

# artur palha

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## Personal details

titles, name dr.ir. A. Palha  
gender male  
birth 10 Dec. 1980, Lisbon, Portugal  
marital status cohabitation  
nationality Portuguese

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## Education

2015 **BKO**, *Technische Universiteit Delft*, Delft, The Netherlands.  
Basis Kwalificatie Onderwijs – Qualification for teaching in Dutch Higher Education system (160 hours)

2008–2013 **Ph.D.**, *Technische Universiteit Delft*, Delft, The Netherlands, Aerospace Engineering.  
Numerical analysis and scientific computing  
title: *High order mimetic discretization: Development and application to Laplace and convection-diffusion problems in arbitrary quadrilaterals*  
date: 3 Sept. 2013  
promotors: Dr.ir. Marc Gerritsma and Prof.dr.ir.drs. Hester Bijl  
description: Development of an arbitrary order finite element mimetic numerical scheme for solving PDEs, incorporating concepts from differential geometry and algebraic topology that exactly satisfy fundamental mathematical relations at the discrete level even on rough meshes. This led to more robust and accurate numerical discretizations. Development of arbitrary order geometric time integrators for ODEs.

2004 **Licenciatura**, *Instituto Superior Técnico, Universidade Técnica de Lisboa*, Lisbon, Portugal, Applied Physics.  
Numerical analysis and scientific computing  
thesis: *Development of a computational model for a PEM fuel cell*  
advisors: Dr.eng. António Joyce and Prof.dr.eng. Manuel Collares-Pereira

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## Scientific Work Experience

2017– **Design Engineer**, *ASML*, Eindhoven, The Netherlands.  
Structure preserving Maxwell solvers.

2017– **Guest Researcher**, *Eindhoven University of Technology*, Eindhoven, The Netherlands.  
Development of real-time MHD equilibrium evolution solvers using mimetic arbitrary order finite element methods. Fast Jacobian-free Newton Krylov solvers. Joint research with EPFL Lausanne.

2014–2017 **Post Doc**, *Eindhoven University of Technology*, Eindhoven, The Netherlands.  
Development of real-time MHD equilibrium evolution solvers using mimetic arbitrary order finite element methods. Fast Jacobian-free Newton Krylov solvers. Joint research with EPFL Lausanne.

2014– **Guest Researcher**, *Delft University of Technology*, Delft, The Netherlands.  
(i) Mimetic (structure-preserving) arbitrary order finite element methods. Supervision of two PhD candidates. (ii) Hybrid Eulerian-Lagrangian solver combining a grid-based solver with a boundary element solver and particle based solver. Supervision of one PhD candidate.

2012–2014 **Post Doc**, *Delft University of Technology*, Delft, The Netherlands.  
Development of a high fidelity hybrid Eulerian-Lagrangian solver combining a grid-based solver with a boundary element solver and particle based solver. Joint research with Sandia National Laboratories.

- 2006–2007 **Research fellow**, *National Laboratory of Civil Engineering (LNEC)*, Lisbon, Portugal.  
Numerical and experimental modelling of free surface flows.
- 2002–2003 **Junior Research fellow (scholarship)**, *European Organization for Nuclear Research (CERN) / Center for Fundamental Physics Interactions (CFIF)*, Geneva, Switzerland and Lisbon, Portugal.  
Numerical simulation of  $J/\psi$  production and suppression in quantum chromodynamics (QCD) and development of the data acquisition system of the experiment.

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## Awards and grants

- 2014 **Research grant**, *Shell-NWO-FOM*, The Netherlands, co-author of application.  
Affordable high resolution reservoir modeling using a multiscale approach (256k€)
- 2008 **Research grant**, *Foundation for Science and Technology*, Portugal, main author of application.  
High order mimetic discretization (100k€)
- 2007 **Adolpho Loureiro prize**, *Portuguese delegation of the International Association for Navigation (PIANC)*, Portugal.  
pyMOIA – real-time prediction of wave state in harbours

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## Service

1. Organizer of workshop on Structure Preserving Discretizations, the Netherlands (2018).
2. Developer of Structure Preserving Discretization website [www.spdisc.org](http://www.spdisc.org), follow up from BIRS workshop on structure preserving discretizations (2017).
3. Reviewer for Journal of Computational Physics, Computers & Mathematics with Applications, and Advanced Modeling and Simulation in Engineering Sciences.
4. Developer of mimeticFEM library for solving PDEs using the mimetic arbitrary order finite element formulation (<https://bitbucket.org/mimeticfem/mimeticfem>).
5. Developer of pHyFlow hybrid Eulerian-Lagrangian flow solver for wind energy applications (<https://github.com/gorkiana/pHyFlow>).

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## Publications

### Peer reviewed and under peer review

1. *Robust computation of tokamak equilibrium with LIUQE using a Jacobian-Free Newton-Krylov method*, [A. Palha](#), F. Carpanese, F. Felici, J.-M. Moret, O. Sauter. (submitted to *Computer Physics Communications* 2017).
2. *Discrete conservation properties for shallow water flows using mixed mimetic spectral elements*, D. Lee, [A. Palha](#), M. Gerritsma. (submitted to *Journal of Computational Physics* 2017).
3. *Mimetic spectral element method for anisotropic diffusion*, M. Gerritsma, [A. Palha](#), V. Jain, Y. Zhang, chapter of *Numerical Methods for PDEs*, Springer (under publication 2017).
4. *Spectral mimetic least-squares method for curl-curl systems*, [A. Palha](#), M. Gerritsma *Lecture Notes in Computer Science* (accepted 2017).
5. *Spectral mimetic least-squares method for div-curl systems*, M. Gerritsma, [A. Palha](#), *Lecture Notes in Computer Science* (accepted 2017).
6. *A mass, energy, enstrophy and vorticity conserving (MEEVC) mimetic spectral element discretization for the 2D incompressible Navier-Stokes equations*, [A. Palha](#), M. Gerritsma. *Journal of Computational Physics*, 328, pp. 200-220 (2017).
7. *A mimetic spectral element solver for the Grad-Shafranov equation*, [A. Palha](#), B. Koren, F. Felici. *Journal of Computational Physics* (invitation only special issue on Numerical methods for energy), 316, pp. 63-93 (2016).
8. *A posteriori uncertainty quantification of PIV-based pressure data*, I. Azijli, A. Sciacchitano, D. Ragni, [A. Palha](#), R. P. Dwight. *Experiments in Fluids* 57(5) (2016).

9. *Physics-compatible discretization techniques on single and dual grids, with application to the Poisson equation of volume forms*, [A. Palha](#), P.P. Rebelo, R. Hiemstra, J. Kreeft, M. Gerritsma. *Journal of Computational Physics* (invitation only special issue on Physics-compatible numerical methods), 257(PB), pp. 1394-1422 (2014).
10. *Mimetic Spectral Element Advection*, [A. Palha](#), P.R. Rebelo, M. Gerritsma. *Lecture Notes in Computational Science and Engineering*, Vol. 95, pp. 325-335 (2014).
11. *The Geometrical Basis of Numerical Methods*, M. Gerritsma, R. Hiemstra, J. Kreeft, [A. Palha](#), P. Rebelo, D. Toshniwal. *Lecture Notes in Computational Science and Engineering*, Vol. 95, pp. 17-35 (2014).
12. *Mixed Mimetic Spectral Element Method Applied to Darcy's Problem*, P. Rebelo, [A. Palha](#), M. Gerritsma. *Lecture Notes in Computational Science and Engineering*, Vol. 95, pp. 17-35 (2014).
13. *Spectral element approximation of the Hodge- $\star$  operator in curved elements*, [A. Palha](#), M. Gerritsma. *Lecture Notes in Computational Science and Engineering*, Vol. 76, pp. 283-291 (2011).
14. *A conservative spectral element method for curvilinear domains*, M. Bouman, [A. Palha](#), M. Gerritsma. *Lecture Notes in Computational Science and Engineering*, Vol. 76, pp. 111-119 (2011).
15. *Composite modelling*, H. Gerritsen, J. Sutherland, J. A. Santos, H. van den Boogaard, S. Caires, R. Deigaard, M. Dixen, C. J. Fortes, J. Fredsøe, P. Freire, M. van Gent, X. Gironella, J. Grüne, N. Grunnet, P. M. Jensen, R. Lemos, M. G. Neves, C. Obhrai, F. Oliveira, T. Oliveira, H. Oumeraci, [A. Palha](#), L. Pinheiro, R. Schmidt-Koppenhagen, U. Schmidtke, M. T. Reis, M. M. Rita, F. Sancho, J.-P. Sierra, I. Sousa, B. M. Sumer. *Users Guide to Physical Modelling and Experimentation*, CRC Press (2011).
16. *Mimetic Least-Squares spectral/hp finite element method for the Poisson equation*, [A. Palha](#), M. Gerritsma. *Lecture Notes in Computer Science*, Vol. 5910, pp. 662-670 (2010).
17. *Least-Squares spectral element method on a staggered grid*, M. Gerritsma, M. Bouman, [A. Palha](#). *Lecture Notes in Computer Science*, Vol. 5910, pp. 653-661 (2010).
18. *The impact of wave energy farms in the shoreline wave climate: Portuguese pilot zone case study using Pelamis energy wave devices*, [A. Palha](#), L. Mendes, C. J. Fortes, A. Brito-Melo, A. Sarmiento. *Renewable Energy*, 35(1), pp. 62-77 (2010).
19. *Irregular wave propagation at Torres-Mostardas beach, Brazil*, [A. Palha](#), C.J. Fortes, P.R.F. Teixeira, L.V. Pinheiro. *Maritime Engineering*, 163(MA2), pp. 57-71 (2010).

### Preprints

1. *A hybrid Eulerian-Lagrangian flow solver*, [A. Palha](#), L. Manickathan, C.S. Ferreira, G. van Bussel. *arXiv* (2016).
2. *Mimetic spectral element method for Hamiltonian systems*, [A. Palha](#), M. Gerritsma. *arXiv* (2015).
3. *Mimetic framework on curvilinear quadrilaterals of arbitrary order*, J. Kreeft, [A. Palha](#), M. Gerritsma. *arXiv* (2011).

### Selected talks

1. *High order mimetic discretizations for the Cahn-Hilliard equations*, High order mimetic methods and applications, International Conference on Spectral and High Order Methods (ICOSAHOM), United Kingdom (2018). **invited speaker**
2. *High order mimetic discretizations*, Connections in Geometric Numerical Integration and Structure-Preserving Discretization, Banff International Research Station (BIRS), Canada (2017). (see palha.org for video). **invited speaker**
3. *Spectral mimetic least-squares method for curl-curl systems*, Large Scale Scientific Computing (LSSC), Bulgaria (2017). **invited speaker**
4. *High order mimetic discretizations*, Canadian Mathematical Society Winter meeting, Niagara Falls, Canada (2016). **invited speaker**

5. *Helicity- and Energy-conserving discretization for the 3D Euler equations*, ENUMATH, Ankara, Turkey (2015). **invited speaker**
6. *Mass, Energy, Enstrophy and Vorticity conserving mimetic spectral element inviscid flow solver*, WCCM-ECCM-ECFD, Barcelona, Spain (2014). **invited speaker**
7. *Physically accurate advection with the discrete representation of the Lie derivative*, Conference in Finite elements for flow problems (FEF2011), Munich, Germany (2011). **invited speaker**
8. *High-order grad-, curl- and div- conforming discretization in computational electromagnetism: part I*, NLR workshop on discontinuous Galerkin methods (dgNLR2011), Amsterdam, The Netherlands (2011). **invited speaker**
9. *Numerical solution of the advection equation with the discretization of the Lie derivative*, Conference of the European community on computational methods in applied sciences (ECCOMAS2010), Lisbon, Portugal (2010).
10. *High-order cochain interpolation*, Non-standard numerical methods for PDEs , Pavia, Italy, 2010 (2010).

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## International experience

- 2017 Canada, Banff International Research Station (BIRS), Prof.dr. S. Steinberg, Dr. J.-C. Nave, Dr. A. Wan, Dr. A. Bihlo (5 days visit).
- 2016 Canada, Canadian Mathematical Society, Dr. A. Wan, Dr. A. Bihlo (4 days visit).
- 2016 Switzerland, EPFL, Dr. O. Sauter (1 week visit)
- 2015 Germany, IPP, Prof.dr. E. Sonnendrücker and Dr. M. Kraus (2 weeks visit)
- 2014 Switzerland, EPFL, Dr. O. Sauter (1 week visit)
- 2012 USA, Sandia National Laboratories, Dr. M. Barone (1 week visit)
- 2002 Switzerland, CERN, Prof.dr. J. Seixas (2 months visit)

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## Teaching

*Eindhoven University of Technology, Department of Mechanical Engineering*

- 2015-2017 Control and Operation of Tokamaks (with dr.ir. F. Felici)

*Delft University of Technology, Faculty of Aerospace Engineering*

- 2013–2015 Computational Fluid Dynamics I, M.Sc. course (with dr.ir. M.I. Gerritsma)
- 2013–2014 Design Synthesis Exercise, B.Sc. course (winning team)
- 2012–2013 Rotor Aerodynamics, B.Sc. course (with dr.ir. C.S. Ferreira)
- 2010–2011 Aerodynamics II, B.Sc. course (with prof.dr.ir. F. Scarano)

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## Supervision

*Eindhoven University of Technology, Department of Mechanical Engineering*

**B.Sc.**

- 2015 Derks, M., *A spectral element solver for the Grad-Shafranov equation*
- 2015 Duys, A., *A Mesh-free magnetic field solver*

*Delft University of Technology, Faculty of Aerospace Engineering*

**Ph.D.**

- 2016 Zhang, Y., *Structure-preserving discretization for the Navier-Stokes equation* (ongoing)
- 2016 Varun, J., *Affordable high resolution reservoir modeling using a multiscale approach* (ongoing)
- 2015 Baptista, C., *Development of a hybrid Eulerian/Lagrangian flow solver for wind turbines* (ongoing)

**M.Sc.**

- 2017 Dieben, V., *Isogeometric pressure reconstruction from PIV data*
- 2017 de Diego, G. G., *Modelling of depositional pattern of turbidity currents*
- 2015 Zhang, Y., *An energy and helicity conserving mimetic spectral element Navier-Stokes solver*
- 2014 Egilsson, B., *A Hybrid Eulerian/Lagrangian numerical method for the study of vertical axis wind turbines in 3D*
- 2014 Manickathan, L., *A Hybrid Eulerian/Lagrangian numerical method for the study of vertical axis wind turbines in 2D*
- 2012 He, C., *Investigation of the wake of vertical axis wind turbines*
- 2012 Hermidas, N., *Error analysis of high order mimetic spectral element method*
- 2012 Toshniwal, D., *A Geometric Approach Towards Momentum Conservation*
- 2011 Rebelo, P., *Mimetic spectral element method for hyperbolic problems*
- 2010 Lantsheer, M., *Tracking free surface flows using the least-squares spectral element method*
- 2010 Bouman, M.P., *Mimetic spectral element method for elliptic problems*

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## References

Available upon request.