Alessio Del Vigna

Curriculum Vitæ

Personal data

Date and place of birth: 03 June 1989, Pescia (PT)

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Education

2014-2018 **Doctoral Degree in Mathematics**
Department of Mathematics, University of Pisa

Thesis: *On Impact Monitoring of Near-Earth Asteroids*

Supervisor: Prof. Andrea Milani Comparetti

Final mark: 110/110 *cum laude*

Referees: Prof. Ugo Locatelli, Dr. Steven Chesley, Dr. Giovanni Valsecchi

Description: I worked on short arc orbit determination and hazard assessment through the improvement of the manifold of variations method and the development of a suitable probabilistic model. I also explored the problem of impact monitoring completeness by proving the existence of an optimal step-size choice in the line of variations sampling and finding its explit equation.

As further topics, I proved results about the evolution of the line of variations at a close encounter, I developed a semilinear theory to determine the impact location of a possibly impacting asteroid, and I studied non-gravitational perturbations among near-Earth asteroids.

2011-2014 **Master's Degree in Mathematics**
Department of Mathematics, University of Pisa

Thesis: *La missione BepiColombo: l'esperimento di relatività*

Supervisor: Prof. Andrea Milani Comparetti, Prof. Giacomo Tommei

Final mark: 110/110 *cum laude*

Description: The thesis is devoted to the relativity experiment of the BepiColombo mission. I computed the equations of motion of the n-body problem in the post-Newtonian limit using Lagrangian formulation and I investigated methods for the light-time computation.

2008-2011 **Bachelor's Degree in Mathematics**
Department of Mathematics, University of Pisa

Thesis: *Funzioni simmetriche e rappresentazioni del gruppo simmetrico $\mathcal{S}_n$*

Supervisor: Prof. Giovanni Gaiffi

Final mark: 110/110 *cum laude*

Description: The main topic is the theorem proving the existence of an isometric isomorphism between the graded ring of symmetric functions in countably many variables and the graded ring of the irreducible representations of the symmetric groups.

Professional experience

Sep. 2021-Present **Mathematics and Physics Teacher** – Liceo Scientifico "A. Vallisneri"

Via delle Rose 68, Lucca (LU)

`www.liceovallisneri.edu.it`

Tasks Involved in the Mathematical Olympiad project, training students for both individual and team mathematics competitions

Sep. 2013-Present **Teaching assistant** – University of Pisa

Largo Bruno Pontecorvo 5, Pisa (PI)

Academic year from 2020-2021 to 2024-2025

- Exercises for the course of *Linear Algebra and Geometry* at the Department of Aerospace Engineering and related exams. Form teacher: Prof. Alessandro Berarducci.

Academic year 2019-2020

- Exercises for the course of *Discrete Mathematics and Linear Algebra* at the Department of Computer Science (frontal lessons, 20 hours) and related exams. Form teacher: Prof. Alessandro Berarducci.
- Supplementary teaching (24 hours) for the course of *Mathematical Analaysis II* at the Department of Industrial Engineering. Form teacher: Prof. Claudio Bonanno.

Academic year 2018-2019

- Exercises for the course of *Discrete Mathematics and Linear Algebra* at the Department of Computer Science (frontal lessons, 20 hours) and related exams. Form teacher: Prof. Alessandro Berarducci.
- Exercises for the course of *Mathematics and Statistics* at the Department of Agricultural Science (frontal lessons, 24 hours) and exams. Form teacher: Prof. Pier Daniele Napolitani.
- Course for the preparation of the maths entry test of the Department of Agricultural Science (20 hours).

Academic year 2017-2018

- Exercises for the course of *General Mathematics* at the Department of Agricultural Science (frontal lessons, 24 hours) and related exams. Form teacher: Prof. Giuseppe Puglisi.
- Course for the preparation of the maths entry test of the Department of Agricultural Science (20 hours).

Academic year 2016-2017

- Exercises for the course of *General Mathematics* at the Department of Agricultural Science (frontal lessons, 24 hours) and related exams. Form teacher: Prof. Giuseppe Puglisi.
- Exercises for the course of *Geometry 1* at the Department of Physics (frontal teaching, 6 hours). Form teacher: Prof. Mario Salvetti.
- Exams for the courses *Mathematical Analysis* (Dep. of Chemistry) and *Mathematical Analysis II* (Dep. of Engineering). Form teacher: Prof. Mauro Sassetti.

Academic year 2015-2016

- Exercises for the course of *General Mathematics* at the Department of Agricultural Science (frontal lessons, 24 hours) and related exams. Form teacher: Prof. Giuseppe Puglisi.
- Supplementary teaching (10 hours) for the course *Linear Algebra* of the Department of Biomedical Engineering. Form teacher: Prof. Ekaterina Pervova.

Academic years 2013-2014 and 2014-2015

- Exercises for the course of *General Mathematics* at the Department of Agricultural Science (frontal lessons, 24 hours) and related exams. Form teacher: Prof. Giuseppe Puglisi.
- Course for the preparation of the maths entry test of the Department of Agricultural Science (40 hours).

Jan. 2021-Aug. 2021 **Post-doctoral researcher** – Department of Mathematics

Largo Bruno Pontecorvo 5, Pisa (PI)

Description Beneficiary of the two-year research grant "Regular and stochastic behaviour in dynamical systems, particularly concerning transfer operator methods, ergodic theory and continued fraction algorithms, and random dynamical systems".

Scientific sector: MAT/07 - Mathematical Physics

Supervisor Prof. Claudio Bonanno

Jan. 2019-Dec. 2020 **Researcher** – Department of Mathematics

Largo Bruno Pontecorvo 5, Pisa (PI)

Free of charge research contract. My activity covered two main topics:

- dynamical systems and ergodic theory, with applications to number theory, in particular to multidimensional continued fractions;
- celestial mechanics, with applications to the problem of asteroid close approaches with the Earth, both from the theoretical point of view and for impact monitoring.

Dec. 2014-Dec. 2020 **Researcher** – Space Dynamics Services s.r.l.

Via Mario Giuntini 63, Cascina (PI)

`www.spacedys.com`

Tasks SpaceDyS is a worldwide leader in orbit determination and impact monitoring of asteroids, also because responsible of the software systems NEODyS and AstDyS. In particular, NEODyS is devoted to near-Earth asteroids orbital data and impact monitoring.

My main tasks:

- research and software development for asteroid dynamics;
- management of NEOScan (`https://newton.spacedys.com/neodys2/NEOScan/`), a service dedicated to the discovery of imminent impactors and to short arc orbit determination which I developed throughout my doctorate;
- development and maintenance of NEODyS.

Scientific activity

Publications

[17] Bonanno, C. and Del Vigna, A. and Isola, S., *A Poincaré map for the horocycle flow on $PSL(2,\mathbb{Z}) \setminus \mathbb{H}$ and the Stern-Brocot tree*, Annali della Scuola Normale Superiore di Pisa - Classe di Scienze, 2024

[16] Fenucci, M. and Faggioli, L. and Gianotto, F. and *et al.*, *The Aegis orbit determination and impact monitoring system and services of the ESA NEOCC web portal*, Celestial Mechanics and Dynamical Astronomy **136**(6), 2024

[15] Bonanno, C. and Del Vigna, A. and Garrity, T. and Isola, S., *On integer partitions and continued fractions type algorithms*, The Ramanujan journal **63**(3), 2024

[14] T. Hromakina, M. Birlan, M. A. Barucci, M. Fulchignoni, F. Colas, S. Fornasier, F. Merlin, A. Sonka, S. Anghel, G. Poggiali, I. Belskaya, D. Perna, E. Dotto, and the NEOROCKS team, *NEOROCKS project: surface properties of small near-Earth asteroids*, Monthly Notices of the Royal Astronomical Society **520**(2), 2023

[13] A. Del Vigna, *On a solution to the Basel problem based on the fundamental theorem of calculus*, The American Mathematical Monthly **130**(2), 2023

[12] C. Bonnano and A. Del Vigna, *Representation and coding of rational pairs on a Triangular tree and Diophantine approximation in $\mathbb{R}^2$*, Acta Arith. **200**(4), 2021

[11] A. Del Vigna, L. Dimare, and D. Bracali Cioci, *The Manifold Of Variations: impact location of short-term impactors*, Celestial Mech. Dynam. Astronom. **133**(6), 2021

[10] C. Bonnano, A. Del Vigna, and S. Munday, *A slow triangle map with a segment of indifferent fixed points and a complete tree of rational pairs*, Monatsh. Math. **194**(1), 2021

[9] A. Del Vigna, *The Manifold Of Variations: hazard assessment of short-term impactors*, Celestial Mech. Dynam. Astronom. **132**(10), 2020

[8] A. Del Vigna, F. Guerra, and G. B. Valsecchi, *Improving impact monitoring through LOV densification*, Icarus **351**, 2020

[7] L. Dimare, A. Del Vigna, D. Bracali Cioci, and F. Bernardi, *Use of a semilinear method to predict the impact corridor on ground*, Celestial Mech. Dynam. Astronom. **132**(3), 2020

[6] G. B. Valsecchi, A. Del Vigna, and M. Ceccaroni, *The evolution of the Line of Variations at close encounters: an analytic approach*, Celestial Mech. Dynam. Astronom. **131**(10), 2019

[5] A. Del Vigna, J. Roa, D. Farnocchia, M. Micheli, D. Tholen, F. Guerra, F. Spoto, and G. B. Valsecchi, *Yarkovsky effect detection and updated impact hazard assessment for Near-Earth Asteroid (410777) 2009 FD*, Astron. Astrophys. **627**, 2019

[4] A. Del Vigna, A. Milani, F. Spoto, A. Chessa, and G. B. Valsecchi, *Completeness of Impact Monitoring*, Icarus **321**, 2019

[3] A. Del Vigna, L. Faggioli, F. Spoto, A. Milani, D. Farnocchia, and B. Carry, *Detecting the Yarkovsky effect among near-Earth asteroids from astrometric data*, Astron. Astrophys. **617**, 2018

[2] F. Spoto, A. Del Vigna, A. Milani, G. Tommei, P. Tanga, F. Mignard, B. Carry, W. Thuillot, and P. David, *Short arc orbit determination and imminent impactors in the Gaia era*, Astron. Astrophys. **614**, 2018

[1] A. Del Vigna, *On Impact Monitoring of Near-Earth Asteroids*, PhD thesis, Department of Mathematics, University of Pisa, Dec. 2018

Refereeing activity

I served as referee for the following international journals: *Icarus*, *The Astronomical Journal*, and *Nature Communications*.

Conferences

- Stardust-R, The Global Virtual Workshop I, 7-10 Sep. 2020, Pisa (IT)
  Contributed talk: *The evolution of the Line Of Variations at close encounters: an analytical approach*
- *DinAmicI VI*, 4-7 June 2019, CRM Ennio De Giorgi, Pisa (IT)
- *Dynamical systems and beyond 2019*, 25-27 March 2019, Department of Mathematics, Pisa (IT)
- *60 years of dynamics and number expansions*, 10-14 December 2018, CRM Ennio De Giorgi, Pisa (IT)
- *Thermodynamic formalism in dynamical systems*, 18-22 June 2018, ICMS, Edinburgh (UK)
- CELMEC VII, 4-9 Sep. 2017, Roma (IT)
  Contributed talk: *Short arc orbit determination and imminent impactors*
- Asteroid Comets Meteors 2017, 10-14 Apr. 2017, Montevideo (UY)
  Contributed talk: *Short arc orbit determination and imminent impactors*
- Asteroid Comets Meteors 2017, 10-14 Apr. 2017, Montevideo (UY)
  Poster: *Use of the semilinear method to predict the impact corridor on ground*
- StarDust Final Conference, 31 Oct.-4 Nov. 2016, ESA ESOC, Leiden (NL)
  Contributed talk: *The impact monitoring problem: a new sampling of the Line Of Variations*
- Congresso Nazionale di Scienze Planetarie, 21-26 Feb. 201, Bormio (IT)
  Contributed talk: *An automated system for the prediction of imminent impactors*

Schools

- *Spring School on Transfer Operators (Classical and Modern Techniques)*, 22-26 March 2021, Bernoulli Center, Lausanne (CH)
- *Thermodynamic formalism: modern techniques in smooth ergodic theory (Research School)*, 1-5 July 2019, CIRM, Marseille (FR)
- *Pisa-Hokkaido-Roma2 Summer school on mathematics and its applications*, 27 Aug.-7 Sep. 2018, CRM Ennio De Giorgi, Pisa (IT)
- *Summer School in Dynamics (advanced week)*, 23-27 July 2018, ICTP, Trieste (IT)

Affiliations

Member of the UMI (Unione Matematica Italiana)

Member of the SIMCA (Società Italiana di Meccanica Celeste e Astrodinamica)

Member of the GNFN (Gruppo Nazionale per la Fisica Matematica)

Qualifications

Secondary school teaching qualification for A027 "Mathematics and Physics".

Appointed as graduate teaching assistant in the branch 01/A2 - Geometry and Algebra, in particular in MAT/02 Algebra and MAT/03 Geometry, for the years 2019, 2020 and 2021.

Computer skills

Scientific software	TEX, LATEX, Matlab, Octave, R
Programming	Advanced knowledge of Fortran, Perl, Bash, HTML
	Basic knowledge of Python, Visual Basic, C++
Educational software	Google Classroom, Google Meet, Microsoft Teams, Moodle
Basic software	Advanced knowledge of Microsft Office: Word, Excel, Access, Power Point, Outlook
	Knowledge of the main operating systems: Linux, Mac OS, and Windows

Language skills

Italian	Mother tongue
English	Advanced level (C1)
French	Basic level (A1)
Spanish	Basic level (A1)

Personal skills

Communication skills

Excellent ability to work with other people, in positions where communication is important and situations where teamwork is essential, skills developed during my education and researcher experience.

Good listening skills, understanding of problems and solutions development.

Sense of responsibility and inclination to innovation.

Organisational and managerial skills

Strong organisational and management skills, ability to manage work independently, setting priorities and taking on responsibility, skills gained both with professional experience and education.

Co-management of the dance school *Emozione Danza* (`www.emozionedanza.it`), with excellent interpersonal skills gained thanks to public relations.

Artistic skills

I have been an athlete and competitor in the International Class of the World Dance Sport Federation, for the Standard Dances, for twelve years.

Personal interests

Music has been a constant presence in my life, primarily through the study of the piano, which I am currently pursuing. Thus I really enjoy listening to classical music, especially Chopin, Beethoven, Bach, Tchaikovsky, and Rachmaninoff.

Other activities I usually do in my free time are playing chess and reading.

In compliance with Italian Legislative Decree no. 196/2003, I hereby authorise the user of this document to process my personal data.