Curriculum vitæ

Daniele A. Di Pietro

January 8, 2021

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1 Personal information

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Birth date:	1st January 1979	**Email (work):**	daniele.di-pietro@umontpellier.fr
Birth place:	Messina, Italy	**Web page:**	http://imag.umontpellier.fr/~di-pietro
Nationality:	Italian		
CV (linked pdf):	http://imag.umontpellier.fr/~di-pietro/cv.pdf		
Address (work):	Université de Montpellier CC051, place Eugène Bataillon, 34095 Montpellier (France)		

1.1 Education

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

28/3/2006 **Ph.D. Thesis**, Università di Bergamo, *Discontinuous Galerkin methods for the incompressible Navier–Stokes equations*, supervisor **F. Bassi**. Part of my Ph.D. thesis was carried out at EPFL (see below)

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

1.2 Positions

1/9/2012–pres. **Full professor** (PR1C) at Institut Montpelliérain Alexander Grothendieck (IMAG), Université de Montpellier (UM)

2021–pres. **Director of IMAG**

2019–2020 **Deputy director of IMAG**

2014–2020 Head of the ACSIOM research team (23 permanent members)

1.3 Previous positions

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

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

1/1/2005–30/6/2006 **Visiting Ph.D. assistant**, CMCS, École Polytechnique Fédérale Lausanne (EPFL)

1.4 Fellowships, awards, and distinctions

2019–2020 CNRS professor[1] appointment (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 SMAI (French Society of Industrial and Applied Mathematics)

2015–pres. Member of the French Research Network MaNu (*Mathématiques pour le Nucléaire*)

[1] Délégation CNRS

2 Supervision of doctoral and post-doctoral fellows

2.1 Supervision of Ph.D. students

2018–pres. **Ilaria Fontana**, Contact problems in dam modelling, in collaboration with EDF
2018–pres. **André Harnist**, Hybrid High-Order methods for non-Newtonian fluids
2018–pres. **Pierre Matalon**, Algebraic multi-grid solvers for Hybrid High-Order methods
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 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 Ph.D. students **Lorenzo Botti** and **Sissel Mundal** during their 6 months stay at IFPEN.

2.2 Supervision of post-doctoral fellows

2017–2019 **Daniel Castanon Quiroz**, Advanced implementation of Hybrid High-Order methods. D. Castanon Quiroz is now post-doctoral researcher at Université de Nice–Côte d'Azur
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
2016–2017 **Francesco Bonaldi**, Advanced discretization methods for plate problems. F. Bonaldi is now post-doctoral researcher at Université de Nice–Côte d'Azur
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

2.3 Participation in Ph.D. theses committees (* Referee)

2019 C. Facciolà* (Politecnico di Milano)
2018 C. Marcati* (Université Pierre et Marie Curie)
2017 A. Raeli* (Université de Bordeaux), A. Della Rocca* (Politecnico di Milano, Italy), S. Zonca (Politecnico di Milano, Italy)
2016 R. Porcù* (Politecnico di Milano, Italy), K. Haddaoui* (Université Pierre et Marie Curie)
2015 V. Baron* (Univ. Nantes, France), K. Mallem* (Aix-Marseille Univ., France)
2014 J. Bonelle (EDF-Univ. Paris-Est), A. Duran (UM)

2013 S. Gérald* (ONERA-UPMC, referee), M. Cathala (UM), A. Baldit (UM)
2012 J. Richard (UM), T. Hai Ong* (Univ. Paris-Est, France).

3 Teaching activities

3.1 Post-graduate courses (Ph.D. 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.edu.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 I2S, Univ. Montpellier
2015 *Discontinuous Galerkin methods and applications* (4h), École de Mécanique des Fluides Numériques (Porquerolles, France), cf. https://ecolemfn.limsi.fr/doku.php?id=2015:start
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), cf. https://ecolemfn.limsi.fr/doku.php?id=2013:start
2012 *Discontinuous Galerkin methods and applications* (20h), doctoral school I2S, Univ. Montpellier

3.2 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

3.2.1 As professor at University of Montpellier

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)

3.2.2 Other undergraduate courses in France

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)

3.2.3 Supervision of master theses (* Ph.D. thesis under my direction)

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

4 Scientific outreach

4.1 Evaluation of the research

- Referee for all the major international journals in Numerical Analysis and Scientific Computing.
- Referee for several national research agencies (ANR France, CONACYT Chile, FWF Austrian Science Found, PRIN Italy, The Royal Swedish Academy of Science, NWO Netherlands, POR FSE Regione Friuli-Venezia-Giulia).
- Member of evaluation panels for ANR*.

* Owing to the confidentiality agreement, the details are omitted

4.2 Editorial activity

2020–pres. Associate editor of Numerical Algorithms, Springer
2020 Editor for the volume *Polyhedral methods in geosciences* of the SEMA-SIMAI Springer series. Publication expected by the end of 2020/beginning of 2021
2016 Editor for the volume *Numerical methods for PDES: State of the Art Techniques* of the SEMA-SIMAI Springer series

4.3 Organization of scientific meetings

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). See https://www.mate.polimi.it/siamgs21/

2020 Organizer of the mini-symposium *Low and high-order polytopal methods: developments and applications*, ALGORITHMY 2020 conference (Vysoke Tatry, Podbanske). See http://www.math.sk/alg2020/. 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). See https://www.wccm-eccomas2020.org. 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://conferences.cirm-math.fr/1954.html and 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). See http://people.brunel.ac.uk/~icsrsss/bicom/mafelap/

2017 Organizer of the mini-symposia *Polyhedral Methods and Applications* and *Recent advances on polyhedral discretizations*, ENUMATH 2017 international conference (Bergen, Norway). See http://www.uib.no/en/enumath2017

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 http://imag.edu.umontpellier.fr/event/ihp-nmpdes 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)

4.4 Selection of recent invited presentations

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

4.4.1 Outside France

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.

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). Postponed to 2021 owing to the COVID-19 crisis

May 2020 Keynote speaker at the InDAM Workshop *Polygonal methods for PDEs: Theory and applications*, Rome (Italy). Postponed to 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 ECCOMAS 2016 conference, minisymposium *High-Order methods for polygonal and polyhedral meshes* (declined because the date conflicted with another commitment)
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
Feb. 2016 Invited seminar at Univ. di Pavia-IMATI
Sept. 2015 Invited speaker at the *eXtended Discretization Methods 2015* conference, minisymposium *Polygonal and polyhedral methods* (Ferrara, Italy)
July 2015 Invited lecturer for the Ph.D. course *An introduction to Hybrid High-Order methods*, Univ. di Bergamo
June 2015 Invited lecturer at the CEA-EDF-INRIA school *New Trends in Compatible Discretizations* (Paris)
June 2015 Invited speaker at the international workshop *Discontinuous Galerkin Methods and Applications* (Paris)
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)
Dec. 2011 Invited seminar at Univ. Bergamo
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)

4.4.2 In France

Dec. 2020 Seminar at IMAG, Univ. Montpellier
July 2020 Keynote speaker at the session *Advances in polygonal and polyhedral methods*, WCCM-ECCOMAS 2020, Paris. Conference moved to January 2021 in fully virtual mode 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

4.5 Press

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

5 Institutional responsibilities

5.1 Main responsibilities

Jan. 2021–pres. **Director** of IMAG
Oct. 2019–June 2020 **Deputy director** of IMAG
Oct. 2014–June 2020 Head of the **ACSIOM research team** http://imag.edu.umontpellier.fr/acsiom (23 permanent researchers)
Oct. 2014–June 2020 Member of the board of directors of **IMAG**
Sept. 2015–2019 In charge of the second year of the Master *Modeling and Numerical Analysis*, cf. http://tinyurl.com/UM-M2-MANU
Sept. 2013–2019 Member of the board of the **Department of Mathematics** of the University of Montpellier
June 2017–pres. 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*

5.2 Participation in selection committees

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)

6 Research funding track-record

6.1 Academic research projects

6.1.1 As Principal Investigator (PI)

Reference	Timeframe	Funding	Description
To be announced	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 Ph.D. thesis of M. Botti
UFI Vinci	2015–2018	90 000€	Ph.D. 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

* JCJC projects are the only form of individual projects funded by ANR, and are reserved to researchers whose Ph.D. thesis has been defended up to 10 years prior to the call

6.1.2 As co-investigator

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

6.2 Industrial collaborations as PI

Reference	Timeframe	Funding	Description
EDF	2018–2021	135 000€	Funding for the Ph.D. 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 Ph.D. 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 Ph.D. thesis of R. Riedlbeck + scientific collaboration

7 Research

My main research topics include:

- Advanced numerical methods for PDEs
- A priori and a posteriori error analysis
- Fluid- and solid-mechanics
- Porous media flows
- Modern implementation techniques

7.1 Bibliometrics

According to the MathSciNet database, my works have been **cited 1530 times by 1098 authors**; see http://www.ams.org/mathscinet/search/author.html?mrauthid=790640. My ten most cited publications:

371 cit. D. A. Di Pietro and A. Ern. *Mathematical aspects of discontinuous Galerkin methods*, volume 69 of *Mathématiques & Applications*. Springer-Verlag, Berlin, 2012.

122 cit. D. A. Di Pietro and A. Ern. A hybrid high-order locking-free method for linear elasticity on general meshes. *Comput. Meth. Appl. Mech. Engrg.*, 283:1–21, 2015.

83 cit. D. A. Di Pietro, A. Ern, and S. Lemaire. An arbitrary-order and compact-stencil discretization of diffusion on general meshes based on local reconstruction operators. *Comput. Meth. Appl. Math.*, 14(4):461–472, 2014

75 cit. F. Bassi, A. Crivellini, D. A. Di Pietro, and S. Rebay. An artificial compressibility flux for the discontinuous Galerkin solution of the incompressible Navier-Stokes equations. *J. Comput. Phys.*, 218(2):794–815, 2006.

69 cit. F. Bassi, L. Botti, A. Colombo, D. A. Di Pietro, and P. Tesini. On the flexibility of agglomeration based physical space discontinuous Galerkin discretizations. *J. Comput. Phys.*, 231(1):45–65, 2012.

68 cit. B. Cockburn, D. A. Di Pietro, A. Ern. Bridging the hybrid high-order and hybridizable discontinuous Galerkin methods. *ESAIM: Math. Model Numer. Anal. (M2AN)*, 50(3):635–650, 2016.

61 cit. D. A. Di Pietro and A. Ern. Discrete functional analysis tools for discontinuous Galerkin methods with application to the incompressible Navier–Stokes equations. *Math. Comp.*, 79:1303–1330, 2010.

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50 cit. F. Bassi, A. Crivellini, D. A. Di Pietro, and S. Rebay. An implicit high-order discontinuous Galerkin method for steady and unsteady incompressible flows. *Comp. & Fl.*, 36(10):1529–1546, 2007.

39 cit. D. A. Di Pietro, A. Ern, and J.-L. Guermond. Discontinuous Galerkin methods for anisotropic semi-definite diffusion with advection. *SIAM J. Numer. Anal.*, 46(2):805–831, 2008.

According to Google Scholar my **h-index is 30** (28 since 2015) and my **i10-index is 62** (51 since 2015).

7.2 Summary of five selected publications

Title: **The Hybrid High-Order Method for polytopal meshes. Design, analysis, and applications**
Ref.: D. A. Di Pietro and J. Droniou, Modeling, Simulation and Application, 19. Springer International Publishing (2020). ISBN: 978-3-030-37202-6 (Hardcover) 978-3-030-37203-3 (eBook).

This research monograph provides an introduction to the **design and analysis of Hybrid High-Order (HHO) methods** for diffusive problems, along with a panel of **applications to advanced models in computational mechanics**. Hybrid High-Order methods are new-generation numerical methods for partial differential equations with features that set them apart from traditional ones. These include: the support of polytopal meshes, possibly

including non-star-shaped elements and hanging nodes; the possibility of having arbitrary approximation orders in any space dimension; an enhanced compliance with the physics; a reduced computational cost thanks to compact stencil and static condensation.

The first part of the monograph lays the foundations of the method, considering linear scalar second-order models, including scalar diffusion – possibly heterogeneous and anisotropic – and diffusion-advection-reaction. The second part addresses applications to more complex models from the engineering sciences: **non-linear Leray-Lions problems, elasticity, and incompressible fluid flows**. This book is primarily intended for graduate students and researchers in applied mathematics and numerical analysis, who will find here valuable analysis tools of general scope.

Title: **Discontinuous Skeletal Gradient Discretisation methods on polytopal meshes**
Ref.: D. A. Di Pietro, J. Droniou, and G. Manzini, *J. Comput. Phys.* 355 (2018), p. 397–425.

In this article we establish a link between HHO methods and *Gradient Discretizations* (GD). GD is a unified analysis framework for linear and nonlinear problems whose weak formulation hinges on the notion of **discrete gradient operator**. The key point to interpret the HHO methods in this framework is the design of a new **consistent and stable gradient reconstruction**. This gradient reconstruction is composed of two terms: (i) a consistent contribution obtained mimicking an integration by parts formula inside each element and (ii) a stabilizing term for which sufficient conditions are proposed. An example of a stabilizing term is obtained from **local liftings of high-order residuals in a Raviart–Thomas–Nédélec space built on a sub-mesh**. We prove in this paper that the new HHO schemes based on this gradient reconstruction satisfy coercivity, consistency, conformity, and compactness requirements that ensure their **convergence for a variety of elliptical and parabolic problems**. Links with other polyhedral methods (Mimetic Finite Differences and Non-Conforming Virtual Elements) are also explored.

Title: **A Hybrid High-Order discretisation of the Brinkman problem robust in the Darcy and Stokes limits**
Ref.: L. Botti, D. A. Di Pietro, and J. Droniou, *Comput. Meth. Appl. Mech. Engrg.* 341 (2018), p. 278–310.

This article deals with the development and analysis of a **new HHO method for the Brinkman problem**. The method hinges on hybrid discrete velocity unknowns at faces and elements and on discontinuous pressures. Based on the discrete unknowns, we reconstruct inside each element a **Stokes velocity** one degree higher than face unknowns, and a **Darcy velocity** in the Raviart–Thomas–Nédélec space. These reconstructed velocities are respectively used to formulate the discrete versions of the Stokes and Darcy terms in the momentum equation, along with suitably designed penalty contributions. The proposed construction is tailored to yield optimal error estimates that are **robust throughout the entire spectrum of local (Stokes- or Darcy-diminated) regimes**, as identified by a **novel dimensionless number** which can be interpreted as a friction coefficient. The **singular limit** corresponding to the Darcy equation is also fully supported by the method.

This paper also contains two contributions whose interest goes beyond the specific method and application considered: (i) an investigation of the **dependence of the constant in the second Korn inequality on star-shaped domains** and (ii) its application to the study of the **approximation properties of the strain projector** in general Sobolev seminorms.

Title: **A hybrid high-order locking-free method for linear elasticity on general meshes**
Ref.: D. A. Di Pietro, A. Ern, *Computer Methods in Applied Mechanics and Engineering*, 2015, 283:1–21.

This is the **founding paper of HHO methods**, dealing with the **development of a method for linear elasticity both efficient and robust in the quasi-incompressible limit**. To date, this article has **117 citations on MathSciNet**. The proposed method is based on a primal formulation, and leads to a positive definite symmetric matrix with compact stencil. The lowest order version of the scheme requires only 4 (resp. 9) unknowns per face in 2 (resp. 3) space dimensions. The key idea is to reconstruct **discrete counterparts of the symmetric gradient and divergence operators** within each element by solving inexpensive and embarrassingly parallel local problems. The global problem is then assembled element by element using these operators together

with a suitably tailored stabilization bilinear form. **We prove optimal error estimates, robust in the quasi-incompressible limit.**

This article also provided a positive answer to the long-standing open question: "Is it possible to obtain superconvergence of the potential unknowns on general meshes for Hybridizable Discontinuous Galerkin methods?"; see [35] for details.

Title: **Mathematical Aspects of Discontinuous Galerkin Methods**
Ref.: D. A. Di Pietro and A. Ern, Mathématiques & Applications, 69. Springer, Heidelberg

This book provides an introduction to **discontinuous Galerkin (DG)** methods and, at the same time, incorporates several recent mathematical developments. The material covers a **wide range of model problems**, both steady and unsteady, ranging from conservation laws to pure diffusion problems, up to the Navier–Stokes equations and Friedrichs systems. Both the Finite Elements and Finite Volumes points of view are combined to convey the main ideas underlying the design of the methods. The analysis is presented in a **rigorous mathematical framework** where the discrete counterparts of the key properties of the continuous problem are identified. This book is also the first research monograph where the analysis of DG methods is developed on **general meshes**, possibly containing polyhedral elements and nonconforming interfaces. Salient implementation issues are also addressed.

This monograph has given rise to or contributed to a **wide range of publications**, impossible to cover here in detail. Currently, it has **350 citations on MathSciNet**.

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. ISBN: 978-3-030-37202-6 (Hardcover) 978-3-030-37203-3 (eBook). 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, pp. xviii+384. ISBN: 978-3-642-22979-4 (Softcover) 978-3-642-22980-0 (eBook). 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 the Geosciences*. SEMA-SIMAI. To appear. Springer International Publishing, 2021.

[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. ISBN: 978-3-319-94675-7 (Hardcover) 978-3-319-94676-4 (eBook). DOI: 10.1007/978-3-319-94676-4.

8.3 Papers in international peer-reviewed journals

[5] 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.* (2020). Published online. DOI: 10.1016/j.camwa.2020.06.004.

[6] 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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8.4 Book chapters

[69] L. Botti, M. Botti, and D. A. Di Pietro. "Polyhedral Methods in the Geosciences". In: ed. by R. Masson D. A. Di Pietro L. Formaggia. SEMA-SIMAI. Accepted for publication. Springer, 2020. Chap. A Hybrid High-Order method for multiple-network poroelasticity. URL: https://hal.archives-ouvertes.fr/hal-02461755.

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[71] D. A. Di Pietro and R. Tittarelli. "Numerical Methods for PDEs. State of the Art Techniques". In: ed. by L. Formaggia D. A. Di Pietro A. Ern. SEMA-SIMAI 15. Springer, 2018. Chap. An introduction to Hybrid High-Order methods. ISBN: 978-3-319-94675-7 (Print) 978-3-319-94676-4 (eBook). DOI: 10.1007/978-3-319-94676-4_4.

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8.5 Preprints

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