematics* (IHP, 21–23 Nov. 2016)

Detailed information at https://imag.umontpellier.fr/~di-pietro/ihp-nmpdes.html An IHP thematic quarter requires two years of preparation after the project is selected. A book and two special issues resulted from this thematic quarter:

- D. A. Di Pietro, A. Ern, and L. Formaggia, eds. *Numerical Methods for PDEs. State of the Art Techniques*. Vol. 15 SEMA-SIMAI. Springer International Publishing, 2019. ISBN: 978-3-319-94675-7 (Hardcover) 978-3-319-94676-4 (eBook). DOI: 10.1007/978-3-319-94676-4.
- P. F. Antonietti, J. Droniou, and R. Eymard, eds., *Special Issue: Advanced Numerical Methods: Recent Developments, Analysis and Applications*, Computational Methods in Applied Mathematics, Volume 18, Issue 3.
- T. Leliévre, S. Perotto, G. Rozza, eds. *Special Issue on Model Reduction*, Journal of Scientific Computing, Volume 81, Issue 1. ISSN: 0885-7474 (Print) 1573-7691 (Online).

2007 Organizer of the international workshop *Discontinuous Galerkin Methods: From theoretical developments to industrial applications* (Bergamo, Italy)

3.4 Selection of recent invited presentations

For some of the following presentations, slides (and, occasionally, videos) are available on my web page http://imag.umontpellier.fr/~di-pietro.

3.4.1 Outside France (selection 2011–pres.)

July 2022 Invited speaker at SIAM AN22, minisymposium *Recent developments in mathematical analysis and numerics for incompressible flow and related problems*. Upcoming

June 2022 Invited speaker at ECCOMAS 2022, minisymposia *Structure preserving and adaptive polytopal methods*, *Structure-Preserving Finite Element Methods in Computational Fluid Dynamics*, and *Multi-scale and multi-level numerical methods for non-linear solids*, Oslo (Norway). Upcoming

May 2022 Plenary speaker at *100 years Unione Matematica Italiana – 800 years Università di Padova* conference

Jan. 2022 Colloquium talk at École Polytechnique Fédérale de Lausanne

May 2021 Invited seminar at Dipartimento di Matematica *Tullio Levi-Civita*, Università di Padova (Italy)

April 2021 Invited speaker at the Bi.discrete seminar, Universität Bielefeld (Germany). Seminar held remotely owing to the COVID-19 crisis

Mar. 2021 Invited speaker at the SIAM Conference on Computational Science and Engineering, minisymposium *Compatible Discretizations for Models in Magnetostatics, Magnetohydrodynamics and Fluid Flow*, Fort Worth, Texas (US). Conference in hybrid mode after the COVID-19 crisis

Jan. 2021 Keynote lecturer at the Oberwolfach thematic week *Nonstandard Finite Element Methods*

Nov. 2020 Invited seminar at Dipartimento di Matematica *Tullio Levi-Civita*, Univ. Padova (Italy). Seminar held remotely owing to the COVID-19 crisis

Jul. 2020 Invited speaker at the ICOSAHOM conference, minisymposium *High order methods on polyhedral meshes*, Vienna (Austria). Held remotely in 2021 owing to the COVID-19 crisis

May 2020 Keynote speaker at the InDAM Workshop *Polygonal methods for PDEs: Theory and applications*, Rome (Italy). Held remotely in 2021 owing to the COVID-19 crisis

Jul. 2019 Invited speaker at the ICIAM 2019 international conference (Valencia, Spain), minisymposium *Polygonal and polyhedral methods in Applied Mathematics*

June 2019 Invited speaker at the MAFELAP 2019 international conference (Brunel University, UK), minisymposium *High Performance Finite Element Technique*

Mar. 2019 Invited seminar at SISSA (Italy)

Oct. 2018 Invited seminar at Univ. Udine (Italy)

May 2018 STaRs (*Supporting Talented Researchers*) invited seminar (4h) at Univ. Bergamo (Italy)

Dec. 2017 Invited seminar at Univ. Bergamo (Italy)

July 2017 Plenary speaker at the *POEMS 2017* international workshop (Univ. Milano Bicocca)

July 2017 Invited doctoral mini-course at Univ. Bergamo

Dec. 2016 Invited seminar at MOX, Politecnico di Milano (Italy)

June 2016 Invited speaker at the MAFELAP 2016 conference, Brunel University (UK), minisymposia *PDE discretization methods on polygonal and polyhedral meshes* and *Hybridizable discontinuous Galerkin methods*

May 2016 Invited speaker at the ZHACM Colloquium, Univ. Zürich-ETHZ (Swiss)

Feb. 2016 Invited seminar at Univ. di Pavia-IMATI (Italy)

Sept. 2015 Invited speaker at the *eXtended Discretization Methods 2015* conference, minisymposium *Polygonal and polyhedral methods*, Ferrara (Italy)

July 2015 Invited lecturer for the PhD course *An introduction to Hybrid High-Order methods*, Univ. di Bergamo

Feb. 2015 Invited seminar at Univ. Milano Bicocca (Italy)

July 2014 Invited speaker at the *World Congress on Computational Mechanics XI*, minisymposium *Structure-preserving and polyhedral discretizations* (Barcelona, Spain)

Feb. 2013 Invited seminar at MOX, Politecnico di Milano (Italy)

Dec. 2011 Invited seminar at Univ. Bergamo (Italy)

June 2011 Invited plenary speaker at the *Finite Volumes for Complex Applications VI* conference, Prague (Czech Republic)

May 2011 Invited seminar at the Department of Mathematics, Univ. of Sussex (UK)

3.4.2 In France (selection 2011–pres.)

Dec. 2022 LMA2S seminar at Onera (in virtual mode)

Dec. 2021 Keynote speaker at the SimRace workshop, IFPEN, Rueil-Malmaison

Dec. 2020 NAGANA seminar at IMAG, Univ. Montpellier

July 2020 Keynote speaker at the session *Advances in polygonal and polyhedral methods*, WCCM-ECCOMAS 2020, Paris. Held in virtual mode in 2021 owing to the COVID-19 crisis

Dec. 2019 Invited seminar at IFP Energies Nouvelles

Sept. 2019 Invited seminar at Laboratoire de Mathématiques de Besançon

May 2019 Invited seminar at Laboratoire J. A. Dieudonné, Nice

May 2018 Invited speaker at the minisymposium on *Polyhedral methods and applications*, *44e Congrès National d'Analyse Numérique*, Cap d'Agde

Nov. 2017 Invited plenary speaker at the *Journées Multiphasiques et Incertitudes* Nantes

Apr. 2017 Invited seminar at UMPA, Lyon
Mar. 2017 Invited seminar at Institut de Mathémathiques de Bordeaux
Sept. 2016 Invited seminar at *EDF research lab Chatou*, Paris
Sept. 2016 Invited seminar at the *Laboratoire de Mécanique et Génie Civil*, Univ. de Montpellier
May 2016 Invited lecturer at the *Journées Numériques*, Laboratoire Jean Dieudonné, Univ. de Nice
June 2015 Invited lecturer at the CEA-EDF-INRIA school *New Trends in Compatible Discretizations* (Paris)
June 2015 Invited lecturer at the international workshop *Méthode de Galerkine discontinue et ses applications*, CNAM, Paris
June 2015 Invited lecturer at the *École de de Mécanique des Fluides Numérique 2015* (Porquerolles, France)
Mar. 2015 Invited seminar at Départment de Mathématiques d'Orsay, Univ. Paris 11
Jan. 2015 Invited seminar at Institut Camille Jordan, Lyon
Oct. 2014 Invited seminar at Saint-Gobain-CNRS research unit *Surface du Verre et Interfaces*, Paris Aubervilliers
Jan. 2014 Invited seminar at EDF research lab Clamart, Paris
Oct. 2013 Invited seminar at I2M, Aix–Marseille Univ.
June 2013 Invited lecturer at the *École de de Mécanique des Fluides Numérique 2013* (Porquerolles, France)
Jan. 2013 Invited seminar at LAMSID, EDF, Paris Clamart
Dec. 2012 Invited seminar at Laboratoire J. A. Dieudonné, Nice
Oct. 2012 Invited speaker at the workshop *Innovative schemes and highly performing methods for the numerical simulation of fluid flows*, Marseille
Apr. 2012 Invited speaker at the *Workshop on complex grids and fluid flows*, Lyon
Dec. 2011 Invited seminar at Laboratoire de Mathématiques de Besançon
Nov. 2011 Invited seminar at Institut de Mathématiques de Bordeaux
May 2011 Invited seminar at LAGA, Univ. Paris 13

3.5 Press

MaddMaths interview by M. Briani (in Italian): *Daniele Di Pietro: l'analisi numerica come antidoto contro noia e frustrazione*, rubrica *Giovani matematici crescono*

4 Research funding track-record

4.1 Academic research projects

4.1.1 As Principal Investigator (PI)

Reference	Timeframe	Funding	Description
DICE	2022–2025	51 790€	Funding for Co-funding for the PhD thesis of M. Salah
ANR-16-IDEX-0006 (RHAMNUS)	2021–2023	75 000€	Funding for an 18-months post-doctoral fellow
ANR-20-MRS2-0004 (NEMESIS)	2020–2022	23 281€	*New methods for numerical simulations*. MRSEI funding scheme
ANR-10-LABX-0002-01	2017–2018	47 700€	Co-funding for the project *Development of an HHO method for the direct simulation of turbulent flows in Code_Saturne*
ANR (HHOMM)	2015–2019	172 224€	*Hybrid High-Order Methods on polyhedral Meshes*. Only JCJC project in Numerical Analysis funded in the 2015 call. Details at http://imag.umontpellier.fr/~di-pietro/HHOMM.html
NUMEV 2014-2-006	2015–2018	50 000€	Co-funding for the PhD thesis of M. Botti
UFI Vinci	2015–2018	90 000€	PhD thesis of F. Chave

ERT IFPEN-LJLL	2008–2013	220 000€	*Enhanced oil recovery and geological sequestration of CO_2: mesh adaptivity, a posteriori error control, and other advanced techniques*, co-PI with M. Vohralík

4.1.2 As unit coordinator or co-investigator

Reference	Timeframe	Role	Funding	Description
ANR fast4hho	2017–2021	Unit coordinator	465 686€	*Fast Solvers for robust discretisations in CFD* (PI: F. Hülsemann)
ANR HAMM	2010–2014	Co-investigator	1 060 721€	*Hybrid Architectures and Multiscale Methods* (PI: C. Prud'homme)
ANR VFSitCom	2009–2012	Co-investigator	180 000€	*Volumes Finis pour Situations Complexes* (PI: J. Droniou)

4.2 Industrial collaborations as PI

Reference	Timeframe	Funding	Description
EDF	2018–2021	135 000€	Funding for the PhD thesis of I. Fontana + scientific collaboration
EDF	2017–2020	36 000€	Co-funding for the project *Development of an HHO method for the direct simulation of turbulent flows in Code_Saturne*
BRGM	2014–2018	60 000€	Co-funding for the PhD thesis of M. Botti
Saint-Gobain	2015–2016	15 000€	*Hybrid High-Order methods for the Cahn–Hilliard equation*, fundamental research program Phi-Zero
EDF	2014–2017	135 000€	Funding for the PhD thesis of R. Riedlbeck + scientific collaboration

5 Supervision of doctoral and post-doctoral fellows

5.1 Supervision of PhD students

2022–pres. **Marwa Salah**, Discrete elasticity complexes

2021–pres. **Aurelio Edoardo Spadotto**, Numerical simulation of the electrodeformation of blood cells. Application to medical diagnostic, co-director with S. Mendez (UM)

Def. 2022 **Ilaria Fontana**, Interface models for dam modelling, in collaboration with EDF. TEL manuscript tel-03703584.

Def. 2021 **André Harnist**, Hybrid High-Order methods for complex problems in fluid mechanics TEL manuscript tel-03518264. A. Harnist is now post-doctoral researcher at INRIA Paris

Def. 2021 **Pierre Matalon**, Fast solvers for robust discretizations in computational fluid dynamics, co-director with U. Rüde (FAU). TEL manuscript tel-03401691. P. Matalon is now post-doctoral researcher at MOX, Politecnico di Milano

Def. 2018 **Michele Botti**, Advanced polyhedral discretization methods for poromechanical modelling, in collaboration with BRGM. TEL manuscript tel-01871074. M. Botti has obtained a Marie Skłodowska–Curie fellowship then a Researcher position (RTD-A) at MOX, Politecnico di Milano

Def. 2018 **Florent Chave**, Hybrid High-Order methods for interface problems. TEL manuscript tel-01881007. F. Chave is now post-doctoral researcher at INRIA Lille

Def. 2017 **Rita Riedlbeck**, A posteriori-based adaptive algorithms for poro-mechanics. TEL manuscript tel-01676709. R. Riedlbeck is now research manager at TWT

Def. 2016 **Joubine Aghili**, Numerical resolution of partial differential equations with variable coefficients. TEL manuscript tel-01616910. J. Aghili is Associate Professor (*Maître de Conférences*) at University of Strasbourg

Def. 2013 **Jean-Marc Gratien**, Development of a domain-specific embedded language for lowest-order methods on general meshes. TEL manuscript tel-00926232. Co-director with C. Prud'homme (professor, Univ. Strasbourg). J.-M. Gratien is now research engineer at IFPEN

Def. 2013 **Simon Lemaire**, Hybrid finite volume methods for poro-mechanics. TEL manuscript tel-00957292. Co-supervisor with R. Eymard (professor, Univ. Paris-Est). S. Lemaire is now researcher (*Chargé de Recherche*) at INRIA

Def. 2013 **Soleiman Yousef**, A posteriori error estimates and adaptivity for the SAGD proceeding, co-supervisor with M. Vohralík (senior researcher, INRIA) and V. Girault (professor, UPMC — Univ. Pierre et Marie Curie). S. Yousef is now research engineer at IFPEN

I also supervised the PhD students **Silvano Pitassi** (Università di Udine, Italy) during his 2-months stay at IMAG (2021) as well as **Lorenzo Botti** (Università di Bergamo, Italy) and **Sissel Mundal** (University of Bergen) during their 6 months stay at IFPEN.

5.2 Supervision of post-doctoral fellows

2021–pres. **Francesco Bonaldi**, DDR methods for the incompressible Navier–Stokes equations

2017–2019 **Daniel Castanon Quiroz**, Advanced implementation of Hybrid High-Order methods. D. Castanon Quiroz is now Assistant Professor at UNAM (Mexico City)

2018 **Saghar Heidari**, Advanced aspects of Hybrid High-Order methods for applications in computational physics

2017–2018 **Alice Raeli**, Hybrid High-Order methods on octree meshes. A. Raeli is now research assistant at Politecnico di Torino, Italy

2016–2017 **Francesco Bonaldi**, Advanced discretization methods for plate problems

2016–2017 **Roberta Tittarelli**, A posteriori error estimators for incompressible problems. R. Tittarelli is now Associate Professor (*Maître de Conférences*) at Université de Besançon

2008–2009 **Ivan Kapyrin**, Multi-points finite volume methods for porous media flows. I. Kapyrin is now Senior Researcher at the Institute of Numerical Mathematics of the Russian Academy of Sciences

5.3 Participation in PhD theses and HDR[1] committees (* Referee)

2023 M. Hanot (PhD, UM)

2022 S. Pitassi* (PhD, Università di Udine)

2021 L. Sokhna (PhD, UM), S. Krell (HDR, Université de Nice Côte d'Azur)

2019 C. Facciolà* (PhD, Politecnico di Milano)

2018 C. Marcati* (PhD, Université Pierre et Marie Curie)

2017 A. Raeli* (PhD, Université de Bordeaux), A. Della Rocca* (PhD, Politecnico di Milano, Italy), S. Zonca (PhD, Politecnico di Milano, Italy)

2016 R. Porcù* (PhD, Politecnico di Milano, Italy), K. Haddaoui* (PhD, Université Pierre et Marie Curie)

2015 V. Baron* (PhD, Univ. Nantes, France), K. Mallem* (PhD, Aix-Marseille Univ., France)

2014 J. Bonelle (PhD, EDF-Univ. Paris-Est), A. Duran (PhD, UM)

2013 S. Gérald* (PhD, ONERA-UPMC, referee), M. Cathala (PhD, UM), A. Baldit (PhD, UM)

2012 J. Richard (PhD, UM), T. Hai Ong* (PhD, Univ. Paris-Est, France).

[1] French habilitation for professorship

6 Teaching activities

6.1 Post-graduate courses (PhD level)

2018 *An introduction to the convergence analysis of discretisation methods for PDEs with application to Hybrid High-Order methods* (4h), Univ. Bergamo (Italy)

2016 *Hybrid High-Order methods* (6h), Institut Henri Poincaré (Paris), cf. http://imag.umontpellier.fr/event/ihp-nmpdes

2016 *An introduction to Hybrid High-Order methods* (3h), Università di Bergamo (Italy)

2015 *Hybrid High-Order methods and applications* (18h), doctoral school *Information, Structures et Systèmes*, Univ. Montpellier

2015 *Discontinuous Galerkin methods and applications* (4h), École de Mécanique des Fluides Numériques (Porquerolles, France)

2016 *An introduction to Hybrid High-Order methods* (3h), Università di Bergamo (Italy)

2013 *Discontinuous Galerkin methods and applications* (6h), École de Mécanique des Fluides Numériques (Porquerolles, France)

2012 *Discontinuous Galerkin methods and applications* (20h), doctoral school I2S, Univ. Montpellier

6.2 Undergraduate courses

Legend: CM = *Cours Magistral* (Masterclass), TD = *Travaux Dirigés* (Exercices), TP = *Travaux Pratiques* (Practical exercises). In France 1h CM = 1.5h TD, 1h TD = 1.5h TP; LX = Xth year of Licence, MX = Xth year of Master

6.2.1 As professor at University of Montpellier

2021–2022 **Analyse Numérique 4** (M2, 33 CM), **Algèbre Linéaire Numérique** (L2, 15 CM + 10.5 TD)

2020–2021 **Analyse Numérique 3** (M2, 33 CM), **Modélisation Numérique** (M2, 8CM), **Analyse Numérique Matricielle** (L2, 18 CM + 10.5 TD + 13.5 TP)

2019–2020 **Analyse Numérique 3** (M2, 33 CM), **Analyse Numérique Matricielle** (L2, 18 CM + 10.5 TD + 9 TP)

2018–2019 **Analyse Numérique 3** (M2, 33 CM), **Modélisation Numérique** (M2, 7 CM), **Analyse Numérique Matricielle** (L2, 21 CM + 12 TD + 15 TP), **Analyse et Algèbre** (L1, 48 TD), **Biomaths** (L1, 24 TD)

2017–2018 **Analyse Numérique 3** (M2, 33 CM), **Modélisation Numérique** (M2, 7 CM), **Analyse Numérique Matricielle** (L2, 21 CM + 12 TD)

2016–2017 **Analyse Numérique des EDP 3** (M2, 33 CM), **Analyse Numérique Matricielle** (L2, 21 CM + 12 TD)

2015–2016 **Analyse Numérique des EDP 3** (M2, 33 CM), **Analyse Numérique Matricielle** (L2, 21 CM + 12 TD), Algèbre Linéaire et Analyse 1 (2 x 48 TD)

2014–2015 **Calcul scientifique et Applications** (M2, 28 CM), **Algèbre Linéaire Analyse 1** (48 TD), **Optimisation numérique** (M1, 24 CM + 15 TD + 12 TP), **Biomaths** (L1, 36 TD)

2013–2014 **Calcul scientifique et Applications** (M2, 30 CM), **Algèbre Linéaire Analyse 1** (78 TD + 6 CM)

2012–2013 **Calcul scientifique et Applications** (M2, 30 CM), **Algèbre Linéaire Analyse 1** (78 TD + 6 CM), **Analyse Numérique Matricielle** (21 CM + 12 TD)

For most of the above courses, supports are available on my webpage http://imag.umontpellier.fr/~di-pietro.

6.2.2 Other undergraduate courses in France

UPMC = Université Pierre et Marie Curie (Paris 6)

2011–2012 **Discontinuous Galerkin Methods and Applications** (M2, UPMC, 24h CM), **Calcul Scientifique** (L3, Ecole des Ponts ParisTech, 27 CM)

2010–2011 **Discontinuous Galerkin Methods and Applications** (M2, UPMC, 24h CM), **Calcul Scientifique** (L3, Ecole des Ponts ParisTech, 27 CM)

2009–2010 **Discontinuous Galerkin Methods and Applications** (M2, UPMC, 24h CM), **Calcul Scientifique** (L3, Ecole des Ponts ParisTech, 27 CM)
2008–2009 **Discontinuous Galerkin Methods and Applications** (M2, UPMC, 10 CM), **Calcul Scientifique** (L3, Ecole des Ponts ParisTech, 27 CM)
2007–2008 **Calcul Scientifique** (L3, Ecole des Ponts ParisTech, 27 CM)

6.2.3 Supervision of master theses (* PhD thesis under my direction followed)

2022 **Marwa Salah*** (3–8/2022), DDR methods for problems in continuum mechanics
2022 **Alessandra Crippa** (2–8/2022), HHO methods for interface problems
2021 **Aurelio Edoardo Spadotto***, HHO methods for magnetostatics
2020 **Rafiq Driss**, de Rham cohomology for an HHO discretization of the Maxwell equations
2019 **Isaak Bachache**, A numerical exploration of Finite Element Exterior Calculus
2019 **Hind Bouyri**, Implementation of Hybrid High-Order methods for convective terms in Code_Saturne, in collaboration with EDF
2019 **Alessandra Guglielmana**, A low-order method for linear elasticity on general meshes
2018 **André Harnist***, Applications of Hybrid High-Order methods to computational mechanics
2016 **Bastien Hamlat**, Discontinuous Galerkin methods for free-surface flows
2015 **Michele Botti***, Nonconforming discretization methods for poro-mechanics
2015 **Florent Chave***, Hybrid High-Order methods for the Cahn–Hilliard problem, in collaboration with Saint–Gobain
2013 **Rita Riedlbeck***, Spectral methods for the incompressible Navier–Stokes equations
2009 **Soleiman Yousef***, Finite volume methods for petroleum reservoir modelling
2005 **Nicoletta Franchina**, Discontinuous Galerkin methods for problems in fluid mechanics
2004 **Pietro Gabbiadini**, Development of a Matlab code for brake modelling, in collaboration with Freni Brembo

7 Institutional responsibilities

7.1 Main responsibilities

2021–pres. **Director of IMAG**
2022–pres. *Correspondant recherche* for the Department of Mathematics
2019–2020 **Deputy director of IMAG**
2014–2020 Head of the **ACSIOM research team**
2014–2020 Member of the board of directors of **IMAG**
2015–2019 In charge of the second year of the Master *Modeling and Numerical Analysis*
2013–2019 Member of the board of the **Department of Mathematics** of the University of Montpellier
2017–2020 Member of the *Commission de Section 26* (local expert committee for Applied Mathematics)
2012–2015 In charge of the first year of the Master *Mathématiques, Statistique et Applications*

7.2 Participation in selection committees

2022 Member of the selection committee for a post of **Full Professor** (ref. PR-0342490X-9, Université de Montpellier)
2020 Member of the selection committee for a post of **Full Professor** (Politecnico di Milano, Italy)
2019 Member of the selection committee for a post of **Full Professor** (Università di Trento, Italy)
2016 President of the selection committee for a post of **Associate Professor** (ref. 26MCF99, Université de Montpellier)
2015 President of the selection committee for a post of **Full Professor** (ref. 2526PR4118, Université de Nîmes, France)
2014 Member of the selection committee for a post of **Associate Professor** (MAT/08, ref. 2010/MAT3, Politecnico di Milano, Italy)

2014 President of the selection committee for a post of **Full Professor** (ref. 26PR4171, Université de Montpellier)

8 Publications

8.1 Research monographs

[1] D. A. Di Pietro and J. Droniou. *The Hybrid High-Order method for polytopal meshes. Design, analysis, and applications*. Vol. 19. Modeling, Simulation and Application. Springer International Publishing, 2020. DOI: 10.1007/978-3-030-37203-3.

[2] D. A. Di Pietro and A. Ern. *Mathematical aspects of discontinuous Galerkin methods*. Vol. 69. Mathématiques & Applications (Berlin) [Mathematics & Applications]. Springer, Heidelberg, 2012. DOI: 10.1007/978-3-642-22980-0.

8.2 Edited books

[3] D. A. Di Pietro, L. Formaggia, and R. Masson, eds. *Polyhedral Methods in Geosciences*. Vol. 27. SEMA-SIMAI. To appear. Springer International Publishing, 2021. ISBN: 978-3-030-69362-6. DOI: 10.1007/978-3-030-69363-3.

[4] D. A. Di Pietro, A. Ern, and L. Formaggia, eds. *Numerical Methods for PDEs. State of the Art Techniques*. Vol. 15. SEMA-SIMAI. Springer International Publishing, 2018. DOI: 10.1007/978-3-319-94676-4.

8.3 Papers in international peer-reviewed journals

[5] L. Beirão da Veiga, F. Dassi, D. A. Di Pietro, and J. Droniou. "Arbitrary-order pressure-robust DDR and VEM methods for the Stokes problem on polyhedral meshes". In: *Comput. Meth. Appl. Mech. Engrg.* 397.115061 (2022). DOI: 10.1016/j.cma.2022.115061. URL: https://authors.elsevier.com/a/1fChmAQEIzVqH.

[6] L. Botti and D. A. Di Pietro. "p-Multilevel preconditioners for HHO discretizations of the Stokes equations with static condensation". In: *Commun. Appl. Math. Comput.* 4.3 (2022), pp. 783–822. DOI: 10.1007/s42967-021-00142-5.

[7] F. Chave, D. A. Di Pietro, and S. Lemaire. "A discrete Weber inequality on three-dimensional hybrid spaces with application to the HHO approximation of magnetostatics". In: *Math. Models Methods Appl. Sci.* 32.1 (2022), pp. 175–207. DOI: 10.1142/S0218202522500051.

[8] D. A. Di Pietro and J. Droniou. "A DDR method for the Reissner–Mindlin plate bending problem on polygonal meshes". In: *Comput. Math. Appl.* 125 (2022), pp. 136–149. arXiv: 2105.11773 [math.NA].

[9] D. A. Di Pietro and J. Droniou. "A fully discrete plates complex on polygonal meshes with application to the Kirchhoff–Love problem". In: *Math. Comp.* (2022). Published online. DOI: 10.1090/mcom/3765. arXiv: 2112.14497 [math.NA].

[10] D. A. Di Pietro and J. Droniou. "Homological- and analytical-preserving serendipity framework for polytopal complexes, with application to the DDR method". In: *ESAIM: Math. Model Numer. Anal.* (2022). Accepted for publication. arXiv: 2203.02939 [math.NA].

[11] D. A. Di Pietro, I. Fontana, and K. Kazymyrenko. "A posteriori error estimates via equilibrated stress reconstructions for contact problems approximated by Nitsche's method". In: *Comput. Math. Appl.* 111 (2022), pp. 61–80. DOI: 10.1016/j.camwa.2022.02.008. URL: https://authors.elsevier.com/c/1egEh3CDPQ2-a5.

[12] D. A. Di Pietro, F. Hülsemann, P. Matalon, P. Mycek, U. Rüde, and D. Ruiz. "Algebraic multigrid preconditioner for statically condensed systems arising from lowest-order hybrid discretizations". In: *SIAM J. Sci. Comput.* (2022). Accepted for publication. URL: https://hal.archives-ouvertes.fr/hal-03272468.

[13] D. A. Di Pietro, P. Matalon, P. Mycek, and U. Rüde. "High-order multigrid strategies for HHO discretizations of elliptic equations". In: *Numer. Linear Algebra with Appl.* (2022). DOI: 10.1002/nla.2456.

[14] L. Botti, M. Botti, and D. A. Di Pietro. "An abstract analysis framework for monolithic discretisations of poroelasticity with application to Hybrid High-Order methods". In: *Comput. Math. Appl.* 91.1 (2021), pp. 150–175. DOI: 10.1016/j.camwa.2020.06.004.

[15] M. Botti, D. Castanon Quiroz, D. A. Di Pietro, and A. Harnist. "A Hybrid High-Order method for creeping flows of non-Newtonian fluids". In: *ESAIM: Math. Model Numer. Anal.* 55.5 (2021), pp. 2045–2073. DOI: 10.1051/m2an/2021051.

[16] D. Castanon Quiroz, D. A. Di Pietro, and A. Harnist. "A Hybrid High-Order method for incompressible flows of non-Newtonian fluids with power-like convective behaviour". In: *IMA J. Numer. Anal.* (2021). Published online. DOI: 10.1093/imanum/drab087.

[17] D. A. Di Pietro and J. Droniou. "An arbitrary-order discrete de Rham complex on polyhedral meshes: Exactness, Poincaré inequalities, and consistency". In: *Found. Comput. Math.* (2021). Published online (open access). DOI: 10.1007/s10208-021-09542-8.

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[19] D. A. Di Pietro, J. Droniou, and A. Harnist. "Improved error estimates for Hybrid High-Order discretizations of Leray–Lions problems". In: *Calcolo* 58.19 (2021). DOI: 10.1007/s10092-021-00410-z.

[20] D. A. Di Pietro, F. Hülsemann, P. Matalon, P. Mycek, U. Rüde, and D. Ruiz. "An *h*-multigrid method for Hybrid High-Order discretizations". In: *SIAM J. Sci. Comput.* 43.5 (2021), S839–S861. DOI: 10.1137/20M1342471.

[21] D. A. Di Pietro, F. Hülsemann, P. Matalon, P. Mycek, U. Rüde, and D. Ruiz. "Towards robust, fast solutions of elliptic equations on complex domains through HHO discretizations and non-nested multigrid methods". In: *Internat. J. Numer. Methods Engrg.* 122.22 (2021), pp. 6576–6595. DOI: 10.1002/nme.6803.

[22] M. Botti, D. A. Di Pietro, O. Le Maître, and P. Sochala. "Numerical approximation of poroelasticity with random coefficients using Polynomial Chaos and Hybrid High-Order methods". In: *Comput. Meth. Appl. Mech. Engrg.* 361.112736 (2020). DOI: 10.1016/j.cma.2019.112736.

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[24] D. Castanon Quiroz and D. A. Di Pietro. "A Hybrid High-Order method for the incompressible Navier–Stokes problem robust for large irrotational body forces". In: *Comput. Math. Appl.* 79.8 (2020), pp. 2655–2677. DOI: 10.1016/j.camwa.2019.12.005.

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[47] R. Riedlbeck, D. A. Di Pietro, A. Ern, S. Granet, and K. Kazymyrenko. “Stress and flux reconstruction in Biot’s poro-elasticity problem with application to a posteriori error analysis”. In: *Comput. Math. Appl.* 73.7 (2017), pp. 1593–1610. DOI: 10.1016/j.camwa.2017.02.005.

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