Curriculum vitae and scientific activity

(*updated to June 26, 2022*)

Born in Pisa in 1970, Giovanni Federico Gronchi attended the Liceo Classico *'G. Galilei'* in Pisa together to the Conservatorio di Musica *'L. Cherubini'* in Florence, obtaining in 1988 the Diploma di Maturità with 56/60 and the Diploma di Pianoforte with 10/10, laude and honorable mention. Later he attended the Master Degree course in Mathematics at the Università di Pisa, continuing his pianist activity. In 1997 he obtained the Laurea in Matematica, with 110/110 cum laude. He attended the Scuola di Dottorato in Matematica at the Università di Pisa and got his Ph.D. in Mathematics in 2002, defending a thesis with title *'Theoretical and computational aspects of collision singularities in the N–body problem'*.

From January 1, 2005 to December 28, 2014 he has been Researcher in Mathematical Physics at the Department of Mathematics, University of Pisa. In December 2013 he gained the national scientific abilitation (ASN) both as Associate and Full Professor in Mathematical Physics. From December 29, 2014 to October 31, 2016 he has been Associate Professor and since November 1, 2016 he is Full Professor of Mathematical Physics at the Department of Mathematics, University of Pisa.

He is member of the International Astronomical Union (IAU) since 2006, and since August 2018 he is member of the Organizing Committee of the IAU Commission A4. From 2018 to 2021 he has been Secretary of IAU Inter-Division A-F Commission Celestial Mechanics and Dynamical Astronomy and from 2021 he is vice-President of the same IAU Commission.

In 2007 his name has been given to asteroid (96217), for his contributions to Celestial Mechanics and its applications to Astronomy.

He has been visiting researcher at the Institute for Astronomy, University of Honolulu, Hawaii (US) in the periods 26/7-10/8 2007 and 2/8-30/8 2010 to work at the development of algorithms of orbit determination within the project Pan-STARRS (Panoramic Survey Telescope and Rapid Response System). Since 2008 he is *external scientist* for this project.

Since 2014 he is president of the SIMCA (Italian Society of Celestial Mechanics and Astrodynamics).

Since June 2018 he is member of the Administrative Board of the spin-off SpaceDyS s.r.l.

In the period October 2020 - June 2022 I have been the coordinator of the group of experts (GEV) for the evaluation of the Italian research in Mathematics and Computer Science (VQR 2015-2019), nominated by ANVUR (Italian Agency for the evaluation of Universities and Research).

Communications at meetings, workshops and international schools:

Invited talks

1. March 2000, School on singularities in gravitational systems, Arc 2000, France: *Generalized Averaging Principle and Proper Elements for NEAs*;
2. June 2001, Celmec III, Monteporzio Catone, Roma, Italy: *Generalized Averaging Principle and Proper Elements for NEAs*
3. June 2004, IAU Colloquium 196, Preston, University of Central Lancashire, UK: *Classical and Modern Orbit Determination*;

4. September 2005, Celmec IV, San Martino al Cimino, Viterbo, Italy: *Orbit Determination with Very Short Arcs: Preliminary Orbits and Identifications*;

5. August 2006, IAU Symposium 236, Prague, Czech Republic: *Mutual geometry of confocal Keplerian orbits: uncertainty of the MOID and search for Virtual PHAs*;

6. September 2006, Asteroids and Resonances, Open Problems and Perspectives, Observatoire de Paris, Chateau de Meudon, France: *Asteroid Orbit Determination with different Arc Types: Curvature of the Arc and Multiple Solutions*;

7. June 2007, Theory and Applications of Dynamical Systems, Spoleto, Italy: *Regularization of the Minimal Distance between two Confocal Keplerian Orbits*;

8. July 2007, SCICADE07, Saint-Malo, France: *Multiple Solutions in Preliminary Orbit Determination*;

9. June 2009, La dynamique des systèmes gravitationnels: défis et perspectives, Aussois, France: *Variational methods and periodic solutions of the N-body problem: a (short) review and some new results*;

10. September 2009, Celmec V, San Martino al Cimino, Viterbo, Italy: *Platonic Polyhedra, Topological Constraints and Periodic Solutions of the Classical N-Body Problem*;

11. February 2010, Classical and weak KAM theory: the Aubry-Mather sets, a breakthrough in the study of dynamical systems, Montegrotto Terme, Padova, Italy: *Periodic solutions of the N-body problem with symmetry and topological constraints*;

12. May 2010, Impact et rencontres proches dans le système solaire, Ecole thematique du CNRS, Cussac, France: *Secular evolution, mutual geometry and uncertainty of the orbits of NEAs*;

13. August 2011, Equadiff 2011, Loughborough University, UK: *Platonic Polyhedra, Topological Constraints and Periodic Solutions of the Classical N-Body Problem*;

14. September 2011, International Symposium on Orbit Propagation and Determination, Lille, France: *Orbit determination with the two-body integrals*;

15. May-June 2012, Variational methods in N-body and Vortex Dynamics, Lecce, Italy: *Periodic orbits of the N-body problem with symmetry and topological constraints*;

16. June 2012, Dynamics, topology and computations, Bedlewo, Poland: *The evolution of the orbit distance in the double averaged restricted 3-body problem with crossing singularities*;

17. January 2013, New perspectives in the N-body problem, Banff centre, Canada: *The evolution of the orbit distance on the double averaged restricted 3-body problem with crossing singularities*;

18. May 2013, Mathematical Models and Methods for Planet Earth, Istituto Nazionale Di Alta Matematica, Roma, Italy: *On some periodic orbits of the N-body problem*;

19. July 2013, CRM, Montreal, Canada: *Intersection of curves and orbit determination*;

20. November 2013, Opening Training School of Stardust ITN, Glasgow, Scotland: *Classical methods of orbit determination*;

21. May 2014, Assemblea Scientifica del GNFM, Montecatini Terme (Italy): *Periodic and chaotic motions in the N-body problem with Newtonian and non-Newtonian forces*;

22. July 2014, AIMS Conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain: *Periodic and chaotic motions in the N-body problem with non-Newtonian forces*;

23. December 2014, XVII CBDO, Brazilian Colloquium on Orbital Dynamics, Águas de Lindóia (SP), Brasil: *Recent methods and results concerning orbit determination of asteroids*;

24. July 2016, Computational perturbative methods for Hamiltonian systems, Atene, Greece: *On the averaged restricted N-body problem with orbit-crossing singularities*;

25. July-August 2017 Computational Symplectic Topology, Cologne, Germany: *Variational methods to search for periodic orbits of the N-body problem with the symmetry of Platonic polyhedra*;

26. June 2018 Perspectives in Hamiltonian Systems, Venice, Italy: *On the existence of connecting orbits for critical values of the energy.*

27. March 2019 Mathematical Models and Methods in Earth and Space Sciences, Rome, Italy: *On the restricted three-body problem with crossing singularities.*

28. June 2019 New Trends in Celestial Mechanics, Cogne, Italy: *On the orbit computation with the Keplerian integrals.*

29. January 2020 NFN Project 'Pathways to Habitability', Bad Hofgasteing, Austria: *On the geometry of two Keplerian orbits with a common focus: results and open problems.*

30. October 2021, IAU Symposium 364 'Multi-scale (time and mass) Dynamics of Space Objects', Iaşi, Romania: *On the geometry of two Keplerian orbits with a common focus.*

Ordinary talks

1. July 1998, IAU Colloquium 172, Namur, Belgium: *Averaging on Earth–crossing orbits*;

2. August 1998, IAU Colloquium 173, Tatranska Lomnica, Slovakia: *Proper elements for Earth–crossers*;

3. July 1999, ACM99, Ithaca, Cornell University, USA: *Proper elements for Earth–crossing asteroids and comets*;

4. October 1999, DPS Meeting, Padova, Italy: *Secular evolution of meteoroid streams*;

5. July 2000, NATO Advanced Study Institute school, Blair Atholl, Scotland: *On the stationary points of the squared distance function between two ellipses with a common focus*;

6. April 2001, San Mommè, Pistoia, Italy: *On the stationary points of the distance function between two Keplerian ellipses*;

7. July-August 2002, ACM 2002, Technical University of Berlin, Germany: *The averaged evolution of the MOID*;

8. September 2003, NATO Advanced Study Institute school, Cortina D'Ampezzo, Italy: *Radial Admissible Regions for Orbit Determination*;

9. April 2004, DDA meeting, Cannes, France: *Orbit Determination with Very Short Arcs: Admissible Regions*;

10. August-September 2004 IAU Colloqium 197, Belgrado, Serbia: *The computation of the MOID for cometary orbits*

11. January 2005, VI Congresso Nazionale di Planetologia, Aosta, Italy: *Le survey della prossima generazione e la scoperta di asteroidi*;

12. August 2005, ACM05, Búzios, Brasil: *The identification of objects discovered in next generation asteroid/comet surveys*;

13. April 2006, Assemblea Generale GNFM, Montecatini Terme, Italy: *Punti critici della distanza kepleriana: applicazioni agli asteroidi incrociatori dell'orbita terrestre*;

14. June 2007, Symmetry and Perturbation Theory (SPT07), Otranto, Italy: *Multiple Solutions in Preliminary Orbit Determination*;

15. October 2007, Assemblea Generale GNFM, Montecatini Terme, Italy: *Soluzioni Multiple nella Determinazione Orbitale Preliminare*;

16. June 2008, International conference on the Dynamics of Celestial Bodies, Litohoro, Greece: *Orbit determination with the two–body integrals*;

17. May 2009, Congresso SAIt 2009, Facoltà di SMFN, Università di Pisa, Italy: *Orbit Determination with the 2-body Integrals*;

18. August 2012, IAU General Assembly, Beijing, China: 1) *Averaging on planet crossing orbits and secular evolution of the MOID*, 2) *On the orbital distribution of the known near-Earth asteroids*;

19. October 2012, Assemblea Generale GNFM, Montecatini Terme, Italy: *On the possible values of the orbit distance between a near-Earth asteroid and the Earth*;

20. July-August 2013, PIMS, University of Victoria, Canada: *Intersection of curves and orbit determination*;

21. July 2014, ACM2014, Marina Congress Center Helsinki, Finland: *Selection effects in the discovery of near-Earth asteroids*;

22. February 2015, XII Congresso Nazionale di Scienze Planetarie, Bormio, Italy: *Algebraic methods for the linkage problem with short arcs of observations*;

23. August 2015, IAU Symposium 318, IAU General Assembly, Honolulu (Hawaii) USA: *Linking very short arcs from large database of asteroid observations*;

24. August 2015, Division F meeting, IAU General Assembly, Honolulu (Hawaii) USA: *On some selection effects in the discovery of NEAs*;

25. October 2015, Assemblea Scientifica GNFM, Montecatini Terme, Italy: *New results on preliminary orbit determination*;

26. October-November 2016, Final Stardust conference, ESA-ESTEC, The Netherlands: *Initial orbit determination with the integrals of Kepler's problem*;

27. March-April 2017, Algebraic Algorithms and Applications, Dipartimento di Matematica, Università di Pisa: *An application of Gröbner bases theory to a problem of Celestial Mechanics*;

28. May 2017, Assemblea Scientifica GNFM, Montecatini Terme, Italy: *On the existence of connecting orbits for critical values of the energy*;

29. September 2018, AMC_{70}, Dipartimento di Matematica, Università di Pisa: *Playing with polynomials for the computation of orbits.*

Invited Lectures:

1. November 2013 Stardust Opening Traning School, Glasgow, Scotland: *Classical methods of orbit determination*, *Charlier's theory of multiple solutions* (2h).

2. December 2015, Hokkaido University, Japan; cycle of lectures on orbit determination (8h).

3. November 2019 four lectures for the course 'Celestial Mechanics and Astrodynamics', Master in Physical Sciences (MPM) Turin (8h).

4. December 2019 Stardust-R Opening Traning School, Glasgow, Scotland: *Linking very short arcs of observations* (2h).

5. February 2020 I-CELMECH Training School, Milan, Italy: *Orbit determination with the Keplerian integrals* (2h).

6. November-December 2020 lectures for the course 'Celestial Mechanics and Astrodynamics', Master in Physical Sciences (MPM) Turin (14h).

7. March 2021 Network Training School, Iaşi, Romania: 'The linkage problem' (4h)

8. November-December 2021 lectures for the course 'Celestial Mechanics and Astrodynamics', Master in Physical Sciences (MPM) Turin (14h).

Invited seminars

1. 13 December 1999, Dept. of Mathematics, Namur, Belgium: *Averaging theory for planet crossing orbits and proper elements for NEAs*;

2. 27 May 2002, Observatoire de la Côte d'Azur, Nizza, France: *The averaged evolution of the MOID*;

3. 10 October 2001, Dip. di Matematica, Univ. di Roma 'Tor Vergata', Italy: *On the stationary points of the squared distance between two ellipses with a common focus*;

4. 7 April 2008, Dip. di Matematica, Univ. di Torino, Italy: *Soluzioni periodiche del problema degli N-corpi combinando vincoli topologici e di simmetria*;

5. 8 April 2008, Dip. di Matematica, Univ. di Milano Bicocca, Italy: *Soluzioni periodiche del problema degli N-corpi combinando vincoli topologici e di simmetria*;

6. 4 February 2009, Dipartimento di Matematica, Univ. di Roma 'La Sapienza', Italy: *Some recent results on the theory of orbit determination*;

7. 4 February 2010, Dipartimento di Matematica, Univ. di Roma 'La Sapienza', Italy: *Periodic solutions of the N-body problem with symmetry and topological constraints*;

8. 24 January 2011, IMCCE, Paris, France: *Some recent advances in the theory of Orbit Determination*;

9. 12 February 2011, Dipartimento di Fisica, Univ. di Roma 'La Sapienza', Italy: *Platonic Polyhedra, Topological Constraints and Periodic Solutions of the Classical N-Body Problem*;

10. April 2013, Dipartimento di Matematica, Univ. di Trento, Italy: *Periodic orbits of the N-body problem with symmetry and topological constraints*;

11. Aprile 2017, Dipartimento di Matematica, Univ. di Torino, Italy, An afternoon in Celestial Mechanics: *An application of Groebner bases theory to a problem of Celestial Mechanics*;

12. Gennaio 2018, Centro De Giorgi, Scuola Normale Superiore, Pisa, Italy: *An application of Gröbner bases theory to a problem of Celestial Mechanics.*

Research activity

His research activity includes different topics in the field of Celestial Mechanics, both from the theoretical point of view and for the applications to Astronomy:

- **The averaging principle in the restricted three-body problem with orbit crossings**: in the restricted three-body problem, e.g. Sun, planet, asteroid, the osculating orbit of the asteroid can cross that of the planet during their evolution. In this case the study of the secular dynamics of the system by an integral average over fast angle variables presents a singularity. We introduce a generalization of the secular evolution theory allowing to deal with this singularity, and to define piecewise-regular solutions of the averaged Hamilton equations. This theory has an important application in the definition of proper elements of near-Earth asteroids, which can be useful to identify families of asteroids and to search for parent bodies of meteor streams.

- **Geometry of confocal Keplerian orbits and uncertainty of the orbit distance**: the problem of the computation of stationary points of the distance between two celestial bodies moving on confocal Keplerian orbits has an algebraic formulation, allowing us to estimate the maximal number of such points (when they are finitely many) and to write efficient algorithms for their computation. Even if the problem has an easy formulation, there is a conjecture which is still open about the optimal estimate on the maximal number of these points. Moreover the minimum values of this distance are a useful tool to understand if there can be a collision or a close approach between two celestial bodies moving approximately on such trajectories. We also consider the case, relevant for the applications to real astronomical data, for which the orbits have an uncertainty, expressed by a covariance matrix of the orbital elements. In this case the orbit crossing singularity does not allow to use standard techniques to compute the uncertainty of the minima of the distance, however it is possible to choose a suitable sign for the minimal distance and obtain analytic maps in a neighborhood of most crossing configurations.

- **Regularization of collisions in the two-body problem**: to regularize collisions in the N-body problem means to continue the solutions beyond these singularities. In the literature there exist several regularization methods. We introduced two new methods and investigated the binary collisions with these. The first method consists in a smoothing of the potential with a parameter epsilon and we study the limits for initial conditions which tend to collision values and for epsilon which goes to zero. The second regularization procedure consists of adapting the barriers method, introduced by De Giorgi for geometric evolution problems, to the case of ordinary differential equations.

- **Analytic theory of planetary close approaches**: in the restricted three-body problem, using a generalization of Öpik theory (1951), we compute the initial conditions for an encounter between a minor body and a solar system planet as function of a previous encounter. With this theory we have an analytic model allowing us to estimate the set of initial conditions leading to collisions.

- **Orbit Determination**: the huge amount of data produced by the current and next generation surveys (e.g. Pan-STARRS, LSST) requires to introduce new orbit determination methods. Indeed there is the problem of identifying short arcs of observations, made in different nights, as belonging to the same celestial bodies. Moreover, to bound the computational complexity of the algorithms employed, it is useful to compute orbits with only two observation arcs, instead of using three observations made in different nights, as in the classical methods by Gauss and Laplace. We introduced different methods to deal with this problem, both in case of solar system objects and for satellites of the Earth, with optical and radar observations. All these methods have been implemented in a programming language and tested with real and simulated observations. Some of these algorithms use the first integrals of the Kepler problem, allowing to write polynomial equations for this problem and to solve it with tools from computational algebra; the problem of optimality of the total degree of these polynomial equations has also been considered and solved using Groöbner basis theory. We have also introduced a geometric interpretation of the occurrence of multiple solutions in the classical methods of orbit determination by Gauss and Laplace, generalizing in a non-trivial way Charlier's theory (1910), which is valid only for geocentric observations.

Several of these results have been included in the book 'Theory of Orbit Determination', written in collaboration with Andrea Milani, and published by Cambridge University Press in 2009.

- **Periodic and chaotic orbits of the N-body problem**: we study the existence of new periodic orbits of the N-body problem, obtained as minima of the Lagrangian action functional on a space of symmetric loops, which also fulfill topological constraints. Such constraints and the symmetry properties of the loops are defined using the symmetry groups of the five Platonic polyhedra. The main difficulty is to prove that the minimizing loops, which do exist by the coercivity of the Lagrangian action restricted to suitable subsets of a functional space, do not have collisions. Some animations related to these orbits can be found at the web page http://adams.dm.unipi.it/ gronchi/nbody

  We also searched for periodic motions with the same symmetry and topological constraints in the case of non-Newtonian forces, with interaction potential of the form $1/r^\alpha$, $\alpha > 1$ where r is the distance between two bodies. For $\alpha > 2$ we can obtain chaotic motions as limit of sequences of periodic ones.

- **Existence of periodic and heteroclinic solutions of Hamiltonian systems with variational methods**: We consider an open set Ω and a regular potential U, positive in Ω and vanishing on the boundary $\partial\Omega$. We study the existence of orbits of the system $\ddot{u} = U_x(u)$ connecting different components of $\partial\Omega$ and lying on the zero energy level. We admit that $\partial\Omega$ contains a finite number of critical points of U. We also consider the case of symmetric potentials.

  Moreover, assuming that $U : \mathbb{R}^m \to \mathbb{R}$ is a nonnegative potential vanishing only on a finite set A with at least two elements, we give a new elementary proof of the existence of a heteroclinic orbit connecting any assigned point $a_- \in A$ to some point $a_+ \in A \setminus \{a_-\}$ through a direct minimization of the action functional on a suitable set of maps.

Publications

Papers

1. Gronchi G. F., Milani A.: *'Averaging on Earth-crossing orbits'*, Cel. Mech. Dyn. Ast., 1998, **71/2**, pp. 109-136

2. Gronchi G. F., Milani A.: *'The stable Kozai State for asteroids and comets with arbitrary semimajor axis and inclination'*, Astron. Astrophys., 1999, **341**, pp. 928-935

3. Valsecchi G.B., Milani A., Gronchi G.F. and Chesley S.R.: *'The distribution of energy perturbations at planetary close encounters'*, Cel. Mech. Dyn. Ast., 2000, **78**, pp. 83-91

4. Gronchi G. F., Milani A.: *'Proper elements for Earth crossing asteroids'*, Icarus, 2001, **152**, pp. 58-69

5. Gronchi G. F., Michel P.: *'Secular Orbital Evolution, Proper Elements and Proper Frequencies for Near-Earth Asteroids: A Comparison between Semianalytic Theory and Numerical Integrations'*, Icarus, 2001, **152**, pp. 48-57

6. Gronchi G. F.: *'On the stationary points of the squared distance between two ellipses with a common focus'*, SIAM Journal on Scientific Computing, 2002, 24/1, p.61-80

7. Gronchi, G. F.: *'Generalized averaging principle and the secular evolution of planet crossing orbits'*, Cel. Mech. Dyn. Ast., 2002 **83/1-4**, pp. 97-120

8. Bellettini, G. and Gronchi, G. F.: *'Barriers for systems of ordinary differential equations: an application to the two-body problem'* Rendiconti Accademia Nazionale delle Scienze, 120° (2003), Vol. XXVI, fasc. 1, pp. 145-160

9. Bellettini, G., Fusco, G. and Gronchi, G. F.: *'Regularization of the two-body problem via smoothing the potential'*, Commun. Pure Appl. Analysis, 2003 **2/3**, pp. 317-347

10. Valsecchi, G. B., Milani, A., Gronchi, G. F. and Chesley, S. R.: *'Resonant returns to close approaches: analytical theory'*, Astron. Astrophys., 2003 **408**, pp. 1179-1196

11. Milani, A., Gronchi, G. F., de'Michieli Vitturi, M. and Knezevic, Z.: *Orbit Determination with Very Short Arcs. I Admissible Regions*, Cel. Mech. Dyn. Ast., 2004 **90**, pp. 59-87

12. Gronchi, G.F.: *'An algebraic method to compute the critical points of the distance function between two Keplerian orbits'*, Cel. Mech. Dyn. Ast., 2005 **93/1**, pp. 297-332

13. Milani, A., Gronchi, G. F., Knežević, Z., Sansaturio, M. E., Arratia, O.: *'Orbit Determination with Very Short Arcs. II Identifications'*, Icarus, 2005 **179**, pp. 350-364

14. Cimatti, G. and Gronchi, G. F.: 2006 'A Nonlocal Problem Arising from a Poiseuille Flow with Electrical Body Forces', Int. Math. Forum, Vol.1 no.39, pp.1913-1918

15. Milani, A., Gronchi, G. F. and Knežević, Z.: *'New Definition of Discovery for Solar System Objects'*, Earth, Moon, and Planets, 2007 **100/1-2**, pp. 83-116

16. Gronchi, G. F. and Tommei, G.: 2007 *'On the uncertainty of the minimal distance between two confocal Keplerian orbits'*, Discrete and Continuous Dynamical Systems-Series B, 2007 **7/4**, pp. 755-778

17. Milani, A., Gronchi, G. F., Farnocchia, D., Knežević, Z., Jedicke, R., Dennau, L., Pierfederici, F.: *'Topocentric Orbit Determination: Algorithms for the Next Generation Surveys'*, Icarus **195**, pp. 474-492 (2008)

18. Gronchi, G. F.: *'Multiple Solutions in Preliminary Orbit Determination from Three Observations'*, Cel. Mech. Dyn. Ast., 103/4, pp.301-326 (2009)

19. Gronchi, G. F., Dimare, L., Milani, A.: *'Orbit Determination with the two–body Integrals'*, Cel. Mech. Dyn. Ast., 107/3, pp.299-318 (2010)

20. Fusco, G., Gronchi, G. F., Negrini, P.: *'Platonic Polyhedra, Topological Constraints and Periodic Solutions of the Classical N–body Problem'*, Invent. Math., 285/2, pp.283-332 (2011)

21. Gronchi, G. F., Farnocchia, D., Dimare, L.: *'Orbit determination with the two-body integrals. II'*, Cel. Mech. Dyn. Ast., 110/3, pp.257-270 (2011)

22. Schunová, E., Granvik, M., Jedicke, R., Gronchi, G., Wainscoat, R., Abe, S.: *'Searching for the first near-Earth object family'*, Icarus 220, pp.1050-1063 (2012)

23. Gronchi, G. F., Valsecchi, G. B. : *'On the possible values of the orbit distance between a near-Earth asteroid and the Earth'*, Monthly Notices of the Royal Astronomical Society 429/3, pp.2687-2699 (2013)

24. Gronchi, G. F., Tardioli, C.: *'The evolution of the orbit distance in the double averaged restricted 3-body problem with crossing singularities'*, Discrete and Continuous Dynamical Systems-Series B, Vol.18/5, pp.1323-1344 (2013)

25. Fusco, G., Gronchi, G.F.: *Platonic polyhedra, periodic orbits and chaotic motions in the N-body problem with non-Newtonian forces*, Journal of Dynamics and Differential Equations 26, pp.817-841 (2014)

26. Gronchi, G.F., Baù, G., Marò, S.: *'Orbit determination with the two-body integrals. III'*, Cel. Mech. Dyn. Ast. 123/2, pp. 105-122 (2015)

27. Gronchi, G.F., Dimare, L., Bracali Cioci, D., Ma, H.: *'On the computation of preliminary orbits for Earth satellites with radar observations'*, Monthly Notices of the Royal Astronomical Society 451 (2), pp. 1883-1891 (2015)

28. Gronchi, G.F., Baù, G., Milani, A.: *'Keplerian integrals, elimination theory and identification of very short arcs in a large database of optical observations'*, Cel. Mech. Dyn. Ast. 127/2, pp. 211-232 (2016)

29. Fusco, G., Gronchi, G.F., Novaga, M.: *'On the existence of connecting orbits for critical values of the energy'*, Journal of Differential Equations 263/12, pp. 8848-8872 (2017)

30. Fusco, G., Gronchi, G.F., Novaga, M.: *'On the existence of heteroclinic connections'*, Sao Paulo Journal of Mathematical Sciences 12/1, pp. 68-81 (2018)

31. Marò, S., Gronchi, G.F.: *'Long term dynamics for the restricted N-body problem with mean motion resonances and crossing singularities'*, SIAM Journal on Applied Dynamical Systems 17/2, pp. 1786-1815 (2018)

32. Fenucci, M., Gronchi, G.F.: *'On the stability of periodic N-body motions with the symmetry of Platonic polyhedra'*, Nonlinearity 31/11 pp. 4935-4954 (2018)

33. Ma, H., Baù, G., Bracali Cioci, D., Gronchi, G.F.: *'Preliminary orbits with line-of-sight correction for LEO satellites observed with radar'*, Cel. Mech. Dyn. Ast. 130/10, pp. 1-20 (2018)

34. Fusco, G., Gronchi, G.F., Novaga, M.: *'Existence of periodic orbits near heteroclinic connections'* Minimax Theory and Applications, Vol.04, 113-149 (2019)

35. Gronchi, G.F., Niederman, L.: 2019 'On the nodal distance between two Keplerian trajectories with a common focus', Cel. Mech. Dyn. Ast. 132:5 (2020)

36. Gronchi, G.F., Baù, G., Rodríguez Ò., Jedicke, R., Moeyens, J.: 'Generalization of a method by Mossotti for initial orbit determination', Cel. Mech. Dyn. Ast. 133:41, open access (2021)

37. Fenucci, M., Gronchi, G.F.: 'Symmetric Constellations of Satellites Moving Around a Central Body of Large Mass', J. Dyn. Diff. Equat. (2021)

38. Cavallari, I., Gronchi, G.F., Baù, G.: 'On the Sun-shadow dynamics', Physica D: Nonlinear Phenomena, open access (2022)

39. Fenucci, M., Gronchi, G.F., Saillenfest, M.: 'Proper elements for resonant planet-crossing asteroids', CMDA, 134, 23 (2022)

40. Rodríguez Ò., Gronchi, G.F., Baù, G., Jedicke, R.: 'Numerical behaviour of the Keplerian Integral methods for initial orbit determination', Icarus, 384, 115080 (2022)

Books

1. Milani, A. and Gronchi, G. F.: *'The Theory of Orbit Determination'*, Cambridge University Press (2010)

Book chapters

1. Gronchi, G. F.: *'Generalized Averaging Principle and Proper Elements for NEAs'*, Lecture Notes in Physics, Vol.590, Springer (2002)

2. Gronchi, G. F.: *'Orbit Determination'*, in UNESCO Encyclopedia of Life Support Systems, Vol. 6.119.55 Celestial Mechanics. Eolss Publishers Co Ltd (2015)

3. Farnocchia, D., Chesley, S. R., Milani, A., Gronchi, G. F., Chodas, P. W.: *'Orbits, Long-Term Prodictions, and Impact Monitoring'*, in Asteroids IV, Univ. of Arizona, Tucson (2016)

Proceedings

1. Gronchi G.F., Milani A.: *'Averaging on Earth-crossing orbits'* (extended abstract), Proceedings of IAU Colloquium 172, Namur, pp. 433-434 (1998)

2. Milani A., Gronchi G.F.: *'Proper elements for Earth-crossers'*, Proceedings of IAU Colloquium 173, Tatranska Lomnica, pp. 75-80 (1998)

3. Milani A. et al.: *'Unbiased orbit determination for the next generation asteroid/comet surveys'*, Proceedings of the ACM05 meeting, Bùzios, BR (2005)

4. Gronchi G.F.: *'Classical and Modern Orbit Determination for Asteroids'*, Proceedings of IAU Colloquium 196, Preston, UK, Cambridge University press (2004)

5. Gronchi, G.F., Tommei, G. and Milani, A.: *'Mutual geometry of confocal Keplerian orbits: uncertainty of the MOID and search for Virtual PHAs'*. In: Near Earth Objects, our Celestial Neighbors: Opportunity and Risk. IAU Symposium 236. Prague, Cech Republic, pp. 3-14, Cambridge University Press (2007)

6. Boattini, A., Milani, A., Gronchi, G.F., Spahr, T. and Valsecchi, G.B.: *'Low solar elongation searches for NEO: a deep sky test and its implications for survey'*. In: Near Earth Objects, our Celestial Neighbors: Opportunity and Risk. IAU Symposium 236. Prague, Cech Republic, pp. 291-300, Cambridge University Press (2007)

7. Milani, A., Gronchi, G. F., Farnocchia, D., Tommei, G., Dimare, L.: *'Optimization of space surveillance resources by innovative preliminary orbit methods'*, Proc. of the Fifth European Conference on Space Debris. 30 March-2 April 2009, Darmstadt, Germany, SP-672 on CD-Rom. (2009)

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11. Gronchi, G.F.: *'Periodic orbits of the N-body problem with the symmetry of Platonic polyhedra'*, in 'Mathematical models and methods for planet Earth', 143–155, Springer INdAM Ser., 6 (2014)

12. Ma, H., Gronchi, G.F.: *'Comparison of different methods to compute a preliminary orbit of Space Debris using radar observations'* (extended abstract), Proceedings of IAU Symposium 310, Complex Planetary Systems, Namur, pp.154-155 (2014)

13. Marò, S., Gronchi, G.F.: *'Orbit identification for large sets of data: preliminary results'* (extended abstract), Proceedings of IAU Symposium 310, Complex Planetary Systems, Namur, pp.156-159 (2014)

14. Gronchi, G.F., Baù, G., Marò, S.: *'Linking very short arcs from large database of asteroid observations'* (extended abstract), Proceedings of IAU Symposium 318, Honolulu, pp.242-243 (2016)

Popular Science

1. Gronchi, G.F.: 2005 'Caccia aperta agli asteroidi! Il calcolo delle orbite dei corpi celesti',
`http://maddmaths.simai.eu/divulgazione/caccia-aperta-agli-asteroidi-il-calcolo-delle-orbite-dei-corpi-celesti/`

Coordination of funded research projects:

He has been responsible for the University of Pisa of the ITN Marie Curie *'Stardust - The Asteroid and Space Debris Network'*, (FP7-PEOPLE-2012-ITN, Project number: 317185).

He is currently responsible for the University of Pisa of the ITN Marie Slodowska Curie *'Stardust-R - The Asteroid and Space Debris Network Reloaded'*, (H2020-MSCA-ITN-2018), funded by the European Commission (kick-off meeting in January 2019).

Advisor of PhD students/post-docs:

PhD

1. Linda Dimare: 'Problems of Celestial Mechanics', Univ. of Roma I 'La Sapienza' (defended in 2010, co-advisor P. Negrini)

2. Helene Ma: 'On the determination of preliminary orbits and detection of possible conjunctions for space debris', Univ. of Pisa (defended on February 14, 2018, co-advisor A. Milani)

3. Marco Fenucci: 'Variational methods and Hamiltonian perturbation theory applied to the N-body problem: a theoretical and computational approach', Univ. of Pisa XXXII ciclo (defended on April 15, 2020)

4. Irene Cavallari: 'Patched dynamics', Univ. of Pisa XXXV ciclo (work in progress, co-advisor G. Baù)

5. Clara Grassi: 'Planetary close encounters', Univ. of Pisa - XXXVI ciclo (work in progress)

post-docs

1. Stefano Marò: Early Stage Researcher of the project 'Stardust', November 2013 - October 2016;

2. Óscar Rodríguez Del Río: Early Stage Researcher of the project 'Stardust-R', November 2019 - today.

Organization of meetings, schools and workshops:

1. CELMEC VI, San Martino al Cimino (Viterbo, Italy) September 1-7, 2013 (`http://adams.dm.unipi.i`

2. Local Training Workshop I of the European project Stardust, Belgrade (Serbia) February 11-13, 2015 (`https://www.stardust2013.eu/Training/Workshops/LocalTrainingWorkshop`

3. SDSM 2017 *Satellite Dynamics and Space Missions: Theory and Applications of Celestial Mechanics*, San Martino al Cimino (Viterbo, Italy) August 28 - September 2, 2017 (`http://adams.dm.unipi.it/ simca/sdsm2017`)

4. CELMEC VII, San Martino al Cimino (Viterbo, Italy) September 3-9, 2017 (`http://adams.dm.unipi.`

5. 2018AMC70 between Mathematics and Astronomy, a workshop in honor of Andrea Milani Comparetti, Pisa (Italy) September 3-5, 2018 (`http://adams.dm.unipi.it/ 2018amc70`)

6. Global Virtual Workshop I of the European project Stardust-R, Pisa (Italy) September 7-10, 2020 (`http://adams.dm.unipi.it/ stardust-r/GVW-I.html`)

7. Theory, Models and Simulations in Celestial Mechanics, June 14-16, 2022, Pisa (Italy) (`https://arnold.dm.unipi.it/wp/tmscm`)