

# María Barbero Liñán

May 30, 2017

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Departamento de Matemática Aplicada	ETS de Arquitectura
Universidad Politécnica de Madrid	m.barbero@upm.es
Avenida Juan de Herrera 4	Phone number: +34 91 336 6562
28040 Madrid, Spain	Webpage

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Instituto de Ciencias Matemáticas	Office: 417
C/Nicolás Cabrera, 13-15	mbarbero@icmat.es
Campus Cantoblanco, UAM	Phone number: +34 91 299 97 97
28048 Madrid, Spain	Webpage

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## PROFESSIONAL EXPERIENCE

**Associate Professor (Contratado Doctor)**, Universidad Politécnica de Madrid, Spain. Oct. 2015–Present

**Research Fellow**, Instituto de Ciencias Matemáticas, Madrid, Spain. Sept. 2011–Present

**Assistant Professor (Ayudante Doctor)**, Universidad Carlos III de Madrid, Spain. Sept. 2011–Oct. 2015

**Visiting Scientific Researcher**, The Fields Institute for the Research in Mathematical Sciences, Toronto, ON, Canada Feb. 2012–May 2012

**“Juan de la Cierva” postdoctoral fellow**, Instituto de Ciencias Matemáticas, Madrid, Spain. Dec. 2010–Sept. 2011

**“Beatriu de Pinós” Postdoctoral fellow**, Department of Mathematics and Statistics, Queen’s University, Kingston, ON, Canada. Sept. 2009–Dec. 2010

**Assistant professor**, Department of Mathematics and Statistics, Queen’s University, Kingston, ON, Canada. Jan. 2010–Feb. 2010

**Postdoctoral fellow**, CORIDA, Centre de recherche INRIA Nancy–Grand Est, France. Jan. 2009–Aug. 2009

## EDUCATION

**Ph.D., Applied Mathematics**, Department of Applied Mathematics IV, Technical University of Catalonia, Barcelona, Spain. Sept. 2004–Dec. 2008

Supervisor: Dr. Miguel C. Muñoz Lecanda.

Title: A geometric study of abnormality in optimal control problems for control and mechanical control systems.

**Bachelor of science (Licenciado, 5 years), Mathematics**, Technical University of Catalonia, Barcelona, Spain. Sept.1999–Jun.2004

## RESEARCH INTERESTS

Geometric mechanics, calculus of variations, geometric control theory, optimal control theory, hybrid control systems, discrete control theory, discrete variational principles, strict abnormal minimizers, affine connection control mechanical systems, tracking laws,  $k$ -symplectic formalism.

## CITATION METRICS (January 2017)

Google scholar: 153 citations and h-index 8. SCI: 57 citations (46 no self-citations) and h-index 5 in SCI. MathSciNet: 46 citations.

## PUBLICATIONS

### Preprints:

1. M. Barbero Liñán, H. Cendra, E. García-Toraño Andrés, D. Martín de Diego, The interplay between Dirac systems, Morse families and interconnection. Preprint 2017. (arXiv:1702.08596 [math-ph])

### In journals:

1. M. Barbero Liñán, M. Farré Puiggalí, D. Martín de Diego, Inverse problem for Lagrangian systems on Lie algebroids and applications to reduction by symmetries. *Monatsh. Math.* **180** (2016), no. 4, 665–691.
2. M. Barbero Liñán, M. Sigalotti, New high order sufficient conditions for configuration tracking. *Automatica J. IFAC* **62** (2015), 222–226.
3. J. M. Pérez-Pardo, M. Barbero Liñán, A. Ibort, Boundary dynamics and topology change in quantum mechanics. *Int. J. Geom. Methods Mod. Phys.*, **12**156011(2015), 11 pages.
4. M. Barbero Liñán, D. Iglesias Ponte, D. Martín de Diego, Morse families in optimal control problems. *SIAM J. Control Optim.*, **53**(1), 352-377, 2015.
5. M. Barbero Liñán, B. Jakubczyk, Second order conditions for optimality and local controllability of discrete-time systems. *SIAM J. Control Optim.*, **53**(1), 414-433, 2015.
6. M. Barbero Liñán, M. Farré Puiggalí, D. Martín de Diego, Isotropic submanifolds and the inverse problem for mechanical constrained systems. *J. Phys. A: Math. Theor.* **48** (2015) 045210, 35 pp.
7. M. Barbero Liñán, M. C. Muñoz Lecanda,  $k$ -symplectic Pontryagin's Maximum Principle for some families of PDES. *Calc. Var. Partial Differential Equations*, Vol. **49**(3-4), 2014, 1199-1221.
8. M. Barbero Liñán, M. de León, D. Martín de Diego, Lagrangian submanifolds and the Hamilton-Jacobi equation. *Monatsh. Math.*, Vol. **171**(3), 2013, 269-290.
9. M. Barbero Liñán, M. de León, J. C. Marrero, D. Martín de Diego, M. C. Muñoz Lecanda, Kinematic reduction and the Hamilton-Jacobi equation. *J. Geom. Mech.*, Vol. **4**(3), 207-237, 2012.

10. M. Barbero Liñán, A. D. Lewis, Geometric interpretations of the symmetric product in affine differential geometry and applications. *Int. J. Geom. Methods Mod. Phys.*, **9**(8)(2012), 33 pages.
11. M. Barbero Liñán, M.C. Muñoz Lecanda, Presymplectic high order maximum principle. *Rev. R. Acad. Cien. Serie A. Mat.*, Volume 106, Issue 1, 2012, Pages 97-110.
12. M. Barbero Liñán, M. Sigalotti, High order sufficient conditions for configuration tracking of affine connection control systems, *System Control Lett.*, Volume 59, Issue 8, August 2010, Pages 491-503.
13. M. Barbero Liñán, M.C. Muñoz Lecanda, Strict abnormal extremals in nonholonomic and kinematic control systems, Special issue “Nonholonomic constraints in Mechanics and Optimal Control Theory” in *Discrete Contin. Dyn. Syst. Ser. S* **3**(1) (2010) 1–17.
14. M. Barbero Liñán, M.C. Muñoz Lecanda, Constraint Algorithm for Extremals in Optimal Control Problems, *Int. J. Geom. Methods Mod. Phys.*, Vol. **6**(7), 2009, 1221–1233.
15. M. Barbero Liñán, M.C. Muñoz Lecanda, Geometric approach to Pontryagin’s Maximum Principle, *Acta Appl. Math.*, Vol. **108**(2)(2009) 429–485.
16. M. Barbero Liñán, A. Echeverría Enríquez, D. Martín de Diego, M.C. Muñoz Lecanda, N. Román Roy, Unified formalism for non–autonomous mechanical systems, *J. Math. Phys.*, Vol. **49**(6) (2008) 062902–062916.
17. M. Barbero Liñán, A. Echeverría Enríquez, D. Martín de Diego, M.C. Muñoz Lecanda, N. Román Roy, Skinner–Rusk Formalism for Optimal Control and Applications. *J. Phys. A: Math. Theor.* **40** (2007) 12071–12093.

**In proceedings:**

1. M. Barbero-Liñán, M. Delgado Téllez, D. Martín de Diego. A geometric framework for discrete Hamilton-Jacobi equation. Proceedings of Geometry and Physics: XX International Fall Workshop. AIP Conference Proceedings, 2012. Volume 1460.
2. M. Barbero Liñán, Characterization of accessibility for affine connection control systems at some points with nonzero velocity. Proceedings of the *IEEE Conference on Decision and Control and European Control Conference*, Orlando, Florida, USA, Dec. 12-15, 2011, 6528-6533.
3. M. Barbero Liñán, M. Sigalotti. Tracking problems: high order algorithms. Proceedings of the *8th IFAC Symposium on nonlinear control systems* 2010.
4. M. Barbero Liñán, D. Martín de Diego, M.C. Muñoz Lecanda, Lie algebroids and optimal control: abnormality. *Geometry and Physics: XVII International Fall Workshop*, F. Etayo, M. Fioravanti and R. Santamaría (eds.), AIP Conference Proceedings, Volume **1130**, pp. 113–119, 2009.
5. M. Barbero Liñán, M.C. Muñoz Lecanda, Optimal control problems for affine connection control systems: characterization of extremals. *Geometry and Physics: XVI International Fall Workshop*, R. L. Fernandes and R. Picken (eds.), AIP Conference Proceedings, Volume **1023**, pp. 127–131, 2008.
6. M. Barbero Liñán, A. Echeverría Enríquez, D. Martín de Diego, M.C. Muñoz Lecanda, N. Román Roy, Skinner–Rusk Formalism for Optimal Control, *Proceedings of the XV International Workshop on Geometry and Physics*, Puerto de la Cruz, Tenerife, Canary Islands, Spain. September 11–16, 2006. *Publ. de la RSME*, Vol. **XX** (2007).

**Books (editor):**

1. M. Barbero-Liñán, F. Barbero, D. Martín de Diego. *Proceedings of Geometry and Physics: XX International Fall Workshop*, Madrid, Spain, August 31-September 3, 2011. AIP Conference Proceedings, 2012. Volume 1460.

**FELLOWSHIPS, SCHOLARSHIPS & AWARDS**

- 3rd candidate in the waiting list (mathematics) for Ramón y Cajal fellowship.** Ministerio de Economía y Competitividad. Jun. 2015
- Professor Erasmus scholarship recipient, University of Coimbra, Portugal.** Jun. 2012
- UC3M Travel scholarship for young post doctoral researchers** at Department of Mathematics and Statistics, Queen’s University, Kingston, ON, Canada, and The Fields Institute for the Research in Mathematical Sciences, Toronto, ON, Canada. Univerisdad Carlos III de Madrid, Spain. Feb.–May. 2012
- Best Doctoral Dissertation Award, Science Curriculum,** Academic Year 2008-2009, Technical University of Catalonia, Spain. Oct. 2011
- Postdoctoral fellowship “Juan de la Cierva”,** Ministerio de Ciencia y Tecnología, Spain. International competition. Dec. 2010–Dec. 2013
- Postdoctoral fellowship “Beatriu de Pinós”,** Agència de Gestió d’Ajuts Universitaris i de Recerca, Spain. Provincial competition. Sept. 2009–Dec. 2010
- Travel scholarship for graduate students at Department of Mathematics and Statistics, Queen’s University, Kingston, ON, Canada.** Spanish Ministry of Education and Science. Jun.–Aug. 2008  
Oct.–Dec. 2007  
Jun.–Aug. 2006
- Travel award Ferran Sunyer i Balaguer,** Societat Catalana de Matemàtiques, Institut d’Estudis Catalans, Spain. Provincial competition. 2008
- Graduate fellowship recipient, Programa Nacional de Formación del Profesorado Universitario (FPU),** Spanish Ministry of Education and Science, Spain. National competition. Apr. 2005–Dec. 2008
- Graduate fellowship recipient, Generalitat of Catalonia, Agència de Gestió d’Ajuts Universitaris i de Recerca – AGAUR,** Spain. Provincial competition. Jan. 2005–March 2005
- Undergraduate research scholarship recipient, Centro Europeo para el Paralelismo de Barcelona (CEPBA) IBM Research Institute (CIRI),** Spain. Duties: Implement scheduling algorithms. May–July 2004
- Undergraduate Erasmus scholarship recipient, University of Sheffield, England.** Sept. 2003–Feb. 2004

**Undergraduate research scholarship recipient**, Department of Applied Mathematics II, Technical University of Catalonia, Spain. Supervisor: Josep Maria Brunat. Duties: Do research and write a dissertation on Cayley graphs and TopSpin game. Jun. 2002–May 2003

## HABILITATIONS

**Profesor titular**, Agencia Nacional de Evaluación de la Calidad y Acreditación, ANECA. June 2015

**Profesor agregado**, Agència per a la Qualitat del Sistema Universitari de Catalunya, AQU. Oct. 2012

**Profesor contratado doctor**, Agencia Nacional de Evaluación de la Calidad y Acreditación, ANECA. Sept. 2012

**Profesor de la universidad privada**, Agencia Nacional de Evaluación de la Calidad y Acreditación, ANECA. Sept. 2012

**Profesor contratado doctor**, Agencia de Calidad y Acreditación y Prospectiva de las Universidades de Madrid, ACAP. August 2012

**Profesor doctor de la universidad privada**, Agencia de Calidad y Acreditación y Prospectiva de las Universidades de Madrid, ACAP. August 2012

**Profesor ayudante doctor**, Agencia Nacional de Evaluación de la Calidad y Acreditación, ANECA. Sept. 2010

**Profesor lector**, Agència per a la Qualitat del Sistema Universitari de Catalunya, AQU. April 2009

**Profesor colaborador**, Agència per a la Qualitat del Sistema Universitari de Catalunya, AQU. April 2009

## TALKS

**Invited talk in “Avances en Sistemas Dinámicos y Aplicaciones” session:** “A geometric integrator for some integrable systems”, Congreso Bienal de la Real Sociedad Matemática Española, Zaragoza, Spain. Jan. 30–Feb. 3, 2017

**Invited talk in Geometry session:** “Subvariedades isótropas en el problema inverso para sistemas mecánicos con ligaduras”, Congreso de Jóvenes Investigadores Real Sociedad Matemática Española, Murcia, Spain. Sept. 7–11, 2015

**Invited talk:** “Geometric description of controllability of hybrid control systems”, Nonlinear Control and Geometry, Banach Center Conferences, Poland. Aug. 23–29, 2015

**Invited talk:** “Where to find Morse families in geometric mechanics?”, Joint STAMP conference and 9th ICMAT International GMC Summer School on Symplectic Geometry, Classical Mechanics and Interactions with Spectral Theory, La Cristalera, Miraflores de la Sierra, Spain. June 29–July 3, 2015

- Talk: “Bäcklund transformations for Lie-Poisson integrators.”**, May 25–28, 2015  
Brainstorming Workshop on New Developments in Discrete Mechanics, Geometric Integration and Lie-Butcher Series, ICMAT, Madrid, Spain.
- Invited talk: “Controllability of hybrid control systems.”**, XVII Jan. 22-23, 2015  
Encuentro de Invierno Geometría, Mecánica y Teoría de Control, Zaragoza, Spain.
- Invited talk: “Applications of Morse families in dynamics.”**, Nov. 17-21, 2014  
ICMAT-China Exploratory Workshop, Madrid, Spain.
- Seminar: “Why to use variational integrators?”**, University of Nov. 12, 2014  
Bergen, Norway.
- Talk: “Pontryagin’s Maximum Principle for some families of PDEs”**, 10th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain. July 7-11, 2014
- Invited talk: ‘Interconnection of Dirac systems for Morse families’**, Fourth Iberoamerican Meeting on Geometry, Mechanics and Control, Bariloche, Argentina. April 7-11, 2014
- Invited talk: “Morse families in optimal control problems”**, XVI Jan. 31-Feb. 1, 2014  
Encuentro de invierno. Geometría, Mecánica y Teoría de Control, Zaragoza, Spain.
- Invited talk: “Second order conditions for local controllability of discrete-time systems”**, deLeónfest, ICMAT, Madrid, Spain. Dec. 16-19, 2013
- Teen seminar: “What is a hybrid system?”**, Technical University of May 24, 2013  
Catalonia, Barcelona, Spain.
- Talk/poster: “Lagrangian submanifolds and Hamilton-Jacobi theory”**, 6th Summer School on Geometry, Mechanics and Control, ICMAT School, La Cristalera, Madrid, Spain. Jun. 22-26, 2012
- Teen seminar: “Aplicaciones de subvariedades lagrangianas en mecánica geométrica y teoría de control óptimo”**, Department of May 30, 2012  
Applied Mathematics IV, Universitat Politècnica de Catalunya, Barcelona, Spain.
- Intergroup seminar: “La reducción cinemática y la ecuación de Hamilton-Jacobi”**, Departamento de Matemáticas, Universidad Carlos III de Madrid, Spain. Jan. 23, 2012
- Talk: “Relationship between kinematic reduction and Hamilton-Jacobi equation”**, Exploratory Workshop on Geometric Control Theory and Applications to Engineering, Madrid, Spain. Jan. 16-18, 2012
- Invited talk: “¿A dónde nos llevó el control óptimo?”**, MiguelFest, Dec. 19-20, 2011  
Barcelona, Spain.

- Talk: “Characterization of accessibility for affine connection control systems at some points with nonzero velocity”**, IEEE Conference on Decision and Control and European Control Conference, Orlando, Florida, USA. Dec. 12-15, 2011
- Invited talk: “Fundamentos de la teoría de control óptimo geométrico”**, Primer Encuentro de Jóvenes Investigadores en Matemáticas, La Laguna, Spain. Sept. 28-30, 2011
- Talk/poster: “A geometric framework for discrete Hamilton-Jacobi equation”**, 20th International Fall Workshop on Geometry and Physics, Madrid, Spain. Aug. 31-Sept.3, 2011
- Invited talk: “Geometric interpretations of the symmetric product in affine differential geometry”**, Workshop on Rough Paths and Combinatorics in Control Theory, San Diego, CA, USA. July 25-27, 2011
- Invited talk: “Free algebras and symmetric algebras to describe accessibility for affine connection control systems at non-zero velocity”**, 7th International Congress on Industrial and Applied Mathematics, ICIAM 2011, Vancouver Canada. July 18-22, 2011
- Poster: “High order sufficient conditions for configuration tracking of affine connection control systems”**, 7th International Congress on Industrial and Applied Mathematics, ICIAM 2011, Vancouver Canada. July 18-22, 2011
- Teen seminar: “Introducción a la teoría geométrica de control óptimo”**, Technical University of Catalonia, Barcelona, Spain. May 25, 2011
- Seminar on Geometry and Physics: “Differential geometry applied to mechanical control systems”**, Universidad Complutense de Madrid, Spain. February 11, 2011
- Invited talk: “The role of parallel transport to describe some mechanical control systems”**, XIII Encuentro de invierno. Geometría, Mecánica y Teoría de Control, Zaragoza, Spain. January 26–27, 2011
- Invited talk: “Insights into the algebra of accessibility of affine connection control systems”**, Second Iberoamerican Meeting on Geometry, Mechanics and Control, Bariloche, Argentina. January 10–14, 2011
- Talk: “The symmetric product in terms of the parallel transport”**, Workshop on Geometric and topological methods in control and robotics, La Cristalera, Madrid, Spain. October 4–6, 2010
- Talk: “High order sufficient conditions for tracking some mechanical control systems”**, International Congress of Mathematicians, Hyderabad, India. August 19–27, 2010
- Talk: “How to describe infinitesimally the symmetric product?”**, 4th Biannual Meeting on Systems and Control Theory, Kingston, ON, Canada. May 13–15, 2010

- Control theory seminar: “How to find abnormal extremals in optimal control problems for nonholonomic mechanical control systems?”**, Department of Applied Mathematics, University of Waterloo, ON, Canada. March 27, 2010
- Talk: “Weak high order Maximum Principle for control-affine systems and applications”**, 2009 Canadian Mathematical Society (CMS) Winter Meeting, Windsor, ON, Canada. Contributed paper. December 5–7, 2009
- Talk: “Higher order conditions for tracking”**, III Summer School on Geometry, Mechanics and Control, L’Ametlla de Mar, Spain. June 22–26, 2009
- Differential geometry, dynamical systems and applications seminar: “A panorama of tracking a submarine”**, Department of Applied Mathematics IV, Technical University of Catalonia, Barcelona, Spain. June 3, 2009  
May 15, 2008  
October 18, 2007
- Corida seminar: “A geometric study of abnormality in optimal control problems for control and mechanical control systems”**, Institut de Mathématiques Élie Cartan de Nancy, Université Nancy 1, Vandoeuvre-lès-Nancy, France. February 5, 2009
- Talk: “Unified formalism for implicit optimal control problems”**, International Young Researchers Workshop on Geometry, Mechanics and Control (Continuous and Discrete Geometric Mechanics), Barcelona, Spain. December 16–18, 2008
- Poster: “Lie algebroids and optimal control: abnormality”**, XVII International Workshop on Geometry and Physics, Cantabria, Spain. September 3–6, 2008
- Talk: “Abnormality for affine connection control systems”**, Mathematical Theory of Networks and Systems, Virginia Tech, Blacksburg, Virginia, USA. July 28–August 1, 2008
- Control seminar: “High order maximum principle, abnormality and affine connection control systems”**, Department of Mathematics and Statistics, Queen’s University, Kingston, Ontario, Canada. July 23, 2008
- Talk: “Pontryagin’s Maximum Principle and abnormality”**, Second International Summer School on Geometry, Mechanics and Control, La Palma, Canary Islands, Spain. June 9–14, 2008
- Talk: “Strict abnormal extremals in nonholonomic and kinematic control systems”**, 7th AIMS International Conference on Dynamical Systems, Differential Equations and Applications, Arlington, Texas, USA. May 18–21, 2008
- Geometric mechanics seminar: “Abnormality in optimal control theory”**, Instituto de Ciencias Matemáticas (CSIC–UAM–UC3M–UCM), Madrid, Spain. April 9, 2008
- Talk: “Soluciones anormales para problemas de control óptimo de tipo mecánico**, X Encuentro de invierno. Geometría, Mecánica y Teoría de Control, Zaragoza, Spain. January 30–31, 2008
- Control seminar: “Characterization of extremals in optimal control theory through a constraint algorithm”**, Department of Mathematics and Statistics, Queen’s University, Kingston, Ontario, Canada. Nov. 28, 2007



- DGDSA seminar: “Looking for strict abnormality in optimal control”**, Department of Applied Mathematics IV, Universitat Politècnica de Catalunya, Barcelona, Spain. Oct. 18, 2007
- Talk: “Optimal control problems for affine connection control systems: characterization of extremals”**, XVI International Workshop on Geometry and Physics, Lisbon, Portugal. September 5–8, 2007
- Poster: “Strict abnormal extremals for control quadratic cost and time-optimal control problems”**, First International Summer School on Geometry, Mechanics and Control, Castro Urdiales, Cantabria, Spain. June 25–29, 2007
- Poster: “Abnormal trajectories in affine connection control systems”**, IV Nolineal, Ciudad Real, Spain. Poster. June 6–9, 2007
- Poster: “Skinner-Rusk formalism for optimal control”**, XV International Workshop on Geometry and Physics, Puerto de la Cruz, Canary Islands, Spain. September 11–16, 2006
- Control seminar: “Notes on *Shortest paths for sub-Riemannian metrics on rank-two distribution*”**, Department of Mathematics and Statistics, Queen’s University, Kingston, Ontario, Canada (11 hours). July–August 2006
- Talk: “Principio del Máximo de Pontryagin: comentarios, ejemplos y aplicaciones”**, VIII Encuentro de invierno. Mecánica, Geometría y Teoría de Control, Zaragoza, Spain. February 1–2, 2006
- Talk: “Structures on tangent and cotangent bundles for optimal control”**, Applied Mathematics to Control, Systems and Signals Seminar, Departamento de Matemáticas, Universidad Carlos III de Madrid, Leganés, Spain. December 16, 2005
- DGDSA seminar: “Tangent and cotangent bundles geometry”**, Department of Applied Mathematics IV, Universitat Politècnica de Catalunya, Barcelona, Spain. December 1, 2005

## RESEARCH STAYS

- Visiting Prof. Miguel C. Muñoz Lecanda**, Department of Applied Mathematics IV, Technical University of Catalonia, Spain. June 3-7, 2015  
May 21-June 1, 2013  
Research topic: Hybrid control systems.
- Visiting Prof. Hans Munthe-Kaas**, University of Bergen, Norway. Nov. 16–20, 2017  
April 13–17, 2015  
Nov. 9-15, 2014
- Visiting Prof. Bronislaw Jakubczyk**, Institute of Mathematics of the Polish Academy of Sciences, Poland. July 14-21, 2012  
Research topic: Discrete controllability.
- Visiting Prof. Miguel C. Muñoz Lecanda**, Department of Applied Mathematics IV, Technical University of Catalonia, Spain. May 25-30, 2012  
Research topic: Pontryagin’s Maximum Principle on  $k$ -symplectic formalism.

- Visiting Prof. Andrew D. Lewis**, Department of Mathematics & Statistics, Queen's University, Kingston, ON, Canada. Feb. 8 - May 8, 2012  
 Research topic: Characterization of accessibility for affine connection control systems at points with non-zero velocity.
- Visiting Prof. Juan Carlos Marrero**, Departamento de Matemática Fundamental, Universidad de La Laguna, Spain. Oct. 10 - 15, 2011  
 Research topic: Kinematic reduction and Hamilton-Jacobi equation.
- Visiting Prof. Melvin Leok**, Department of Mathematics, University of California, San Diego, USA, under the framework of **GEOMECH-IRSES project**. Jul. 16- Aug. 16, 2011  
 Research topic: Discrete Hamilton-Jacobi equation.
- Visiting Prof. Miguel C. Muñoz Lecanda**, Department of Applied Mathematics IV, Technical University of Catalonia, Spain. May 20-30, 2011  
 Research topic: Pontryagin's Maximum Principle on  $k$ -symplectic formalism.
- Visiting Prof. Andrew D. Lewis**, Department of Mathematics & Statistics, Queen's University, Kingston, ON, Canada. March 24- Apr. 24, 2011  
 Research topic: Infinitesimal description of the symmetric product.
- Visiting Professors M. Sigalotti, F. Jean, G. Charlot**, École Nationale Supérieure de Techniques Avancées, Paris, France. March 11–18, 2011  
 Research topic: Complexity of control-affine systems.
- Visiting Prof. Dong Eui Chang**, Department of Applied Mathematics, University of Waterloo, ON, Canada. March 23–27, 2010  
 Research topic: Observers in control systems.
- Visiting Prof. David Martín de Diego**, Instituto de Ciencias Matemáticas (CSIC–UAM–UC3M–UCM), Madrid, Spain. March 30–Apr. 12, 2008  
 Research topic: Abnormality in optimal control problems on Lie algebroids.

## MAIN RESEARCHER IN RESEARCH PROJECTS

- “Discrete Mechanics, Geometric Integration and Lie-Butcher Series”**. 2014-2015  
 Reference: 010-ABEL-CM-2014A.  
 Supporting entity: Iceland, Liechtenstein, Norway, EEA grants (44.328 €).  
 Main researcher: María Barbero Liñán.  
 Number of researchers: 8.

## PARTICIPATION IN RESEARCH PROJECTS

- “Geometric and numerical analysis of dynamical systems and applications to mathematical physics”**. 2016-2018  
 Reference: MTM2016-76072-P.  
 Supporting entity: Ministerio de economía y competitividad (31.921 €).  
 Main researcher: David Martín de Diego, Daniel Peralta Salas.  
 Number of researchers: 10.

- “Estructuras geométricas e integrabilidad en sistemas dinámicos y teoría de control”.** 2014-2016  
 Reference: MTM2013-42870-P.  
 Supporting entity: Ministerio de economía y competitividad (31.921 €).  
 Main researcher: David Martín de Diego, Daniel Peralta Salas.  
 Number of researchers: 10.
- “ICMAT Severo Ochoa Excellence Programme”.** 2012-2015  
 Reference: SEV-2011-0087.  
 Supporting entity: Ministerio de economía y competitividad (4.000.000 €).  
 Main researcher: Manuel de León Rodríguez.
- “Estructuras globales y métodos numéricos, sistemas dinámicos y control: aplicaciones cuánticas”.** 2011-2014  
 Reference: MTM2010-21186-C02-02.  
 Supporting entity: Spanish Ministry of Science and innovation (50.600 €)  
 Main researcher: Alberto Ibort Latre.  
 Number of researchers: 10.
- IRSES Network GEOMECH.** 2011-2014  
 Reference: 246981.  
 Supporting entity: Marie Curie’s International Research Staff Exchange Scheme (IRSES) in the 7th European Framework Program.  
 Main researcher: Frans Cantrijn.  
 Number of researchers: 31.
- “New developments in geometric mechanics: discrete and continuous settings”.** 2011-2012  
 Supporting entity: Comisión mixta agencia estatal CSIC-Academia de Ciencias de Polonia.  
 Main researcher: David Martín de Diego.  
 Number of researchers: 10.
- “Differential geometry, dynamical systems and applications”.** 2009-2014  
 Reference: 2009SGR1338.  
 Supporting entity: Agència de Gestió d’Ajuts Universitaris i de Recerca (AGAUR–Catalan government), (44.720 €).  
 Main researcher: Miguel Carlos Muñoz Lecanda.  
 Number of researchers: 7.
- “Constraint and reduction constraint algorithms for dynamical systems, physics and control”.** 2009-2011  
 Reference: MTM2008–00689/MTM.  
 Supporting entity: Spanish Ministry of Education and Science (59.900 €).  
 Main researcher: Narciso Román Roy.  
 Number of researchers: 8.

- Network “Geometry, Mechanics and Control ”.** 2010-2011  
 Reference: MTM2009–08166–E/MTM.  
 Supporting entity: Spanish Ministry of Education and Science (20.000 €).  
 Main researcher: Juan Carlos Marrero González (Universidad de La Laguna).
- Network “Geometry, Mechanics and Control ”.** 2009-2010  
 Reference: MTM2008–03606–E/.  
 Supporting entity: Spanish Ministry of Education and Science (12.000 €).  
 Main researcher: Juan Carlos Marrero González (Universidad de La Laguna).
- Network “Geometry, Mechanics and Control ”.** 2008-2009  
 Reference: MTM2007–30168–E/.  
 Supporting entity: Spanish Ministry of Education and Science (12.000 €).  
 Main researcher: Juan Carlos Marrero González (Universidad de La Laguna).
- Network “Geometry, Mechanics and Control ”.** 2007-2008  
 Reference: MTM2006–27467–E/.  
 Supporting entity: Spanish Ministry of Education and Science (12.000 €).  
 Main researcher: Juan Carlos Marrero González (Universidad de La Laguna).  
 Number of researchers: 28.
- “Geometry and Control: Applications in Physics and Technology” (GeCoAFT).** 2006-2008  
 Reference: MTM2005–04947.  
 Supporting entity: Spanish Ministry of Education and Science (32.000 €).  
 Main researcher: Narciso Román Roy.  
 Number of researchers: 7.
- Network “Geometry, Mechanics and Control ”.** 2005-2007  
 Reference: MTM2005–24556–E.  
 Supporting entity: Spanish Ministry of Education and Science (20.000 €).  
 Main researcher: Juan Carlos Marrero González (Universidad de La Laguna).  
 Universities and research centers involved: Consejo Superior de Investigaciones Científicas, Universidad de Alcalá, Universidad de Barcelona, Universidad Carlos III de Madrid, Universidad Complutense de Madrid, Universidad de La Laguna, Universidad de Oviedo, Universidad Politécnica de Cataluña, Universidad de Salamanca, Universidad de Sevilla, Universidad de Valladolid, Universidad de Zaragoza, Universidad Estatal de Pensilvania, Universidad de California (Santa Bárbara), Universidad de California (Santa Cruz).  
 Number of researchers: 28.

## STUDENTS ADVISED

- Marta Farré Puiggali:** Geometry of nonholonomic systems on skew-symmetric algebroids (Ph.D. cosupervised with David Martín de Diego). March 2017.
- Nicolás Ildefonso de Miguel Ruano:** Controlabilidad de sistemas híbridos (Trabajo Fin de Grado de Ingeniería en la Universidad Carlos III de Madrid). Feb. 2016.
- María Martín Cano:** Problemas de control óptimo asociados a la extracción de un recurso renovable. (Trabajo Fin de Grado de Ingeniería en la Universidad Carlos III de Madrid). Oct. 2014.
- Co-supervisor of high school mathematics research projects,** Barcelona, Spain. Topics: The mathematics in our election system, How to follow paths?. 2002-2003

## TEACHING

- Cálculo**, Grado en Fundamentos de la Arquitectura, Technical University of Madrid, Spain. Spring 2017  
Spring 2016  
Instructor.
- Curves and surfaces**, Grado en Fundamentos de la Arquitectura, Technical University of Madrid, Spain. Fall 2016  
Instructor.
- Geometría afín y proyectiva**, Grado en Fundamentos de la Arquitectura, Technical University of Madrid, Spain. Fall 2016  
Fall 2015  
Instructor.
- Control theory and applications**, Master in Mathematical Engineering, Universidad Carlos III de Madrid, Spain. Spring 2016  
Instructor.
- Calculus I**, Bachelor in Industrial Electronics and Automation, Bachelor in Mechanical Engineering, Universidad Carlos III de Madrid, Spain. Fall 2015  
Fall 2014  
Instructor in English. Fall 2013
- Curso 0. Matemáticas básicas para la Ingeniería**, Escuela Politécnica Superior, Universidad Carlos III de Madrid, Spain. September 2015  
September 2014  
Instructor. September 2013
- R Course: Linear Algebra**, Escuela Politécnica Superior, Universidad Carlos III de Madrid, Spain. Spring 2015  
edX course. Online tutor.
- Mathematical Methods II (Linear Algebra)**, Bachelor in Statistics and Business, Universidad Carlos III de Madrid, Spain. Fall 2012  
Instructor of two groups (in English and in Spanish).  
Course coordinator.

- ERASMUS Course:** *A geometric framework of optimal control theory*, University of Coimbra, Portugal. (5 hours) June 11-15, 2012
- Master Course:** *Seminario Avanzado en Aplicaciones: Mecánica Geométrica y Aplicaciones en Control*, Universidad Autónoma de Madrid, Spain. (20 hours) Feb.-Jun. 2012
- Mathematical Methods II (Linear Algebra)**, Bachelor in Statistics and Business, Universidad Carlos III de Madrid, Spain. Fall 2011  
Instructor of two groups (in English and in Spanish).  
Course coordinator.
- Invited Master Course:** *The problem of characterizing the accessibility algebra at points with nonzero velocity for affine connection control systems*, Universidad de La Laguna, Canary Islands, Spain. October 2011
- Advanced JAE course for undergraduated:** *Introduction to symplectic geometry and applications to mechanics*, Institute for the Mathematical Sciences, Madrid, Spain. (10 hours) July 2011
- APSC 171–J: Calculus I**, Faculty of Arts and Science, Queen’s University, ON, Canada. Winter 2010  
Instructor: Responsible for all aspects of teaching and grading.
- Math 949: Topics in Global Analysis**, Graduate course, Queen’s University, ON, Canada. Fall 2009  
Instructor.
- Multivariable calculus**, Communication Engineering (ETSETB–UPC), Technical University of Catalonia, Spain. Winter, Fall 2008  
Laboratory: Responsible of lecturing and grading Maple projects.
- Calculus 2 (multivariable calculus)**, School of Mathematics, Technical University of Catalonia, Spain. Winter 2008  
Tutorial: Lectured on problems and partially responsible of grading.

## TEACHING DEVELOPMENT

- University ambassador at high school**, Universidad Carlos III de Madrid. 2014-2015  
2013-2014
- Qualified Teacher Status**, General Teaching Council for England. June 2011
- Course SGS901 on Teaching and Learning in Higher Education**, Centre for Teaching and Learning, Queen’s University, Kingston, ON, Canada. Sept. 2010- Dec. 2010
- Certificate III: Teaching and Learning: Scholarship**, Centre for Teaching and Learning, Queen’s University, Kingston, ON, Canada. Dec. 2010

**Teaching development day**, Centre for Teaching and Learning, Queen's University, Kingston, ON, Canada. Workshops: Building a learning community in the classroom; How to teach to the transition year; When X is not enough: Providing feedback for right/wrong assignments. Sept. 7, 2010

**Certified high school teacher in mathematics**, Institut de Ciències de l'Educació (ICE), Technical University of Catalonia, Barcelona, Spain. Sept. 2004– Jun. 2005

## INNOVATION IN TEACHING AND PUBLICATIONS

**Teaching internationalization** by teaching in English 1st and 2nd year courses. Universidad Carlos III de Madrid, Spain. 2011-2015

**Materials (videos, exercises) edX-UC3M Coure R: Linear Algebra.** <https://www.edx.org/school/uc3mx>. May 2015

**Ghengis project:** Teaching video on planar geometry. <http://www.youtube.com/watch?v=iHpy8D2Xuw> May 2013

**Open Course Ware: Mathematical Methods II.** <http://ocw.uc3m.es/matematicas/mathematical-methods> May 2012

## SERVICES

**¿Vivimos en un mundo áureo?** Feb-March 2016  
Hands-on activity for High Schools students visiting ICMAT and participating at “VI Edición Con Ciencia en la Escuela” in Círculo de Bellas Artes, Madrid, Spain.

**Participant in the project “Eratosthenes” to popularize the science.** June 2015  
High Schools in Alcobendas and San Sebastián de los Reyes, Madrid, Spain.

**Participant in the project “Eratosthenes” to popularize the science.** June 2015  
High Schools in Alcobendas and San Sebastián de los Reyes, Madrid, Spain.

**Member of the teaching committee.** Oct. 2014–present  
Bachelor in Industrial Electronics and Automation, Universidad Carlos III de Madrid, Spain.

**Marker of the university entry exam (selectividad).** Mathematics II. 2013–2015

**Co-editor–in–chief of the Geometry, Mechanics and Control Network info sheet.** <http://gmcnetwork.org/?q=info-sheet> Dec. 2009–Dec. 2012

**Organizer of promoting the research group on Differential Geometry, Dynamical Systems and Applications** at the Technical University of Catalonia in the work fair that takes place every year. 2007–2008

**Member of organizing committees:**

- New Trends in Applied Geometric Mechanics – Celebrating Darryl Holm’s 70th birthday**, ICMAT, Madrid, Spain. Jul. 3–7, 2017  
<https://www.icmat.es/congresos/2017/darryl70/>
- 11th Summer School on Geometry, Mechanics and Control ICMAT school**), ICMAT, Madrid, Spain. Jun. 26–30, 2017  
<http://gmcnet.webs.ull.es/?q=activity-detaill/1812>.
- XXVI International Fall Workshop on Geometry and Physics**, Instituto de Estructura de la Materia, Madrid, Spain. Aug, 29-Sept. 2, 2016  
<https://www.icmat.es/congresos/2016/XXVIFWGP/>
- Parallel session of Differential Equations and Dynamical Systems**, Congreso de Jóvenes Investigadores Real Sociedad Matemática Española, Murcia, Spain. Sept. 7–11, 2015
- Joint STAMP conference and 9th ICMAT International GMC Summer School on Symplectic Geometry, Classical Mechanics and Interactions with Spectral Theory**, La Cristalera, Madrid, Spain. Jun. 29-Jul. 3, 2015.
- Brainstorming Workshop on New Developments in Discrete Mechanics, Geometric Integration and Lie-Butcher Series**, ICMAT, Madrid, Spain. May 25-28, 2015.
- 8th Summer School on Geometry, Mechanics and Control ICMAT school**), La Cristalera, Madrid, Spain. Jun. 30-Jul. 4, 2014
- deLeonfest 2013**, Instituto de Ciencias Matemáticas (CSIC-UAM-UC3M-UCM), Madrid, Spain. Dec. 16-19, 2013  
<http://gmcnetwork.org/drupal/?q=activity-detaill/1097>.
- 7th Summer School on Geometry, Mechanics and Control ICMAT school**), La Cristalera, Madrid, Spain. Jul. 1-5, 2013  
<http://gmcnetwork.org/drupal/?q=activity-detaill/867>.
- 7th International Young Researchers Workshop on Geometry, Mechanics and Control**, Instituto de Ciencias Matemáticas (CSIC-UAM-UC3M-UCM), Madrid, Spain. Dec. 17-19, 2012  
<http://gmcnetwork.org/drupal/?q=activity-detaill/666>.



**Stochastic Systems Simulation and Control**, Instituto de Ciencias Matemáticas (CSIC-UAM-UC3M-UCM), Madrid, Spain. <http://www.icmat.es/congresos/sssc2012/>. Nov. 5-9, 2012

**6th Summer School on Geometry, Mechanics and Control**, La Cristalera, Madrid, Spain. <http://gmcnetwork.org/?q=activity-detail/665>. June 22-26, 2012

**Geometry of Mechanics, Field Theory and Control: A workshop celebrating the 65th birthday of M. C. Muñoz Lecanda**, Technical University of Catalonia (UPC), Barcelona, Spain. <http://gmcnetwork.org/drupal/?q=activity-detail/618>. Dec. 19-20, 2011

**XX International Fall Workshop on Geometry and Physics**, Instituto de Ciencias Matemáticas, ICMAT, Madrid, Spain. <http://www.icmat.es/congresos/xxifwgp>. Aug, 31-Sept. 3, 2011

**5th Summer School on Geometry, Mechanics and Control**, La Cristalera, Madrid, Spain. <http://www.gmcnetwork.org/ssgmc11>. July 4-8, 2011

**Workshop on Geometric and topological methods in control and robotics**, La Cristalera, Madrid, Spain. <http://webpages.ull.es/users/gmcnet/GTMCR2010/Home.html>. Oct. 4-6, 2010

**3rd International Young Researchers Workshop on Geometry, Mechanics and Control**, Technical University of Catalonia (UPC), Barcelona, Spain. <http://www.gmcnetwork.org/ejigmc08>. Dec. 16-18, 2008

**Member of scientific committees:** International Young Researchers Workshop on Geometry, Mechanics and Control from 2010 to 2012.

**Chief of scientific committees:** International Young Researchers Workshop on Geometry, Mechanics and Control since 2012.

**Languages:** Spanish (mother tongue), Catalan (mother tongue), English (Council of Europe Level C1; IELTS 8 out 9 in 2011), French (Council of Europe Level B1, 2011), Chinese (basic).