

# Rafael Vázquez Hernández

## Curriculum Vitae

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### Current Position

Feb 2017 – **Research collaborator (collaborateur scientifique)**, *École Polytechnique Fédérale de Lausanne*, Lausanne (Switzerland).  
Now

### Previous Positions

2009 – 2017 **Researcher (equivalent to Assistant Professor)**, *IMATI-CNR, Istituto di Matematica Applicata e Tecnologie Informatiche “Enrico Magenes”*, Pavia (Italy).

2008 – 2009 **Research contract**, *Project: GeoPDEs*, IMATI-CNR, Pavia.

Jun – Oct **Research contract**, *Project: Grupos de referencia competitiva*, University of Santiago de Compostela.  
2008

2004 – 2008 **Ph.D. fellowship**, University of Santiago de Compostela.

Jan – May **Research contract**, *Project: Modelling and computation of fluid dynamics and combustion in the As Pontes TPP boiler*, University of Santiago de Compostela.  
2004

Jul – Dec **Research contract**, *Project: Prediction of deposit formation in powdered coal furnaces in the As Pontes TPP boiler (Endesa)*, University of Santiago de Compostela.  
2003

### Education

2004-2008 **Ph.D. in Mathematics**, *University of Santiago de Compostela, Spain, Contributions to the mathematical study of some problems in magnetohydrodynamics and induction heating.*

Advisors: Alfredo Bermúdez de Castro and Rafael Muñoz Sola

2002-2004 **M.Sc. in Applied Mathematics**, *University of Santiago de Compostela, Spain, Introduction to the mathematical modelling of microwave heating.*

Diploma de Estudios Avanzados. Advisors: Rafael Muñoz Sola and Carmen Rodríguez Iglesias

1997-2002 **B.Sc. in Mathematics**, *University of Santiago de Compostela, Spain.*

Licenciatura en Matemáticas

### Visiting

Mar 2016 **Visiting researcher**, *Instituto de Matemática Aplicada del Litoral*, Santa Fe (Argentina).

Contact: Eduardo M. Garau

- Jan 2016 **Visiting researcher**, *Department of Mathematics, Dongguk University, Seoul (South Korea)*.  
Contact: Durkbin Cho
- Feb – Apr 2008 **Visiting young researcher**, *Department of Mathematics, University of Trento, Trento (Italy)*.  
Contact: Alberto Valli
- Mar – Jun 2007 **Visiting young researcher**, *Department of Mathematics, University of Trento, Trento (Italy)*.  
Contact: Alberto Valli
- Jan – Apr 2006 **Visiting young researcher**, *Department of Mathematical Analysis, University of Málaga, Málaga (Spain)*.  
Contact: Carlos Parés

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## Awards

- 2011 National award for Ph.D. theses in the field of Industrial Mathematics, *Real Sociedad Matemática Española*.
- 2009 Outstanding award for Ph.D. theses, *Faculty of Mathematics, University of Santiago de Compostela*.
- 2004 FPI grant (Research Personnel Training), *Spanish Ministry of Education and Science*.

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## Student Supervision

- 2012 **Advisor**, *Sergio Rojas Hernández*, Master Degree Thesis, University of Pavia.  
Co-advisor: Annalisa Buffa

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## Teaching

### Graduate courses and workshops

- Sep 2014 *An introduction to the numerical analysis of isogeometric methods*, XVI Jacques-Louis Lions Spanish-French School on Numerical Simulation in Physics and Engineering, Pamplona (Spain). Course duration: 4 hours
- Sep 2013 *An introduction to IGA*, University of Santiago de Compostela (Spain). Course duration: 7 hours
- Jul 2013 *GeoPDEs: an Octave/Matlab implementation for isogeometric methods*, NIMS Summer School on Isogeometric Analysis, Daejeon (South Korea). Course duration: 2 hours
- Apr 2013 *Isogeometric Analysis: a practical introduction*, University of Pavia (Italy). Course duration: 12 hours
- Jun 2012 *Compatible isogeometric discretizations*, CIME-EMS Summer School in applied mathematics, Cetraro (Italy). Course duration: 4 hours

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## Organization of events

- Sep 2017 IperPV 2017, the XVII Italian Meeting on Hyperbolic Equations, Pavia (Italy).
- Sep 2017 IGA 2017, Pavia (Italy).

- Apr 2015 The second Lions-Magenes Days, Pavia (Italy).
- Jun 2010 i-MATH school on *Coupled PDEs in multyphysics and industrial applications*, Castro Urdiales (Spain).

## Participation in Research Projects

### Public funding

- 2016–2021 *CHANGE: New CHallenges for (adaptive) PDE solvers: the interplay of ANalysis and GEometry* Funding institution: European Research Council. PI: Annalisa Buffa.
- 2015-2018 *CAxMan: Computer Aided Technologies for Additive manufacturing*. Funding program: European Union's Horizon 2020. Project coordinator: Tor Dokken.
- 2008-2013 *GeoPDEs: Innovative compatible discretization techniques for Partial Differential Equations*, IMATI-CNR, Pavia. Funding institution: European Research Council. PI: Annalisa Buffa.
- 2009-2012 *Analysis and numerical simulation of mathematical models with industrial applications*, University of Santiago de Compostela (Spain). Funding institution: Ministerio de Ciencia e Innovación. PI: Alfredo Bermúdez de Castro.
- 2006-2009 *Grupos de referencia competitiva*, University of Santiago de Compostela (Spain). Funding institution: Xunta de Galicia. PI: Alfredo Bermúdez de Castro.
- 2006-2009 *Numerical simulation in electromagnetism. Applications in industry*, University of Santiago de Compostela (Spain). Funding institution: Xunta de Galicia. PI: Alfredo Bermúdez de Castro.
- 2003-2006 *Thermo-magneto-hydrodynamic simulation of an induction furnace*, University of Santiago de Compostela (Spain). Funding institution: Ministerio de Ciencia y Tecnología. PI: Alfredo Bermúdez de Castro.

### Private funding

- 2004 *Modelling and computation of fluid dynamics and combustion in the boiler of Maritsa-East 3 (Bulgary) TPP*, University of Santiago de Compostela. Funding company: Totema Engineering Ltd. PI: Alfredo Bermúdez de Castro.
- 2004 *Prediction of deposit formation in powdered coal furnaces in the As Pontes TPP boiler (Endesa)*, University of Santiago de Compostela. Funding company: Endesa Generación S.A. PI: Alfredo Bermúdez de Castro.
- 2003–2004 *Modelling and computation of fluid dynamics in the As Pontes TPP boiler*, University of Santiago de Compostela. Funding company: Totema Engineering Ltd. PI: Alfredo Bermúdez de Castro.

## Patents and software

- Jun 2007 **THESIF**, *Numerical thermal-magneto-hydrodynamic simulation of an induction furnace*, Registered in: Regional Register of Intellectual Property (Xunta de Galicia, Spain), Register number: SC-282/7.
- 2010–Now **GeoPDEs**, *A package for Isogeometric Analysis in Matlab and Octave*.  
<http://rafavzqz.github.io/geopdes/>

## Presentations in international conferences

- Sep 2017 **IGA 2017**, *Pavia, Italy*, Study of coarsening algorithms for adaptive methods with hierarchical B-splines, Joint work with E.M. Garau.
- Oct 2016 **IGA 2016**, *La Jolla, California, United States*, Algorithms for adaptive isogeometric methods using hierarchical splines, with an implementation in GeoPDEs, Joint work with E.M. Garau.
- Sep 2016 **SIMAI 2016**, *Milan, Italy*, Algorithms for adaptive isogeometric methods using hierarchical splines, with an implementation in GeoPDEs, Joint work with E.M. Garau.
- Sep 2015 **OctConf 2015**, *Darmstadt, Germany*, The NURBS and GeoPDEs packages..  
Invited lecture
- Sep 2015 **UMI 2015**, *Siena, Italy*, Compatible discretization with hierarchical splines, Joint work with J.A. Evans, M.A. Scott, D.C. Thomas.
- Jun 2015 **CGTA 2015**, *Linz, Austria*, Isogeometric discrete differential forms with hierarchical splines, Joint work with J.A. Evans, M.A. Scott, D.C. Thomas.
- Jun 2015 **IGA 2015**, *Trondheim, Norway*, Isogeometric discrete differential forms with hierarchical splines, Joint work with J.A. Evans, M.A. Scott, D.C. Thomas.
- Jul 2014 **SIMAI 2014**, *Taormina, Italy*, Compatible discretizations based on hierarchical splines., Joint work with J. A. Evans, M. A. Scott, D. C. Thomas.
- May 2014 **CEFC 2014**, *Annecy, France*, A survey on isogeometric analysis. Applicability in computational electromagnetics., Joint work with A. Buffa, G. Sangalli.  
Plenary lecture
- Jan 2014 **IGA 2014**, *Austin, United States*, Compatible discretizations in isogeometric analysis, Joint work with A. Buffa, G. Sangalli.
- Jul 2013 **USNCCM12**, *Raleigh, United States*, Differential forms in isogeometric analysis based on T-splines, Joint work with A. Buffa, G. Sangalli.
- Jun 2013 **MAFELAP 2013**, *Uxbridge, United Kingdom*, Implementation of high order impedance boundary conditions on isogeometric methods, Joint work with A. Buffa, L. Di Rienzo.
- Jun 2013 **ACE'13**, *Trento, Italy*, Discrete differential forms based on T-splines, Joint work with A. Buffa, G. Sangalli.
- Feb 2013 **ACM 2013-TH70**, *San Diego, United States*, Compatible discretizations in isogeometric analysis, Joint work with A. Buffa, G. Sangalli.
- Jan 2013 **WONAPDE 2013**, *Concepción, Chile*, Compatible discretizations in isogeometric analysis, Joint work with A. Buffa, G. Sangalli.
- Oct 2012 **ECCOMAS 2012**, *Vienna, Austria*, Isogeometric differential forms based on T-splines, Joint work with A. Buffa, G. Sangalli.
- Jun 2012 **DD21**, *Rennes, France*, Multilevel preconditioning for isogeometric analysis based on hierarchical splines, Joint work with A. Buffa, H. Harbrecht, A. Kunoth, G. Sangalli.

- Sep 2011 **ISEM 2011**, *Naples, Italy*, NURBS-based implementation of high-order surface impedance boundary conditions, Joint work with A. Buffa, L. Di Rienzo.  
Poster presentation.
- Jul 2011 **RSME Conference on Transfer and Industrial Mathematics**, *Santiago de Compostela, Spain*, Contributions to the mathematical study of some problems in magnetohydrodynamics and induction heating.
- Jun 2011 **HOFEIM 2011**, *Krakow, Poland*, NURBS-based implementation of high-order surface impedance boundary conditions, Joint work with A. Buffa, L. Di Rienzo.  
Poster presentation.
- Jan 2011 **IGA 2011**, *Austin, United States*, GeoPDEs: a research tool for isogeometric analysis. Description of its design, Joint work with C. de Falco, A. Reali.
- Jul 2010 **ACE'10**, *Zurich, Switzerland*, Isogeometric Analysis in electromagnetism: discretization with NURBS, Joint work with A. Buffa, G. Sangalli.
- May 2010 **ECCM 2010**, *Paris, France*, Isogeometric Analysis in electromagnetism, Joint work with A. Buffa, G. Sangalli.
- Feb 2010 **Oberwolfach workshop: Computational Electromagnetism and Acoustics**, *Oberwolfach, Germany*, Isogeometric Analysis in electromagnetism: analysis and testing, Joint work with A. Buffa, J. Rivas, G. Sangalli.
- Nov 2009 **COMPUMAG 2009**, *Florianopolis, Brasil*, Isogeometric Analysis for electromagnetic problems, Joint work with A. Buffa, G. Sangalli.  
Poster presentation.
- Sep 2009 **ICEAA 2009**, *Turin, Italy*, Numerical Solution of Maxwell Equations using B-splines, Joint work with A. Buffa, G. Sangalli.
- Jul 2009 **USNCCM10**, *Columbus, United States*, Isogeometric Analysis for electromagnetic problems, Joint work with A. Buffa, G. Sangalli.
- Jun 2009 **MAFELAP 2009**, *Uxbridge, United Kingdom*, Numerical approximation of Maxwell equations with B-splines, Joint work with A. Buffa, G. Sangalli.
- Jun 2008 **ESCO 2008**, *Jetrichovice, Czech Republic*, Thermal-Magneto-Hydrodynamic Simulation of Cylindrical Induction Melting Furnaces, Joint work with A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado.
- May 2007 **Coupled Problems 2007**, *Ibiza, Spain*, Thermo-Magneto-Hydrodynamic Simulation of Cylindrical Induction Heating Furnaces, Joint work with A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado.
- Jun 2006 **MAFELAP 2006**, *Uxbridge, United Kingdom*, Numerical Simulation of an Induction Furnace, Joint work with A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado.

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### Invited seminars

- 2016 Instituto de Investigaciones Matemáticas “Luis A. Santaló”, CONICET and University of **Buenos Aires**, Argentina.
- 2016 Instituto de Matemática Aplicada del Litoral, **Santa Fe**, Argentina.
- 2015 Schools of Engineering and Mathematics, University of **Glasgow**, Scotland.
- 2015 Dipartimento di Matematica, Politecnico di **Milano**, Italy.

- 2015 Laboratoire Jean Kuntzmann, University of **Grenoble**, France.
- 2010 Departamento de Matemática Aplicada, Universidade de **Santiago de Compostela**, Spain.
- 2010 Departamento de Matemáticas, Universidad del País Vasco, **Bilbao**, Spain.
- 2009 Istituto di Matematica Applicata e Tecnologie Informatiche, **Pavia**, Italy.
- 2007 Departamento de Matemática Aplicada, Universidade de **Santiago de Compostela**, Spain.
- 2006 Departamento de Análisis Matemático, Universidad de **Málaga**, Spain.

## Publications

### Papers in international journals

- E.M. Garau, R. Vázquez, *Algorithms for the implementation of adaptive isogeometric methods using hierarchical splines*. Appl. Numer. Math. 123 (2018), 57–78.
- G. Sangalli, T. Takacs, R. Vázquez, *Unstructured spline spaces for isogeometric analysis based on spline manifolds*. Comput. Aided Geom. Design 47 (2016), 61–82.
- R. Vázquez, *A new design for the implementation of isogeometric analysis in Octave and Matlab: GeoPDEs 3.0*. Comput. Math. Appl. 72 (2016), 3, 523–554.
- L. Beirão da Veiga, A. Buffa, G. Sangalli, R. Vázquez, *Approximation estimates for isogeometric spaces in multipatch geometries*. Numer. Methods for Partial Differential Equations 31 (2015), 2, 422–438.
- L. Beirão da Veiga, A. Buffa, G. Sangalli, R. Vázquez, *Mathematical analysis of variational isogeometric methods*. Acta Numer. 23 (2014), 157–287.
- R. Vázquez, A. Buffa, L. Di Rienzo, *Isogeometric FEM implementation of high order surface impedance boundary conditions*. IEEE Trans. Magn., 50 (2014), 6, Article no. 7400508.
- R. Vázquez, A. Buffa, L. Di Rienzo, D. Li, *Isogeometric Finite Elements with Surface Impedance Boundary Conditions*. IEEE Trans. Magn., 50 (2014), 2, Article no. 7010504.
- A. Buffa, G. Sangalli, R. Vázquez, *Isogeometric methods for computational electromagnetics: B-spline and T-spline discretizations*. J. Comp. Phys. 257 (2014), 1291–1320.
- L. Beirão da Veiga, A. Buffa, G. Sangalli, R. Vázquez, *Analysis-suitable T-splines of arbitrary degree: definition, linear independence and approximation properties*. Math. Models Methods Appl. Sci., 23 (2013), 11, 1979–2003.
- R. Vázquez, A. Buffa, L. Di Rienzo, *A NURBS-based BEM implementation of high order surface impedance boundary conditions*. IEEE Trans. Magn., 48 (2012), 12, 4757–4766.
- A. Buffa, J. Rivas, G. Sangalli, R. Vázquez, *Isogeometric discrete differential forms in three dimensions*. SIAM J. Numer. Anal., 49 (2011), 2, 818–844.

- A. Bermúdez, D. Gómez, M.C. Muñiz, R. Vázquez, *A thermoelectrical problem with a nonlocal radiation boundary condition*. *Math. Comput. Modelling*, 53 (2011), 1-2, 63–80.
- C. de Falco, A. Reali, R. Vázquez, *GeoPDEs: a research tool for isogeometric analysis of PDEs*. *Adv. Eng. Softw.*, 42 (2011), 12, 1020–1034.
- R. Vázquez, A. Buffa, *Isogeometric Analysis for electromagnetic problems*. *IEEE Trans. Magn.*, 46 (2010), 8, 3305–3308.
- A. Bermúdez, R. Muñoz-Sola, R. Vázquez, *Analysis of two stationary magnetohydrodynamics systems of equations including Joule heating*. *J. Math. Anal. Appl.*, 368 (2010), 2, 444–468.
- A. Buffa, G. Sangalli, R. Vázquez, *Isogeometric Analysis in electromagnetics: B-splines approximation*. *Comput. Methods Appl. Mech. Engrg.*, 199 (2010), 1143–1152.
- A. Alonso-Rodríguez, A. Valli, R. Vázquez-Hernández, *A formulation of the eddy current problem in the presence of electric ports*. *Numer. Math.* 113 (2009), 4, 643–672.
- A. Alonso-Rodríguez, R. Vázquez-Hernández, *Iterative methods for the saddle-point problem arising from the  $\mathbf{H}_C/\mathbf{E}_I$  formulation of the eddy current problem*. *SIAM J. Sci. Comput.* 31(2009), 4, 3155–3178.
- A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado, R. Vázquez, *Numerical simulation of a thermo-electromagneto-hydrodynamic problem in an induction heating furnace*. *Appl. Numer. Math.*, 59 (2009), 9, 2082–2104.

#### Conference proceedings

- A. Buffa, R. Vázquez, *Isogeometric analysis for electromagnetic scattering problems*, International Conference on Numerical Electromagnetic Modeling and Optimization for RF, Microwave, and Terahertz Applications, NEMO 2014, article no. 6995712, (2014)
- L. Beirão da Veiga, A. Buffa, G. Sangalli, R. Vázquez, *Dual compatible splines on nontensor product meshes*. *Approximation Theory XIV: San Antonio 2013*, 15–26, Springer Proc. Math. 83 (2014).
- R. Vázquez Hernández, *Contributions to the mathematical study of some problems in magnetohydrodynamics and induction heating*. *Proceedings of the RSME Conference on Transfer and Industrial Mathematics*, 68–72. Publicacións da Universidade de Santiago de Compostela, Santiago de Compostela, 2011.
- R. Vázquez (joint with A. Buffa, G. Sangalli), *Isogeometric analysis in electromagnetism: analysis and testing*. *Computational Electromagnetism and Acoustics*, organized by R. Hiptmair, R.H.W. Hoppe, P. Joly and U. Langer. *Oberwolfach Rep.* 7 (2010), no. 1, 506–509.
- A. Buffa, R. Vázquez, *Numerical simulation of Maxwell's equations using B-splines*. *International Conference on Electromagnetics in Advanced Applications, ICEAA'09, Turin*. Pages: 234–236.

- A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado, R. Vázquez, *Numerical Simulation of Induction Furnaces for Silicon Purification*. Progress in Industrial Mathematics at ECMI 2006, 48–65. Math. Ind. 12, Springer, Berlin, 2008.

#### Book chapters

- L. Beirão da Veiga, A. Buffa, G. Sangalli, R. Vázquez, *An introduction to the numerical analysis of isogeometric methods*, in *XVI Jacques-Louis Lions Spanish-French School on Numerical Simulation in Physics and Engineering*, I. Higuera, T. Roldán, J.J. Torrens, eds., SEMA-SIMAI Springer Series, 2016.
- A. Bermúdez, D. Gómez, M.C. Muñiz, P. Salgado, R. Vázquez, *Numerical modelling of industrial induction*, in *Advances in induction and microwave heating of mineral and organic materials*, S. Grundas, ed., Intech, 2011.

#### Ph.D. Thesis

- R. Vázquez Hernández, *Contributions to the mathematical study of some problems in magnetohydrodynamics and induction heating*, Ph.D. Thesis, Departamento de Matemática Aplicada, Universidade de Santiago de Compostela, 2009.

#### Preprints and technical reports

- J.A. Evans, M.A. Scott, K. Shepherd, D. Thomas, R. Vázquez, *Hierarchical B-spline complexes of discrete differential forms*. MATHICSE Reports 17.2017 (2017).
- R.N. Simpson, Z. Liu, R. Vázquez, J.A. Evans, *An isogeometric boundary element method for electromagnetic scattering with compatible B-spline discretization*. MATHICSE Reports 13.2017 (2017).
- D. Cho, R. Vázquez, *BPX preconditioners for isogeometric analysis using analysis-suitable T-splines*. IMATI Report Series 17-01 (2017).