

CURRICULUM VITAE

Roberto Castelli

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PERSONAL DATA

Date of Birth: November 12th 1981
Nationality: Italian
Languages: Italian, English, Spanish

Address: Vrije Universiteit Amsterdam
Department of Mathematics
De Boelelaan 1081
1081 HV Amsterdam
The Netherlands

EDUCATION

Feb. 2009 **Ph.D in *Pure and Applied Mathematics***
Univ. Milano-Bicocca, Milano, Italy
Thesis: *On the variational approach to the one and N-centre problem with weak forces.*
Advisor: Prof. Susanna Terracini.

Dec. 2005 **M.Sc in Mathematics**
Graduated cum laude: *Laurea Specialistica in Matematica*
Univ. Milano-Bicocca, Milano, Italy
Thesis: *Il moto di filamenti vorticosi quasi paralleli.*
Supervisor: Prof. Susanna Terracini.

Nov. 2003 **B.Sc in Mathematics**
Graduated cum laude: *Laurea in Matematica*
Univ. Milano-Bicocca, Milano, Italy
Thesis: *Approssimazione di funzioni integrabili mediante funzioni continue.*
Supervisor: Prof. Arrigo Cellina.

EMPLOYMENT

Apr. 2014	Postdoctoral Researcher VU University Amsterdam
Feb. 2011- Dec. 2013	Postdoctoral Researcher BCAM, - Basque Center for Applied Mathematics, Bilbao, Spain.
Sep. 2009 - Dec. 2010	Marie Curie Experienced Researcher Institut für Industriemathematik, Universität Paderborn, Germany.

GRANTS AND FELLOWSHIPS

Grant RC_2013_2_41	Basque Government for the organisation of workshop, 2112 Eur. (2013)
Marie Curie Fellowship	European Sixth Framework Programme project Astronet. (2009-10)
PhD Fellowship	University of Milano-Bicocca (2006-08)
ISU fellowship	Student Scholarship (2001-05).

RESEARCH INTERESTS

Rigorous computation in finite and infinite dimensional dynamical system: development of rigorous computational methods to:

- prove existence, within rigorous bounds, of stationary solutions, steady states, periodic orbits for dynamical systems, ODEs, PDEs
- study the stability properties of the invariant sets;
- parametrize the invariant manifolds and compute connecting orbits both for ODEs and PDEs.

Singular dynamical system: regularization of the singularity in case of homogeneous or logarithmic type potential. Application to the N-center problem and to the model of the dynamics of vortex filaments. Variational approach to prove existence of non-collision solutions and symbolic dynamics for the N-center problem.

Astrodynamics: analysis and numerics in the restricted three-body problem with application to mission design.

PAPERS

1. R. Castelli, J.-P. Lessard, J.-D. Mireles James, Analytic enclosure of the fundamental matrix solution. *Applications of Mathematics*, 60(6), 617-636, 2015.
2. R. Castelli, *The monotonicity of the apsidal angle in power-law potential systems*, *Journal of Mathematical Analysis and Applications*, 428(1), 653-676, 2015
3. R. Castelli, J.-P. Lessard, J.-D. Mireles James. *Parameterization of invariant manifolds for periodic orbits(I): efficient numerics via the Floquet normal form*, *SIAM J. Appl. Dyn. Syst.*, 14(1), 132-167, 2015.
4. R. Castelli, A study of the apsidal angle and a proof of monotonicity in the logarithmic potential case. *Journal of Mathematical Analysis and Applications*, 413(2), 727-751, 2013. (5y Imp. Fact. 1.259). (<http://dx.doi.org/10.1016/j.jmaa.2013.12.035>)
5. R. Castelli, J.-P. Lessard. A method to rigorously enclose eigenpairs of complex interval matrices. In *Proceedings of the Conference Applications of Mathematics 2013, in honor of the 70th birthday of Karel Segeth*. Prague, 2013. ISBN 978-80-85823-61-5

6. R. Castelli, J.-P. Lessard. Rigorous numerics in Floquet theory: computing stable and unstable bundles of periodic orbits. *SIAM J. Appl. Dyn. Syst.*, 12(1): 204–245, 2013. (5y Imp. Fact. 1.941). DOI 10.1137/120873960
(arxiv.org/abs/1112.4874)
7. R. Castelli, F. Paparella and A. Portaluri. Singular dynamics under a weak potential on a sphere. *Nonlinear Differential Equations and Applications NoDEA*, 20(3), 845–872, 2013. (5y Imp. Fact. 0.921) DOI: 10.1007/s00030-012-0182-1
(arxiv.org/abs/1109.1128)
8. R. Castelli. Regions of prevalence in the coupled restricted three-body problems approximation. *Communications in Nonlinear Science and Numerical Simulation*, 17(2):804–816, 2012. (5y Imp. Fact. 2.671). DOI 10.1016/j.cnsns.2011.06.034
9. R. Castelli, A. Zanzottera, G. Mingotti and M. Dellnitz. Intersecting invariant manifolds in spatial restricted three-body problems: Design and optimization of Earth-to-halo transfers in the Sun-Earth-Moon scenario. *Communications in Nonlinear Science and Numerical Simulation*, 17(2):832–843, 2012. (5y Imp. Fact. 2.671). DOI:10.1016/j.cnsns.2011.06.032
10. R. Castelli and S. Terracini. On the regularization of the collision solutions of the one-center problem with weak forces. *Discr. Cont. Dyn. Syst.-A* 31(4): 1197–1218, 2011. (5y Imp. Fact. 1.057). DOI: 10.3934/dcds.2011.31.1197
11. R. Castelli, A. Zanzottera, G. Mingotti and M. Dellnitz Earth-to-Halo Transfers in the Sun-Earth-Moon Scenario, In *Proceedings of the Third Conference on Nonlinear Science and Complexity (NSC10)*, Ankara 2010
12. R. Castelli, The Prevalence of each CR3BP in the Approximation of the Bicircular model, In *Proceedings of the Third Conference on Nonlinear Science and Complexity (NSC10)*, Ankara 2010
13. R. Castelli. On the relation between the bicircular model and the coupled circular restricted three-body problem approximation. In *Nonlinear and Complex Dynamics: Applications in Physical, Biological, and Financial Systems*, 53–68. Springer New York, 2011. DOI 10.1007/978-1-4614-0231-2_4. ISBN 978-1-4614-0231-2
14. R. Castelli, A. Zanzottera, G. Mingotti and M. Dellnitz. Low-energy Earth-to-halo transfers in the Earth–Moon scenario with Sun-perturbation. In *Nonlinear and Complex Dynamics: Applications in Physical, Biological, and Financial Systems*, 39–51. Springer New York, 2011. DOI 10.1007/978-1-4614-0231-2_3. ISBN 978-1-4614-0231-2

PREPRINT

15. R. Castelli, H. Teismann. *Rigorous numerics for NLS: bound states, spectra, and controllability*, Under review (2015). (arxiv.org/abs/1310.6531)
16. R. Castelli. Rigorous computation of non-uniform patterns for the 2-dimensional Gray-Scott reaction-diffusion equation, Submitted (2014)
17. R. Castelli. Topologically distinct collision-free periodic solutions for the N-center problem, Submitted (2015)
18. R. Castelli, M. Gameiro, J.-P. Lessard. Rigorous numerics for ill-posed PDEs: periodic orbits in the Boussinesq equation. Submitted (2015)

19. R. Castelli, E. Fantino. Two-body approximations in the design of low-energy transfers between Galilean moons. Proceedings of the International final conference AstroNet II. Submitted

INVITED TALKS

Non collision periodic solutions for the planar N -center problem with mild topological assumptions, July 2014, The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain.

High order parametrization of invariant manifolds for periodic orbits, June 2014, BCAM, Bilbao, Spain.

Floquet theory and dynamical systems: computations and applications, February 2014, ICMC Summer Meeting on Differential Equations, 2014, Sao Carlos, Brazil

Rigorous computations and Floquet theory. A method to enclose the tangent bundles of periodic orbits, June 2013, Conference of the Canadian Applied and Industrial Mathem. Society, Quebec City, Canada.

A rigorous computational method to enclose the eigendecomposition of interval matrices. April 2012, Basque / Hungarian Workshop on Numerical Methods for Large Systems, BCAM Bilbao, Spain.

Rigorous computations of fundamental matrix solution, stable and unstable bundles of periodic orbits, February 2012, Univ. del Salento, Lecce, Italy.

Rigorous numerics in Floquet theory: computing stable and unstable bundles of periodic orbits, Nov. 2011, Univ. Laval, Quebec, Canada.

Application of the Circular Restricted Three-Body problem to mission design, March 2011, Univ. del Salento, Lecce, Italy.

Introduction to Set Oriented Numerics, October 2010, Jagiellonian University, Krakow, Poland.

Dynamical Systems in Space Mission Design, October 2010, Jagiellonian University, Krakow, Poland.

A Variational Approach to the Planar 2-Center Problem, May 2010. The 8th AIMS Conference on Dynamical Systems, Differential Equations and Applications, University of Technology, Dresden Germany.

TALKS

Analytical enclosure of fundamental matrix solution with applications. International Conference Applications of Mathematics 2015, Prague, November 2015.

Fourier-Taylor parameterization of invariant manifolds for periodic orbits of vector fields. Dy-ToComp 2015, Belewo, Poland, June 2015.

Parameterization of invariant manifolds for periodic orbits of vector fields, Canadian Math. Soc. Meeting, Charlettetown, Canada, June 2015

A method to rigorously compute the tangent bundles of hyperbolic periodic orbits of vector fields, VUvA seminar, VU University Amsterdam, October 2014.

Computing tangent bundle for hyperbolic periodic orbits of system of ODEs, December 2013, Workshop on Dynamical Systems and Applications, Bilbao, Spain.

The parametrization of invariant manifolds for periodic orbits of vector fields, October 2013, The Second BCAM Workshop on Computational Mathematics, Bilbao, Spain.

Fix-point argument in rigorous computation, October 2012, BCAM Workshop on Computational Mathematics, Bilbao, Spain.

A variety of non-collision periodic solutions for the N-centre problem, June 2012, Workshop on Variational methods in N-body and Vortex Dynamics, Lecce, Italy.

Application of the Circular Restricted Three-Body problem to mission design, Jan. 2011. Univ. Milano-Bicocca, Italy.

Dynamical system theory and numerical methods applied to Astrodynamics, December 2010, Basque Center for Applied Mathematics, Bilbao, Spain.

Distant Periodic Orbits and Invariant Manifolds in Space Trajectory design, Nov. 2010. First Intern. Workshop on Set Oriented Numerics, CINVESTA-IPN, Mexico City, Mexico.

Prevalence Of Each CR3BP In The Approximation Of The Bicircular Problem, July 2010. Conference on Nonlinear Science and Complexity, Cankaya University, Ankara, Turkey.

On the relation between the Bicircular model and the planar CR3BP, July 2010, AstroNet Annual Meeting, Turku, Finland.

A variational approach to the N center problem: symbolic dynamics. July 2009. IFIM, Univ. Paderborn, Germany

The N-centre problem: new results and considerations, April 2009. Dip. Matematica, Univ. Federico II, Napoli.

A variational approach to the N-centre problem, Conference in memory of professor Yadava, Jan. 2009, TIFR Bangalore India

Considerazioni su sistemi dinamici con potenziali debolmente singolari e logaritmici, Feb. 2008, Università Milano-Bicocca

VISITED DEPARTMENTS

Univ. Laval, Quebec, Canada. November 2011, October 2012, January 2015, October 2015 visiting J.-P. Lessard

Univ. del Salento, Lecce, Italy. March 2011 and February 2012, visiting A. Portaluri

Jagiellonian University, Krakow, Poland. October 2010, visiting P. Zgliczynski

OTHER RELEVANT ACTIVITIES

Refereeing for: *SIAM Journal of Applied Dynamical Systems*, *Celestial Mechanics*, *Mathematical Reviews*, *Reliable Computing*, *Discrete Dynamics in Nature and Society*, *International Journal of Applied Nonlinear Science*, *Astrophysics and Space Science*.

Organizer of the session *Rigorous Computation for Differential-Equation Problems* within the CMS Meeting, Charlottetown, Canada, June 2015

Member of the Scientific Committee of the *The Third BCAM Workshop on Computational Mathematics, Bilbao, Spain, July 17-18, 2014*

Organizer of the *Workshop on Dynamical system and Applications, Bilbao, Spain, December 10-11, 2013.*

Co-organizer of the *The Second BCAM Workshop on Computational Mathematics, Bilbao, Spain, October 17-18, 2013.*

Co-organizer of the *BCAM Workshop on Computational Mathematics, Bilbao, Spain, October 2, 2012.*

Co-organizer of the *International Workshop and Advanced School on Variational Methods in N-body and Vortex Dynamics, Lecce Italy, May 28 - June 8, 2012.*

SCHOOLS AND WORKSHOPS

- Nov. 2013. The evolution of vortex filaments with corners, BCAM, Bilbao.
- Apr. 2013. High dimensional approximation: theory and algorithms, BCAM, Bilbao.
- Nov. 2012. Basic tools of functional analysis and PDE, BCAM, Bilbao.
- June 2012. Topics on numerics for wave propagation, BCAM, Bilbao.
- May 2012. Selected topics in the finite element analysis, BCAM, Bilbao.
- March 2012. Finite dimensional optimal control: theory, applications, numerical implementation, BCAM, Bilbao.
- Nov. 2010. *First International Workshop on Set Oriented Numerics* , Mexico City, Mexico.
- Apr.- Jun., 2009. ERC-Indam intensive period: *New connections between dynamical systems and Hamiltonian PDEs* , Napoli, Italy.
- Sept. 8-12, 2008. Summer school *Hamiltonian PDE's and Variational methods*, Capri, Italy
- May 2008. Workshop *On singularities, hamiltonian and gradient flow*, Montreal, Canada.
- Dec. 2007. Workshop *On mathematical aspects of celestial mechanics*, Institut Henri Poincaré, Paris, France.
- Jul. 2007. Summer school *Topics in nonlinear pdes*, Coimbra, Portugal.
- May 2007. Workshop *International conference on variational methods*, Nankai University, Tianjin, China.
- Oct. 2006. School *On nonlinear differential equations*, SISSA, Trieste, Italy.
- Aug. 2005. *Scuola matematica interuniversitaria*, Perugia

PARTECIPATION IN RESEARCH PROJECTS

- 2012-14 Member of the project MTM2011-24766 "Metodos computacionales fiables para problemas de dimensiones infinitas" led by Prof. Sergey Korotov.

- 2011-12 Member of the project “Collisioni tra vortici puntiformi e tra filamenti di vorticità: singolarità, trasporto e caos ”, within the “5 per mille per la ricerca”founding project. (20000 Eur)
- Sep. 2009/Dec 2010 Member of “AstroNet - Marie Curie Research Training Network”. Part of the European Community’s Sixth Framework Programme.
- 2006/14 Member of the Gruppo Nazionale per l’Analisi Matematica, la Probabilità e loro Applicazioni (GNAMPA),part of Istituto Nazionale di Alta Matematica (INDAM) (Italian institute for High Mathematics).
- 2006/08 Member of the Milano-Bicocca research unit of the MIUR research Project “Metodi Variazionali ed Equazioni differenziali non lineari”. Principal investigator Prof. Susanna Terracini
- 2007/08 Member of the GNAMPA project “Esistenza e stabilità di onde solitarie per equazioni differenziali non lineari”

TEACHING AND TUTORING

- Co-supervisor of Ph.D student since Sep. 2014
- Co-supervisor of Early-Stage Researchers (A. Zanzottera, M. Slonina), Sep. 2009 - Dec 2010
- 2015 Teacher of the course *Numerical methods* at VU University Amsterdam (60 hours)
- 2008/09: Exercise class for the course *Analisi e geometria 1*. B.sc in Aerospace-Mechanical-Energy Engineering, Politecnico di Milano
- 2007/08: Exercise class for the course *Analisi B*, B.sc in Engineering and Management, Politecnico di Milano
- 2007/08: Exercise class for the course *Istituzioni di matematiche*, B.sc in Biological Science, Univ Milano-Bicocca
- 2006/07: Exercise class for the course *Equazioni differenziali ordinarie* B.sc in Computer Science Engineering, Politecnico of Milano
- 2006/07: Exercise class for the course *Matematica*, B.sc in Life Science, Univ Milano-Bicocca
- 2006/07: Tutorial for the course *Istituzioni di matematiche*. B.sc in Material Science, Univ Milano-Bicocca
- 2006: Tutorial for the course *Matematica 2*, B.sc in Material Science, Univ Milano-Bicocca
- 2005: Tutorial for the course *Matematica 1*, B.sc in Material Science, Univ Milano-Bicocca

INFORMATIC SKILLS

- Matlab, Maple, Latex.
- Basic knowledge of Microsoft Office suite.

COLLABORATORS

J.-P. Lessard, Université Laval, Quebec City, Canada
H. Teismann, Acadia University, Canada
J.D Mireles James, Rutgers University, USA
M. Gameiro, University of Sao Paulo at Sao Carlos, Brazil
E. Faction, Space Studies Inst. of Catalonia (IEEC), Polyt. Univ. of Catalonia (UPC), Spain
M. Dellnitz, University of Paderborn, Germany
G. Mingotti, University of Paderborn, Germany
A. Zanzottera, Politecnico di Milano, Italy
A. Portaluri, Università di Torino, Italy
F. Paparella, Università del Salento, Italy
S. Terracini, Università di Milano-Bicocca, Italy

REFERENCE PERSONS

Prof. Jan Bouwe van den Berg,
Chair of Differential Equations and Application,
Department of Mathematics, VU University, Amsterdam
janbouwe@few.vu.nl

Prof. Susanna Terracini,
Dipartimento di Matematica "Giuseppe Peano" ,
Univ. di Torino, Via Carlo Alberto 10, 10123 Torino, Italy
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Prof. Jean-Philippe Lessard,
Université Laval, Québec, Canada,
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Prof. Enrique Zuazua
Ikerbasque Research Professor
Director of the BCAM Chair in PDEs, Control and Numerics
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Prof. Dr. Michael Dellnitz
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