CURRICULUM VITAE
MARCO SANSOTTERA

Personal Information

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Current position

2017.03.01 – now Post-Doctoral position (RTD-A), University of Milan.

Research experiences

2013.09.01 – 2017.02.28 Post-Doctoral position (i.e., Assegno di Ricerca) at the University of Milan. I work on the research project: *"Construction of Invariant Manifolds via Normal Forms: from Celestial Mechanics to Hamiltonian PDE"*, under the supervision of Prof. A. Giorgilli.
2011.10.01 – 2013.08.31 FSR Postdoctoral Researcher at the University of Namur. "FSR Incoming Post-doctoral Fellowship of the Académie universitaire Louvain, co-funded by the Marie Curie Actions of the European Commission". I worked on the research project *"Dynamics near invariant manifolds (DyNeInMa)"*, under the supervision of Prof. A. Lemaître.

2010.11.01 – 2011.04.30 Post-Doctoral position (i.e., Assegno di Ricerca) at the University of Rome "Tor Vergata". I worked on the research project: *"Stabilità dei sistemi planetari, aspetti teorici e computazionali"* (i.e., *"Stability of planetary systems, theory and computations"*), under the supervision of Prof. U. Locatelli.

2007.11.05 – 2011.02.11 Ph.D. in Mathematics at the University of Milan with full marks and honors. Title of the thesis: *"Effective Stability of Hamiltonian Planetary Systems"*. Supervisors: Prof. A. Giorgilli and Prof. U. Locatelli.

Award

2011 Awarded of a “INdAM-COFUND Fellowships in Mathematics and/or Applications for Experienced Researchers cofunded by Marie Courie” (outgoing type), not accepted because already beneficiary of a “FSR Incoming Post-doctoral Fellowship of the Académie universitaire Louvain, cofunded by the Marie Curie Actions”.

Education

2005.07.22 – 2007.07.16 Master’s degree in Mathematics at the University of Milano-Bicocca with full marks and honors (110/110 cum laude). Title of the thesis: *“Stabilità nel senso di Nekhoroshev di tori KAM”* (i.e., *“Stability in Nekhoroshev sense of KAM tori”*). Supervisors: Prof. A. Giorgilli and Prof. U. Locatelli.

2002.09.17 – 2005.07.18 Bachelor’s degree in Mathematics at the University of Milano-Bicocca with full marks and honors (110/110 cum laude). Title of the thesis: *“Funzioni a variazione limitata”* (i.e., *“BV Functions”*). Supervisor: Prof. A. Cellina.

Graduate Teaching

2015/16 Teaching assistant of the course: *“Laboratorio di Modellistica Matematica”* (i.e., *“Mathematical Modeling Lab”*), charged by Dr. F. Ieva, CdL in Mathematics, University of Milan.

2015/16 Teaching assistant of the course: *“Laboratorio di programmazione in CUDA”*, (i.e., *“CUDA-GPU Programming”*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2014/15 Teaching assistant of the course: *“Laboratorio di Modellistica Matematica”*, (i.e., *“Mathematical Modeling Lab”*), charged by Prof. G. Aletti, CdL in Mathematics, University of Milan.

2014/15 Teaching assistant of the course: *“Laboratorio di programmazione in CUDA”*, (i.e., *“CUDA-GPU Programming”*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2013/14 Teaching assistant of the course: *“Laboratorio di Modellistica Matematica”*, (i.e., *“Mathematical Modeling Lab”*), charged by Prof. G. Aletti, CdL in Mathematics, University of Milan.

2012/13 Charge of the course: *“Applications des systèmes dynamique”*, (i.e., *“Dynamical Systems and Applications”*), Master in Mathematics, University of Namur.

Undergraduate Teaching

2016/17 Teaching assistant of the course: *"Fisica Matematica 1"* (i.e., *"Classical Mechanics"*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2015/16 Teaching assistant of the course: *"Fisica Matematica 1"* (i.e., *"Classical Mechanics"*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2014/15 Teaching assistant of the course: *"Fisica Matematica 1"* (i.e., *"Classical Mechanics"*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2013/14 Teaching assistant of the course: *"Fisica Matematica 1"* (i.e., *"Classical Mechanics"*), charged by Prof. A. Giorgilli, CdL in Mathematics, University of Milan.

2009/10 Teaching assistant of the course: *"Metodi e Modelli Matematici per le Applicazioni"* (i.e., *"Mathematical Methods and Model for Applications"*), charged by Prof. S. Paleari, CdL in Mathematics, University of Milan.

2009/10 Teaching assistant of the course: *"Progetto MiniMat"* (i.e., *"Introduction to Mathematics"*), Facoltà di Scienze e Tecnologie, University of Milan.

2008/09 Teaching assistant of the course: *"Progetto MiniMat"* (i.e., *"Introduction to Mathematics"*), Facoltà di Scienze e Tecnologie, University of Milan.

Theses supervision

Currently co-advisor for the Ph.D. thesis of M. Volpi, *"Analysis of the long-term stability of multi-planetary extrasolar systems and implications on their orbital characteristics"* (supervisor: Prof. A.-S. Libert), Department of Mathematics, University of Namur.

Co-advisor of 7 Master Thesis in Mathematics at the University of Milan:

- V. Danesi: "Continuazione di orbite periodiche su tori risonanti" (2017).
- M. Nicoletti: "Ricerca di Orbite Periodiche nel Problema di Sitnikov" (2016).
- G. Pichierri: "Expansions in elliptic functions for highly eccentric planetary orbits" (2015).
- P. Corazza: "Evoluzione di sistemi extrasolari in risonanza" (2015).
- S. Boiani: "Stabilità dei sistemi extrasolari: analisi della dipendenza dai parametri orbitali" (2015).
- G.F. Pontoni: "Costruzione di funzioni invarianti per mappe simplettiche" (2014).
- L. Grassi: "Classical and Relativistic dynamics of extrasolar planetary systems" (2013).

Lectures at Schools

2016 *"Programmazione su schede grafiche (GPU) in CUDA"*, Infrastrutture di Calcolo a Basso Costo (INCA-ABACO), Università di Roma "Tor Vergata", Roma, Italia.

2011 *"Methods of algebraic manipulation in perturbation theory"*, Third La Plata International School on Astronomy and Geophysics, La Plata, Argentina.

Organizing Experience

Member of the Local Organizing Committee for the "International Astronomical Union (IAU) Symposium 310: Complex planetary systems", 7–11 July 2014, Namur, Belgium.

2013 – now Member of the "Commissione Informatica", Dipartimento di Matematica, Università degli Studi di Milano.

2008 – 2011 Member of the "Commissione Informatica", Dipartimento di Matematica, Università degli Studi di Milano.

Referee experiences

Referee for the journals:

- Celestial Mechanics and Dynamical Astronomy;
- Discrete & Continuous Dynamical Systems — Series A;
- Journal of Nonlinear Mathematical Physics;
- *Reviewer* for Mathematical Reviews.

Research Activity

My research activity mainly concerns the following topics: (a) Celestial Mechanics; (b) Dynamical Systems; (c) Control Theory (*a priori control*).

The main goal of my research activity is the study of the stability properties of dynamical systems, with a special emphasis on planetary ones. For this purpose, I investigated the dynamics in the neighborhood of some invariant objects, like equilibrium points, maximal dimension KAM tori and lower dimensional elliptic tori. In particular, I am interested in the long-time behavior of *realistic* dynamical systems (e.g., our Solar System, extrasolar planetary systems, particle accelerators and non-linear FPU-like chains). These kind of systems are usually extremely complex and exhibit a plethora of different behaviors. Notably, one of the most striking facts is the coexistence of regular and chaotic comportments.

I deal with both the theoretical and computational aspects, with a special care on their interplay. Specifically, the results are mainly obtained in the framework of the *normal form theory* via Lie series, exploiting the combination of the KAM and Nekhoroshev theories. The applications to realistic models (e.g., the major planets of our Solar System, extrasolar planetary systems) are obtained by translating the *explicit* normal form algorithms into symbolic computations that are implemented via a specifically designed algebraic manipulator (see [11] for an introduction to the main ideas that have been translated in our codes).

The research results have been published in international publications and presented in international conferences. For the complete lists of the talks and papers, please refer to the subsequent sections "Talks & posters" and "Papers", respectively.

The problem

The subject of my studies is the so-called general problem of dynamics, as named by Poincaré. Namely, a system that is described by a nearly-integrable Hamiltonian, i.e., $H(p,q) = h_0(p) + \varepsilon h_1(p,q)$ in action-angle variables (p,q), with ε small parameter. As previously said, I am interested in realistic results, therefore I am mostly interested in explicit techniques, e.g., explicit normal form algorithms, that can be effectively implemented, e.g., via symbolic computation.

In order to make clear the differences between a theoretical and an applied result, let me stress that in a physical problem the small parameter ε *is given by Nature* and has a fixed value (e.g., in the planetary problem it is essentially the mass ratio between the star and the biggest planet).

The purely analytic results are not enough in order to get realistic estimates. The first attempt to apply the KAM theorem to prove the stability of the Solar System was performed by Hénon in 1965, who found that the mass ratio between Jupiter and Sun should be smaller than 10^{-320}. Quoting Hénon: "Thus the theorem has only a theoretical interest and is absolutely not of practical use, at least in the presented form".

The key remark is that a practical application of the theory to a realistic system needs an explicit constructive algorithm that can be effectively implemented using computer algebra. On the other hand, as suggested by Poincaré, the constructive method should be based on a rigorous mathematical framework.

This kind of approach (also implementing interval arithmetic) opens a complete new field in Celestial Mechanics and allowed some authors (among the others Calleja, Celletti, Chierchia, de la Llave, Gabern, Giorgilli, Jorba, Locatelli, Simó) to (rigorously) prove the existence of KAM tori for some interesting problems in Celestial Mechanics.

Original contributions

(a.1) Celestial Mechanics — secular dynamics of the giant planets of the Solar system

A productive combination of KAM and Nekhoroshev theories consists in applying the usual, local theory for an elliptic equilibrium to the neighbourhood of an invariant Kolmogorov torus. This is exactly the problem I tackled in my Ph.D. thesis[15].

In [14] we investigated the long-time stability for the Sun-Jupiter-Saturn (SJS) system in the framework of the three-body problem. We started from a previous result on the existence of a torus for the SJS system (see Locatelli and Giorgilli, DCDS-B, 7, 2007) based on the explicit expansion of the Hamiltonian and on the explicit application of Kolmogorov method up to a finite, not too low order. Then we worked out a Birkhoff normalization and showed that there is a domain of effective stability, which is centered around an invariant KAM torus. The results were close to realistic ones.

In [10] we studied the stability of the secular evolution of the planar Sun-Jupiter-Saturn-Uranus (SJSU) system. Our method may be considered as an extension of Lagrange theory for the secular motions. Indeed, we improved the classical circular approximation by replacing it with a torus which is invariant up to order two in the masses. Therefore, we investigated the stability of the elliptic equilibrium point of the secular system for small values of the eccentricities. For the initial data corresponding to a real set of astronomical observations, we found an estimated stability time of 10^7 years, which is not extremely far from the estimated lifetime of the Solar System.

A similar approach has been applied to the SJS system in [13], where a technical improvement concerning the bound of a polynomial function in a poly-disk allows us to get a better estimated stability time.

The results obtained in the above-quoted works show that in order to better study the long-time stability of a planetary system, one should find an approximated invariant object that is as close as possible to the dynamics described by the system. Concerning the planetary orbital revolutions, the classical approach consists in taking the circular orbit as a reference. However, due to the effects of near-resonances between the planets (e.g., Jupiter and Saturn are close the the 5:2 mean-motion resonance, the so-called *great inequality*) one should replace the circular approximation with a torus that is invariant up to order two in the masses, using a Kolmogorov-like procedure. This allows to study the stability of the secular system for rather small values of the eccentricities. Coming to the secular evolution, the simplest approach consists in the study of the dynamics around the elliptic equilibrium (i.e., the Lagrange-Laplace secular theory). A refined approach consists in replacing the elliptic equilibrium with a KAM torus, which approximates very well the secular orbits.

The natural extension consists in looking for an invariant object that replaces the circular approximation and the invariant torus at order two in the masses, namely an elliptic lower dimensional invariant torus. The existence of elliptic lower dimensional invariant tori is not a straightforward consequence of Kolmogorov's theorem and all available theorems (see, e.g., Pöschel, Math. Z., 202, 1989) are not suitable for explicit calculations, even if one is interested just in finding the locations of the elliptic invariant tori, being clever adaptations of Arnold's proof of KAM theorem.

In [12] we devised a semi-analytic algorithm for the construction of lower dimensional elliptic tori in planetary systems, following the original Kolmogorov scheme. Moreover we applied our algorithm in order to to construct an elliptic torus for a planar model of the SJSU system. Finally, by using the frequency analysis method, we verified that our location of the initial conditions on an invariant elliptic torus is really accurate. This semi-analytic algorithm has been supported with rigorous convergence estimates in [7], where we gave a constructive proof of the existence of elliptic lower dimensional tori in nearly-integrable Hamiltonian systems. In particular we adapted the classical Kolmogorov normalization algorithm to the case of planetary systems. With respect to previous works on the same subject we exploited the characteristic of Lie series giving a precise control of all terms generated by our algorithm. This allowed us to slightly relax the non-resonance conditions on the frequencies.

Recently, in [1] we investigated again the long-time stability of the planar SJSU system. In particular we improved the results obtained in [10] by using a similar approach to the one adopted in [14]. First, we explicitly constructed a Kolmogorov normal form, so as to find an invariant KAM torus which approximates very well the secular orbits. Finally, we adapted the approach that is at basis of the analytic part of the Nekhoroshev's theorem, so as to show that there is a neighborhood of that torus for which the estimated stability time is larger than the lifetime of the Solar System. The size of such a neighborhood, compared with the uncertainties of the astronomical observations, is not far from the physical parameters.

(a.2) Celestial Mechanics — spin-orbit problem, Titan and Mercury

In [8] we investigated the long-time stability in the neighborhood of the Cassini state in the conservative spin-orbit problem. We constructed a high-order Birkhoff normal form and gave an estimate of the effective stability time in the Nekhoroshev sense. By extensively using algebraic manipulations on a computer, we explicitly applied our method to the rotation of Titan, the largest moon of Saturn, that is in 1:1 spin-orbit resonance. We obtained physical bounds of Titan's latitudinal and longitudinal librations, finding a stability time greatly exceeding the estimated age of the Universe. In addition, we studied the dependence of the effective stability time on three relevant physical parameters: the orbital inclination, i, the mean precession of the ascending node of Titan orbit, $\dot{\Omega}$, and the polar moment of inertia, C.

In [4] we extended our investigation to Mercury, the unique known planet that is currently situated in a 3:2 spin-orbit resonance. Specifically, we used the same approach adopted for the 1:1 spin-orbit case, with a peculiar attention to the role of Mercury's non negligible eccentricity.

(a.3) Celestial Mechanics — extrasolar planetary systems

The discovery of extrasolar planetary systems has opened a new field in Celestial Mechanics. The first confirmation of an exoplanet orbiting a main-sequence star was made in 1995 and nowadays more than 100 multi-planetary systems have been discovered. The study of extrasolar system raised two particularly relevant problems, namely: (i) most exoplanets have highly eccentric orbits, in contrast with the almost circular orbits of the Solar System; (ii) there are many giant planets orbiting at a low distance from the central star, with periods of a few months or even a few days. In the latter case relativistic effects could have a significant impact and should be taken into account.

In [9] we studied the secular evolution of several exoplanetary systems by extending the classical Laplace-Lagrange theory up to order two in the masses. The aim of the work was to reconstruct the evolution of the eccentricities and pericenters of the planets by using analytic techniques. Our study clearly shows that, for systems close to a mean-motion resonance, the second order approximation describes their secular evolution much more accurately than the usually adopted first order one. Moreover, this approach takes into account the influence of the mean anomalies on the secular dynamics. Furthermore, as a byproduct of the approximation at order two in the masses, we also gave an estimate of the proximity to a mean-motion resonance of the two-planet extrasolar systems discovered so far.

In [5] we extended the Lagrange-Laplace secular theory to high order, also including the main relativistic effects. Specifically, we investigated the long-term evolution of the planetary eccentricities via normal form and we found an excellent agreement with direct numerical integrations. Finally we set up a simple analytic criterion that allows to evaluate the impact of the relativistic effects in the long-term evolution.

(a.4) Celestial Mechanics — the relegation algorithm
In [2] we revisited the relegation algorithm introduced by Deprit et al. (CeMDA, 79, 2001). This relatively recent algorithm is nowadays widely used for implementing closed form analytic perturbation theories, as it generalizes the classical Birkhoff normalization algorithm. Following the usual tradition in Celestial Mechanics, the relegation algorithm has been introduced and used in a *formal* way, i.e. without providing any rigorous convergence or asymptotic estimates. In this work we supported the formal algorithm with rigorous quantitative estimates and showed how the results about stability over exponentially long times can be recovered in a simple and effective way, at least in the non-resonant case.

(b) Dynamical Systems — the Schröder-Siegel problem
In [6] we reconsidered the Schröder-Siegel problem of conjugating an analytic map in $\mathbb{C}$ in the neighborhood of a fixed point to its linear part, extending it to the case of dimension $n > 1$. Assuming a condition which is equivalent to Bruno's one on the eigenvalues $\lambda_1, \ldots, \lambda_n$ of the linear part we showed that the convergence radius ϱ of the conjugating transformation satisfies $\ln \varrho(\lambda) \geq -C\Gamma(\lambda) + C'$ with $\Gamma(\lambda)$ characterizing the eigenvalues λ, a constant C' not depending on λ and $C = 1$. This improves the previous results for $n > 1$, where the known proofs give $C = 2$ (recall that $C = 1$ is known to be the optimal value for $n = 1$).

(c) Control Theory — high-order (a priori) control for symplectic maps
In [3] we revisited the problem of introducing an *a priori control* for devices that can be modeled via a symplectic map in a neighborhood of an elliptic equilibrium, e.g., a particle accelerator. Given a symplectic map, the problem is to add a (small) non-trivial control term such that the resulting modified map is conjugated to a rotation, possibly a twist one. Using a technique based on Lie transform methods we produced a normal form algorithm that avoids the usual step of interpolating the map with a flow. The formal algorithm has been completed with quantitative estimates that bring into evidence the asymptotic character of the normal form transformation. In addition, we discussed how control terms of different orders may be introduced so as to increase the size of the stable domain of the map.

Future plans

In the future I would like to continue the long-time research that we are conducting, namely to investigate the long-time stability of the Solar System. Therefore I plan to enhance our model in order to include at least all the giant planets. The major issue is that increasing the number of degrees of freedom requires a substantial computational effort. I plan to overcome this difficulty in two complementary ways: (i) take as a backbone of the system some refined invariant object (even produced by means of numerical investigation) in order to decrease the importance of the perturbation; (ii) resorting to parallel computing in order to speed up the semi-analytic computations. I hope that this will allow to obtain realistic results for the stability of the major planets of our Solar System in the framework of KAM and Nekhoroshev theory, a classical, long standing and challenging problem, already pointed out by Newton.

Coming to the extrasolar systems, first I plan to extend the investigation to systems that are in mean-motion resonance, extending the secular Lagrange-Laplace theory by making use of resonant normal forms. Some preliminary results in this direction has already been obtained in collaboration with A.-S. Libert (paper in preparation). In addition we plan to investigate the role of the mutual inclinations , that are usually unknown, in connection with the feasibility of the construction of some invariant object (e.g., a KAM torus). Indeed, taking the inclinations as parameters, we hope to be able to confine the range for the inclinations to some specific intervals where the construction holds true, namely the normal form is convergent. This will be very important also for practical application, producing a first hint for the possible range of the mutual inclinations that, up to now, are totally unknown for exoplanets.

Furthermore, we plan to extend the results concerning the stability of the Solar system to extrasolar ones. Let me stress that this is not a straightforward adaptation, as the shape of the orbits is totally different with respect to our Solar System, e.g., the eccentricities are much bigger. This kind of results are crucial also for the search of the habitable exoplanets, a hot-topic in exoplanets studies.

Concerning the control of symplectic maps, with a special emphasis on particle accelerator, we plan to make further investigation. Precisely, we are interested in applying our method to more realistic maps, possibly in collaboration with people working at CERN. Indeed, for a practical application one has to identify some of the terms introduced by the control term and set up a multi-pole magnet so as to recreate the wanted effect. In addition, the control we devised is not limited to increase the stability of the beam, but can be used for example to introduce a wanted resonance that allows the so-called multi-turn extraction of the beam, a hot-topic in particle accelerator studies.

Finally, in a project in collaboration with Kevrekidis, Koukouloyannis, Paleari and Penati, we are studying the problem of breathers, i.e., localized periodic solutions, in nonlinear lattices. In particular we are tackling the problem of the continuation of resonant periodic orbit in the Klein-Gordon and Discrete Non-linear Schrödinger models.

Papers

[1] A. Giorgilli, U. Locatelli and M. Sansottera: *"Secular dynamics of a planar model of the Sun-Jupiter-Saturn-Uranus system; effective stability into the light of Kolmogorov and Nekhoroshev theories"*, Regular and Chaotic Dynamics, **22**, 54–77 (2017).

[2] M. Sansottera and M. Ceccaroni: *"Rigorous estimates for the relegation algorithm"*, CeMDA, **127**, 1–18 (2017).

[3] M. Sansottera, A. Giorgilli and T. Carletti: *"High-order control for symplectic maps"*, Physica-D, **316**, 1–15 (2016).
`DOI:10.1016/j.physd.2015.10.012, arXiv: 1510.06561`

[4] M. Sansottera, C. Lhotka and A. Lemaître: *"Effective resonant stability of Mercury"*, MNRAS, **452**, 4145–4152 (2015).
`DOI:10.1093/mnras/stv1429, arXiv:1510.06543`

[5] M. Sansottera, L. Grassi and A. Giorgilli: *"On the relativistic Lagrange-Laplace secular dynamics for extrasolar systems"*, Proceedings of the IAU Symposium S310, 74–77 (2015).
`DOI:10.1017/S174392131400787X, arXiv:1510.06523`

[6] A. Giorgilli, U. Locatelli and M. Sansottera: *"Improved convergence estimates for the Schroder-Siegel problem"*, Annali di Matematica Pura ed Applicata, **194**, 995–1013 (2015).
`DOI:10.1007/s10231-014-0408-4`

[7] A. Giorgilli, U. Locatelli and M. Sansottera: *"On the convergence of an algorithm constructing the normal form for lower dimensional elliptic tori in planetary systems"*, CeMDA, **119**, 397–424 (2014).
`DOI:s10569-014-9562-7, arXiv:1401.6529`

[8] M. Sansottera, C. Lhotka and A. Lemaître: *"Effective stability around the Cassini state in the spin-orbit problem"*, CeMDA, **119**, 75–89 (2014).
`DOI:10.1007/s10569-014-9547-6, arXiv:1510.06521`

[9] A.-S. Libert and M. Sansottera: *"On the extension of the Laplace-Lagrange secular theory to order two in the masses for extrasolar systems"*, CeMDA, **117**, 149–168 (2013).
`DOI:10.1007/s10569-013-9501-z, arXiv:1306.5624`

[10] M. Sansottera, U. Locatelli and A. Giorgilli: *"On the stability of the secular evolution of the planar Sun-Jupiter-Saturn-Uranus system"*, Math. and Comp. in Sim., **88**, 1–14 (2013).
`DOI:10.1016/j.matcom.2010.11.018, arXiv:1010.2609`

[11] A. Giorgilli and M. Sansottera: *"Methods of algebraic manipulation in perturbation theory"*, Workshop Series of the Asociacion Argentina de Astronomia, **3**, 147–183 (2011).
`arXiv:1303.7398`

[12] M. Sansottera, U. Locatelli and A. Giorgilli: *"A Semi-Analytic Algorithm for Constructing Lower Dimensional Elliptic Tori in Planetary Systems"*, CeMDA, **111**, 337–361 (2011).
`DOI:10.1007/s10569-011-9375-x, arXiv:1010.2617`

[13] A. Giorgilli, U. Locatelli and M. Sansottera: *"Su un'estensione della teoria di Lagrange per i moti secolari"*, Rend. Ist. Lom., **143**, 221–238 (2010).
`arXiv:1303.7392`

[14] A. Giorgilli, U. Locatelli and M. Sansottera: *"Kolmogorov and Nekhoroshev theory for the problem of three bodies"*, CeMDA, **104**, 159–173 (2009).
`DOI:10.1007/s10569-009-9192-7, arXiv:1303.7395`

[15] M. Sansottera: *"Effective Stability of Hamiltonian Planetary Systems"*, Ph.D. Thesis (supervisors: A. Giorgilli and U. Locatelli), Università degli Studi di Milano (2011).

Talks & posters

[t1] *"Quasi-convexity of the Hamiltonian for non Harmonic or non Keplerian central potentials"*, naXys seminar, Namur, Belgium (2017).

[t2] *"High-order control for symplectic maps"*, Computational perturbative methods for Hamiltonian systems — Applications in physics and astronomy, Athens, Greece (2016) [**invited talk**].

[t3] *"Rigorous Results on the Relegation Algorithm and Applications via Algebraic Manipulation"*, AstroNet-II International Final Conference, Tossa de Mar, Spain (2015) [**invited talk**].

[t4] *"Secular dynamics of extrasolar-systems"*, Complex Planetary Systems (IAU Symposium), Namur, Belgium (2014).

[t5] *"Improved convergence estimates for the Schröder-Siegel problem"*, Assemblea Scientifica G.N.F.M., Montecatini Terme, Pistoia, Italia (2014).

[t6] *"Lower dimensional elliptic tori in planetary systems via normal form"*, CELMEC VI — The Sixth International Meeting on Celestial Mechanics, San Martino al Cimino, Viterbo, Italia (2013).

[t7] *"Effective stability around the Cassini state in the spin-orbit problem"*, CELMEC VI — The Sixth International Meeting on Celestial Mechanics, San Martino al Cimino, Viterbo, Italia (2013) [e-poster].

[t8] *"Non-linear oscillations and long-term evolution, application to planetary systems and spin-orbit problem"*, Planetary Motions, Satellite Dynamics, and Spaceship Orbits, CRM Montreal, Canada (2013) [**invited talk**].

[t9] *"Secular Evolution of Extrasolar Planetary Systems: an Extension of the Laplace-Lagrange Secular Theory"*, American Astronomical Society Division on Dynamical Astronomy (DDA 2013), Paraty, Brazil (2013).

[t10] *"On the secular evolution of extrasolar planetary systems"*, Tenth Workshop on Interactions Between Dynamical Systems and Partial Differential Equations (JISD2012), Barcelona, Spain (2012).

[t11] *"On the secular evolution of extrasolar planetary systems"*, Annual Meeting Graduate School Complex, Bruxelles, Belgium (2012).

[t12] *"Explicit Construction of Elliptic Tori for Planetary Systems"*, 8th Alexander von Humboldt Colloquium for Celestial Mechanics, Bad Hofgastein, Salzburg, Austria (2011).

[t13] *"Effective Stability of Hamiltonian Planetary Systems"*, Sistemi dinamici nonlineari e applicazioni, Pisa, Italy, (2011).

[t14] *"Explicit Construction of Elliptic Tori for Planetary Systems"*, Applications of Computer Algebra (ACA'10), Vlora, Albania (2010).

[t15] *"Explicit construction of elliptic tori for planetary systems"*, Emerging Topics in Dynamical Systems and Partial Differential Equations, Barcelona, Spain (2010) [poster].

[t16] *"Towards stability results for planetary problems with more than three bodies"*, Computer Algebra and Differential Equations (CADE 2009), Pamplona, Spain (2009) [**invited talk**].

[t17] *"Risultati sulla stabilità per problemi planetari con più di tre corpi"*, Assemblea Scientifica G.N.F.M, Montecatini Terme, Pistoia, Italy (2009).

[t18] *"Towards stability results for planetary problems with more than three bodies"*, CELMEC V — The Fifth International Meeting on Celestial Mechanics, San Martino al Cimino, Viterbo, Italia (2009).

References

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Additional Information

Programming languages

C (expert), CUDA-C (advanced), FORTRAN (advanced).

Mathematical Packages

Mathematica (expert), Maxima (expert), Matlab (advanced), Octave (advanced), OpenMP (advanced), MPI (advanced), TEX& LATEX(TEXnician).

Operating Systems

GNU/Linux (expert), Windows (advanced).

Languages

Italian (mothertongue); English (fluent); French (intermediate level).