Dr. Francesco Topputo

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Dr. Francesco Topputo is an Assistant Professor (tenured) of Aerospace Systems at Politecnico di Milano, Italy, and holds a position as Visiting Researcher at TU Delft, The Netherlands. His core research activities involve space flight dynamics and control, autonomous navigation, interplanetary CubeSat mission and system design. He has been PI in 8 research projects, with over €1.3M research grants allocated to work under his direction. Dr. Topputo leads a research group composed by 1 PostDoc, 5 PhD students, 1 Research Assistant, and 5 visiting PhD students. He has authored 41 peer-reviewed articles published in international journals and over 150 works in total. He is Associated Editor at the journals Advances in Space Research (Elsevier) and Astrodynamics (Springer).

1 Current positions

2012– *Assistant Professor (tenured) in Aerospace Systems*, Politecnico di Milano

Main duties include: Plan, develop, and lead research projects • Produce applications for funding • Publish research on international journals • Participate to international conferences • Supervise Post-Docs, PhD, and MSc students • Carry out teaching activities • Carry out community/academic service

2016– *Visiting Researcher*, TU Delft

Visiting Researcher on a 10% FTE basis at TU Delft, Faculty of Aerospace Engineering, Space Engineering Department, Astrodynamics and Space Missions research group. Main duties include: Promote joint research projects • Generate publications • Supervise MSc students • Give invited lectures

2 Appointments held

2008–17 *Co-founder and Chief Executive Officer (in 2011–12)*, Dinamica Srl

Led the company through direction and decision-making • Contributed to technical, management, financial, and administrative proposals • Managed the contracts (project manager) • Planned and carried out technical work • Participated to company administration • Guided the growth while CEO

2007–12 *Postdoctoral researcher*, Politecnico di Milano

Projects: "Optimization of space trajectories with deep-space maneuvers" (07–08), "Modeling power generation systems for deep space missions" (09–12); Supervisor: Prof. Franco Bernelli-Zazzera

Led the development of assigned research themes: Dynamics and control of non-Keplerian orbits • Global optimization of interplanetary transfers • Modeling and simulation of Philae solar arrays

3 Fellowships

2006 *Research scholar*, Princeton University

Carried out research as visiting PhD student at the Department of Astrophysical Sciences on "Ballistic capture and resonance transition in multi-body models"; Supervisor: Dr. Edward Belbruno

4 Education

2007 PhD Cum Laude in Aerospace Engineering, Politecnico di Milano. Thesis on "Non-Keplerian Orbits: Analysis, Design, and Control"; Supervisor Prof. Amalia Ercoli-Finzi

2003 MSc in Aerospace Engineering with full marks (100/100), Politecnico di Milano. Thesis on "The Invariant Manifolds of the Restricted Three-Body Problem: A New Tool for Low Energy Space Missions"; Supervisor Prof. Amalia Ercoli-Finzi

5 Research activity

5.1 Research interests

Highly nonlinear astrodynamics • Optimal control theory • Autonomous interplanetary CubeSats • Multiphysics modeling, simulationm and optimization • Numerical methods for astrodynamics

5.2 Scientific production

He has authored or coauthored 157 publications subdivided in: 41 articles published in international peer-reviewed journals • 6 book chapters • 1 PhD thesis • 81 papers published in proceedings of international congresses • 12 scientific reports • 4 article published on national journals • 12 papers published in proceedings of national congresses.

5.3 Bibliometric indicators

The bibliometric indicators relative to his research products are given in Table 1. His identification codes are: ORCID: 0000-0002-5369-6887; Researcher ID: C-2569-2013; Scopus Author ID: 8712815100.

Web of Science	h-index: 15 Times cited: 582 (377 w/o self-citations)
Scopus	h-index: 18 Times cited: 841 (564 w/o self-citations)
Google Scholar	h-index: 22 Times cited: 1228

Table 1: Bibliometric indicators (November 2018).

6 Research grants

Dr. Topputo has been Principal Investigator or Project Manager in 8 research projects awarded through competitive calls, initiating, receiving, and managing over €1.3M in research grants allocated to work under his direction. He has been awarded grants from several institutions, including the European Commission, the European Space Agency, and other public or private bodies.

6.1 *Coordination and direction* of research projects awarded through *competitive calls*

2019–22 *Stardust Reloaded (Stardust-R)*
H2020 ITN, Grant Agreement No. 813644 (260k€)
Project funded within the highly competitive (Innovative Training Networks) ITN scheme
Success rate of MSCA-ITN-2018 call: 6.7%

• Unit coordinator and Scientist in Charge of the Initial Training Network; member of the Supervisory Board. He will supervise an Early Stage Researcher (to be chosen) for three years.

2018–21 *Autonomous Navigation for Interplanetary CubeSats at Different Scales*
ESA Contract 4000123920/18/NL/MH (40k€)
Project funded within ESA's Networking/Partnering Initiative (NPI)
Estimated success rate of 2017 NPI call: 15–20%

• PI and promotor of the Networking/Partnering Initiative with ESA. The grant covers a co-funded PhD position (V. Franzese) on a 50% basis for three years on the subject topic.

2017 *LUMIO: Lunar Meteoroid Impacts Observer (Phase 0)*
ESA Contract 4000120225/17/NL/GLC/as (120k€)
Project funded within ESA's Invitation To Tender (ITT) scheme
Estimated success rate of ITT 8643 call: 10%

• PI and Project Manager of the Phase 0 study. He has coordinated a team of 21 people across 6 different partners: Politecnico di Milano (J. Biggs, M. Massari, P. Di Lizia, D. Dei Tos, K. Mani, S. Ceccherini, V. Franzese), TU Delft (A. Cervone, P. Sundaramoorty, R. Noomen, S. Mestry, S. Speretta, A. Cipriano), EPFL (A. Ivanov), Leonardo SpA (D. Labate, L. Tommasi), S&T Norway (A. Jochemsen, Q. Leroy), and University of Arizona (R. Furfaro, V. Reddy, K. Jacquinot).

— The project has been awarded winner of ESA's LUCE SysNova competition (see Section 7).

2016–17 *Feasibility of Ultra Low Thrust Transfers in L_1, L_2, Sun, Earth & Moon Systems*
ESA Contract 4000118201/16/F/MOS (100k€)
Project funded within ESA's Invitation To Tender (ITT) scheme
Estimated success rate of ITT 8601 call: 15–20%

• PI and Coordinator of the project. He has supervised a PostDoc (M. Nakamiya) and a PhD student (D. Dei Tos). He has directed a team of 5 people, including a Senior Engineer (M. Rasotto) and an Intern at Dinamica Srl (G. Aguiar).

2015–17 *SpaceSHIP: Space Systems with Hybrid Propulsion*
Regione Lombardia, Decree 5744 of 8/7/2015 (164k€)
Project granted to 2014 ERC applicants graded B or higher
Success rate of call issued with Decree 1954 of 13/3/2015: 61% (8 projects funded out of 13 submitted)

• Coordinator and PI of the project. He has supervised a PostDoc (M. Nakamiya) and a Research Assistant (K. Mani). He has directed a team of 5 people, including 2 Assistant Professors at Polimi (P. Di Lizia, M. Massari).

2013–17 *Stardust: The Asteroid and Space Debris Network*
FP7 ITN, Grant Agreement No. 317185 (240k€)
Project funded within the highly competitive Initial Training Network (ITN) scheme
Success rate of FP7-PEOPLE-2012-ITN call: 12.4%

• Unit coordinator and Scientist in Charge of the Initial Training Network; member of the Supervisory Board. He has supervised an Experienced Researcher (K. Kumar) for two years.

— The project has been awarded the 2015 Sir Arthur Clarke Award (see Section 7).

2014–15 *Space Shepherd: Saving Human Lives through Satellite Imagery*
Politecnico di Milano (101k€)

Project funded within Politecnico di Milano's Polisocial scheme
Success rate of 2013 Polisocial call: 15% (8 projects funded out of 52 proposals submitted)

• Creator, coordinator, and PI of the project. He has directly supervised a PostDoc researcher (R. Lombardi) and indirectly two PhD students (M. Aiello, F. Banda). He has coordinated a team of 7 people, including 3 Assistant Professors at Polimi (M. Massari, M. Gianinetto, S. Tebaldini).

— The project has been conferred with the 2014 Polisocial Award (see Section 7).

2012 *Hybrid Propulsion Transfer Strategies*
ESA Contract 105465/12 (90k€)
Project funded within ESA's Invitation To Tender (ITT) scheme
Estimated success rate of ITT 6791 call: 20%

• PI and Project Manager of the study. He has supervised one PostDoc researcher (G. Mingotti), and has directed a team composed of 5 people, including one Senior Partner at Dinamica Srl (M. Massari) and 2 Senior Engineers at Surrey Satellite Technology Ltd. (R. Long, R. Bird).

6.2 *Coordination and direction* of research projects awarded through *direct negotiation*

2016–17 *Integration of Earth Observation-based services with Decision Making systems*
Leonardo SpA, Purchase Order No. 8000018715 (12k€)

• He has performed a study aimed to assessing the impact of new mission concepts on the emergency workflow and risk monitoring. He has supervised a MSc Student (P. Broggi). Project affine to Leonardo's activities in the Sapere/Safe project.

2014 *Study of L- and P-band SAR Tomography Synergies*
ESA Contract 4000112571/14/NL/FF/GP (24k€)

• He has coordinated an independent review of the Mission Analysis for the satellite SAOCOM–CS. He has directed a team of 3 people, including a PostDoc (R. Lombardi) and an assistant professor at Polimi (M. Massari). Project funded within ESA's ITT scheme (Prime contractor: DEIB Dept.).

2014 *Preliminary Design of Low-Cost Spacecraft for Lunar Missions*
Moon Memorials, Ltd., Subcontract of Innovative Orbital Design, Inc. (52k$)

• He has coordinated the pre-Phase A study for a low-cost lunar probe. He has directed a team of 3 people, including a Senior Engineer (G. Di Mauro) and a Senior Partner (M. Massari) at Dinamica Srl. Project funded by Moon Memorial, Ltd., and executed under a subcontract wirth Innovative Orbital Design, Inc.

2011–14 *Trajectory design for future mission concepts*
Boeing Space Group, Subcontract of Innovative Orbital Design, Inc. (50k$)

• He has worked as a consultant with Dr. Edward Belbruno at Innovative Orbital Design, Inc. on trajectory design to support feasibility assessment of future space missions. The activity has been carried out for the Boeing Space Group, under the guidance of K. Post.

2010 *Predictive Control of Industrial Plants*
Sanofi–Aventis Contract 127/09MP (40k€)

• He has performed a study aimed to apply system identification and predictive control methods to drug production plants. The project has been carried out in collaboration with a Senior Partner at Dinamica Srl (P. Di Lizia).

2009 *Remote Monitoring of Migrants Vessels in the Mediterranean Sea*
Italian Ministry of Defense (10k€)

• He has executed an independent study in the framework of the "Research Plan 2009" of the "Military Centre for Strategic Studies" (CeMiSS, Ministry of Defense).

6.3 *Participation* to research projects awarded through *competitive calls*

Dr. Topputo has contributed to the research projects listed below, awarded through competitive calls. His involvement pertained writing the proposals, carrying out the research, producing the reports, managing the projects either as PhD Student/PostDoc at Polimi or as co-founder at Dinamica Srl.

2015–16 *Technology for Improving Re-Entry Predictions of European Upper Stages through Dedicated Observations*, ESA Contract 4000114349/15/D/SR (250k€)

2014–15 *Nonlinear Propagation of Uncertainties in Space Dynamics based on Taylor Differential Algebra*, ESA Contract 4000109643/13/NL/MH (180k€)

2013–14 *End-of-Life Disposal Concepts for Lagrange-Points and HEO Missions*
ESA Contract 4000107618/13 (240k€)

2008 *Predicting Asteroid Trajectories using Validated Integrators and Determining Impact Leading Conditions*, ESA Contract 20271/06 (35k€)

2008 *Support to the Design, Assembly, Test, and Launch of an Earth Observation Satellite (ESEO)* ESA Contract, Subcontractor of Carlo Gavazzi Space SpA (32k€)

2007 *Global Trajectory Optimization: Can We Prune the Solution Space when Considering Deep Space Maneuvers?*, ESA Contract 20271/06 (35k€)

2004 *Assessment of Mission Design Including Utilization of Libration Points and Weak Stability Boundaries*, ESA Contract 18147/04 (15k€)

6.4 *Participation* to research projects awarded through *direct negotiation*

He has taken part to the research projects listed below, awarded through direct negotiations with institutions or companies. His role mainly concerned carrying out the research and producing the deliverables (reports, presentatons).

2007–15 *Rosetta Project: Phase E2*, ASI Contracts I/062/08/00 and I/024/12/00
2011 *Uncertainty Propagation Analysis Service of TEC-ECM*, ESA Contract 4000102634
2009 *Analysis of Covariance for Trajectories*, ESA Contract P1091397
2008 *Mechanical and Thermal Design for an X Telescope*, ASI Contract, Subcontractor of IASF
2008–10 *Stationkeeping of GEO Satellites with Nongrav. Forces*, Italian/Egyptian Mininstry of Foreign Affairs
2008 *Nuclear Multimodule ISRU Mission: Lunar Exploration Architecture*, Alcatel-Alenia Space

6.5 Technology transfer and creation of start-up companies

2008–17 Co-founder and Senior Partner at Dinamica Srl

• He co-funded Dinamica Srl, an engineering firm engaged in technology transfer from the space to the civil sector. As Senior Partner of Dinamica Srl he has participated to some of the projects listed above, for which he has been responsible for the technical, management, and financial proposals.

Beside having the scientific responsibility and supervising the collaborators, he has had an active role in managing the projects, creation of the consortia, definition of the tasks and budget for the subcontractors. He has been Chief Executive Officer of Dinamica Srl in years 2011–2012.

7 Honors & awards

7.1 Major awards

2018 "Best paper award" for the paper "LUMIO: Achieving Autonomous Operations for Lunar Exploration with a CubeSat" presented at SpaceOps 2018 Conference and Exhibition, Marseille, France (June 2018).

2018 "Outstanding paper award for young scientists" awarded by COSPAR Bureau for the manuscript "Trajectory Refinement of Three-Body Orbits in the Real Solar System Model" (July 2018).
The prize is awarded to selected papers published on Advances in Space Research with first authors under 31 years old (D. Dei Tos in this case); 14 awards for the years 2016–2018 given, 3 for the field Celestial Mechanics.

2017 LUMIO (Lunar Meteoroid Impacts Observer) awarded winner (ex aequo) of ESA's SysNova Competition No. 4 "Lunar CubeSats for Exploration" (December 2017). The award granted an independent review carried out by ESA's CDF experts in February 2018 in view of the mission implementation.

2015 "The British Interplanetary Society 2015 Sir Arthur Clarke Award" awarded to the Stardust Network, of which he is member, for "Space achievement in academic study/research" (July 2015)

2014 "Polisocial Award" awarded for the proposal "Space Shepherd: Saving Human Lives through Satellite Imagery"; the grant of 52k€ allowed co-financing the research project (May 2014)

2013 "Best paper" award for the work "Simulation of Low-Intensity, Low-Temperature Solar Arrays with Software and Hardware Tools" presented at AIDAA XXII Conference, Naples, Italy (September 2013).

7.2 International reputation

2017 Appointed Associate Editor at Astrodynamics, co-published by Springer and Tsinghua University Press (February 2017)

2016 Appointed Associate Editor at Advances in Space Research, the official journal of the Committee on Space Research (COSPAR), published by Elsevier (April 2016)

2015 Elected member of the Space Flight Mechanics Committee, American Astronautical Society, term 2015–2020; he was the only non-US-affiliated member elected in 2015 (January 2015)

2014 Scientific American covered a story inspired by the work "Earth–Mars Transfers with Ballistic Capture", published on Celestial Mechanics and Dynamical Astronomy (December 2014) [1]

2011 The work "Controlled Drug Delivery in Cancer Immunotherapy: Stability, Optimization, and Monte Carlo Analysis" was chosen as "research nugget" from Society for Industrial and Applied Mathematics (SIAM) and was posted under the "public awareness" section (December 2011) [2]

7.3 Promotions

2017 National Scientific Habilitation for Full Professor, awarded by the Italian Ministry of University and Scientific Research, in the Scientific Area 09/A1 "Aeronautical, Aerospace, and Naval Engineering" (April 2017; application submitted on December 2016).

2016 Award of academic tenure at Politecnico di Milano and promotion to Senior Assistant Professor. The position lasts 3 years, pending the attainment of the National Scientific Habilitation for Associate Professor (March 2016)

2014 National Scientific Habilitation for Associate Professor, awarded by the Italian Ministry of University

[1] See scientificamerican.com/article/a-new-way-to-reach-mars-safely-anytime-and-on-the-cheap/
[2] See http://www.siam.org/publicawareness/drug.php

and Scientific Research, in the Scientific Area 09/A1 "Aeronautical, Aerospace, and Naval Engineering" (February 2014; application submitted on November 2012).

8 Memberships

8.1 Commissions of trust

2018– Member of Hera mission Worg Group #3: Physical and Dynamical Properties of the Didymos System
2018 Member of the Review Panel of the Space Center at Skolkovo Institute of Sci and Tech, Moscow, Russia
2017– Member of the Editorial Board of the journal Astrodynamics
2016– Member of the Editorial Board of the journal Advances in Space Research
2015– Member of American Astronautical Society's Space Flight Mechanics Committee
2013–16 Member of the Supervisory Board of Stardust: The Asteroid and Space Debris Network
2008–14 Member of the Philae Long Term Science Working Group, Rosetta/Philae Missions
2008–11 Member of the Organizing Committee of New Trends in Astrodynamics and Applications conference

8.2 Member of scientific societies

2017– Committee on Space Research (COSPAR), Associate Member
2014– American Astronautical Society (AAS)
2013– American Institute of Aeronautics and Astronautics (AIAA)
2013– Society for Industrial and Applied Mathematics (SIAM)
2006– Italian Society of Celestial Mechanics and Astrodynamics (SIMCA)
2006– Italian Society of Chaos and Complexity (SICC)
2005– Italian Association of Aeronautics and Astronautics (AIDAA)

9 Service to the community

9.1 Conferences and workshops committees

He has contributed to the organization of conferences and workshop listed below.

2019 8th Interplanetary CubeSat Workshop, Milan, Italy, 28–29 May 2019
2019 29th AAS/AIAA Space Flight Mechanics Meeting, Maui, Hawaii, USA, 13–17 January 2019
2017 LUMIO Workshop, Milan, Italy, 11–12 September 2017
2016 Stardust Final Conference, ESA/ESTEC, Noordwijk, The Netherlands, 31 October–3 November 2016
2016 Stardust 2nd Local Training Workshop, Bremen, Germany, 20–22 April 2016
2015 Space Shepherd Workshop, Milan, Italy, 4 December 2015
2011 New Trends in Astrodynamics and Applications VI, New York City, New York, USA, 6–8 June 2011
2008 New Trends in Astrodynamics and Applications V, Milan, Italy, 30 June–2 July 2008

9.2 Editorial boards

2017– Associate Editor-in-Chief at Astrodynamics, a newly launched journal in the field, co-published by Springer and Tsinghua University Press (ISSN: 2522-008X); IF(2018): TBD [edited 4 submissions]
2016– Associate Editor at Advances in Space Research, the official journal of the Committee on Space Research (COSPAR), published by Elsevier, for the field "Satellite Dynamics, Space Dynamics, Space Debris" (ISSN: 0273-1177); IF(2017): 1.529 [edited 100 submissions with final disposition]

9.3 Conference chair

2019– Co-Chair and responsible for the local organization of the 8th Interplanetary CubeSat Workshop, to be held in Milan, Italy, on 28–29 May 2019

2019– AAS Technical Chair of the 29th AAS/AIAA Space Flight Mechanics Meeting to be held in Maui, Hawaii, USA on 13–17 January 2019

9.4 Session chair

2018 Co-chaired the sessions "Low Earth Orbit – POD Techniques and Applications" and "Moon, Planets, and Beyond" at the Panel on Satellite Dynamics (PSD.1), COSPAR Scientific Assembly 2018, Pasadena, CA, USA, 14–22 July 2018

2016 Chairman of "Symposium on Active and Passive Debris Removal", Stardust Final Conference, ESA/ESTEC, Noordwijk, The Netherlands, 31 October–3 November 2016

2016 Chairman of the session "Spacecraft Dynamics", 26th AAS/AIAA Space Flight Mechanics Meeting, Napa Valley, CA, 14–18 February 2016

2015 Chairman of the sessions "Trajectory Design" and "Orbital Dynamics", 25th AAS/AIAA Space Flight Mechanics Meeting, Williamsburg, VA, 11–15 January 2015

9.5 Activity as reviewer

He regularly serves as reviewer for the major journals in the field: Journal of Guidance, Control, and Dynamics (AIAA), Celestial Mechanics and Dynamical Astronomy (Springer), Advances in Space Research (Elsevier), Acta Astronautica (Elsevier), Communication in Nonlinear Science and Numerical Simulation (Elsevier).

2008– He has performed over 110 reviews certified by Publons[3]

10 Academic service

He leads a group composed by 1 PostDoc, 5 PhD students, 1 Research Assistant, and 5 visiting PhD students.

10.1 Supervision of PostDoc fellows

He has been responsible for the activities of PostDoc fellows in 7 research projects (Table 2).

Year	PostDoc fellow	Project
2017–2018	Diogene Dei Tos	LUMIO: Lunar Meteoroid Impacts Observer
2016	Masaki Nakamiya	SpaceSHIP: Space Systems with Hybrid Propulsion
2014–2016	Kartik Kumar	Stardust: The Asteroid and Space Debris Network
2014–2015	Riccardo Lombardi	Space Shepherd: Saving Human Lives trough Satellite Imagery
2014	Riccardo Lombardi	Study of L- and P-band SAR Tomography Synergies
2014	Giuseppe Di Mauro	Preliminary Design of Low-Cost Spacecraft for Lunar Missions
2012	Giorgio Mingotti	Hybrid Propulsion Transfer Strategies

Table 2: Post-doc research fellows supervised.

[3] See https://publons.com/author/528735/francesco-topputo

10.2 Supervision of PhD students

He has completed 1 PhD supervision and is currently supervising 5 PhD students (Table 3).

Year	PhD student	PhD Thesis
2018–	Christian Hofmann	Autonomous guidance of deep-space systems (provisional)
2018–	Vittorio Franzese	Autonomous optical navigation at different scales (provisional)
2017–	Yang Wang	Closed-loop control of space trajectories (provisional)
2017–	Carmine Giordano	Astrodynamics for fundamental physics missions (provisional)
2016–	Karthik Mani	Preliminary design of interplanetary CubeSats (provisional)
2014–2017	Diogene Dei Tos	Trajectory optimization of limited control authority spacecraft in high-fidelity models

Table 3: PhD students supervised.

10.3 Supervision of visiting PhD students, co-supervision of PhD students

He has temporary supervised 12 visiting PhD students from international universities (Table 4, top). He has been co-supervisor in 2 PhD projects (Table 4, bottom).

10.4 Member in PhD committees

Member of the PhD committees for the evaluation of the candidates listed below.

2018 Lorenzo Niccolai, Dipartimento di Ingegneria Civile e Industriale, Università di Pisa, 20 December 2018; Thesis on "Trajectory analysis of spacecraft with propellantless propulsion systems".

2018 Marcel Duering, Department of Mechanical and Aerospace Engineering, University of Strathclyde, 26 October 2018; Thesis on "Station-keeping and orbital transfers in the vicinity of the Moon exploiting quasi-periodic orbit dynamics".

2018 Federica Maffione, Department of Mechanical and Aerospace Engineering, Politecnico di Torino, 10 July 2017; Thesis on "Analysis of low-thrust interplanetary missions".

2017 Member of the committee for the PhD in Industrial Engineering (multiple candidates: M. Chiatto, S. Boccardi, P. Pasolini, A. Scannapieco, M. Iuzzolino, R. Scognamiglio), Università di Napoli Federico II, 20 June 2017.

2016 Zheng Chen, Laboratoire de Mathématiques d'Orsay, Université Paris-Saclay, 14 September 2016; Thesis on "L^1-Minimization for Space Mechanics"

2015 Hodei Urrutxua, Escuela Tecnica Superior de Ingenieros Aeronauticos, Universidad Politecnica de Madrid, 14 May 2015; thesis on "High Fidelity Models for Near-Earth Object Dynamics".

2013 Generoso Aliasi, Dipartimento di Ingegneria Aerospaziale, Università di Pisa, 18 March 2013; Thesis on "Mission Applications for Continuous-Thrust Spacecraft within a Three-Body Problem".

10.5 Supervision of research assistants

He has been responsible for the activities of Research Assistants in 4 projects (Table 5).

10.6 Supervision of MSc students

He has supervised 23 MSc students for their final thesis projects (average duration of 6–8 months; Table 6). He has been the daily supervisor of 4 visiting MSc students from international universities (Table 7). He has also been co-supervisor of 20 MSc students (Table 8).

Year	PhD Student	Topic	Home Uni.
2018–2019	Yingying Zhang	Autonomous trajectory planning and tracking for asteroid landing	Harbin Institute of Tech (China)
2018–2019	Qi Chen	Computation and analysis of low-thrust reachable sets	Beijing Institute of Tech. (China)
2018–2019	Leonardo Barbosa	Optimal transfers to Lagrange point orbits in the Earth–Moon system	Inst. Nac. de Pesq. Espaciais (Brasil)
2018–2019	Haiyang Li	Closed-loop guidance of space trajectory via deep neural network	Tsinghua University (China)
2018–2019	Zhemin Chi	Low-thrust, variable-specific-impulse trajectory optimization	Tsinghua University (China)
2017–2018	Abbasali Mohammadi	Space trajectory design though shape based methods	Iran Uni of Sci and Tech (Iran)
2016	Juan-Luis Gonzalo	End-of-life disposal of satellites in MEO orbits with low-thrust propulsion	Uni Politécnica de Madrid (Spain)
2015–2016	Kenta Oshima	Dynamics of lunar collision orbits for medium-energy lunar transfers	Waseda University (Japan)
2014	Hongli Zhang	Unscented parameter estimation methods to solve two-point boundary value problems	Beihang University (China)
2013–2014	Chen Zhang	Direct and indirect optimization of low-thrust trajectories	Beihang University (China)
2013–2014	Zongfu Luo	Ballistic capture analysis and design in the real n-body model	National Uni of Def&Tech (China)
2012–2013	Renyong Zhang	Numerical approximations of invariant manifolds in the restricted 3-body problem	Northwestern Polyt Uni (China)
2016–2018	Mohammad Gomroki	Development of state dependent factorized optimal control methods with applications	Middle East Tech Univ (Turkey)
2008–2011	Giorgio Mingotti	Trajectory Design and Optimization in Highly Nonlinear Astrodynamics	Politecnico di Milano (Italy)

Table 4: Visiting PhD students supervised (top), PhD students co-supervised (bottom).

Year	Researcher	Project
2018	Simone Ceccherini	LUMIO: Lunar Meteoroid Impacts Observer
2017	Simone Ceccherini	SpaceSHIP: Space systems with hybrid propulsion
2016–2017	Mirco Rasotto	Navigation of ultra low thrust transfers to the saddle point
2016–2017	Karthik Mani	SpaceSHIP: Space Systems with Hybrid Propulsion

Table 5: Research assistants supervised.

Year	MSc student	MSc Thesis
2018	Riccardo Barocco	Applications and optimization of Extreme Learning Machines for the realization of on-board, real-time guidance algorithms
	Alberto Mañero	A radiation model for power degradation estimation in Earth-centered satellites
	Fernando Soler	Low-thrust heliocentric transfer with ballistic capture and orbit circularization for a standalone Mars CubeSat
	Andrea Malgarini	Deep-Space Pulsar-Based Autonomous Navigation
2017	Andrea Brugnoli	Orbit-attitude coupling for geostationary HAMR debris
	Vittorio Franzese	Autonomous navigation for interplanetary CubeSats
	Natividad Ramos	Indirect optimization of electric propulsion orbit raising to GEO with homotopy
	Antonino Campolo	Safety analysis for near rectilinear orbit close approach rendezvous in the circular restricted three-body problem
	Erind Veruari	Space trajectory optimisation in high-fidelity models
	Carmine Giordano	Modeling and optimisation of aero-ballistic capture
	Pietro Broggi	Impact of novel observation space assets on migrants monitoring in the Mediterranean Sea and on emergency and disaster management
2016	Fabrizio Gaspari	Numerical and experimental characterization of Philae's photovoltaic balcony panel
	Marco Caiazzo	Robustness analysis of ballistic capture orbits in the elliptic restricted three-body problem
	Simone Ceccherini	Preliminary mission analysis and design for a hybrid transfer to the geostationary orbit
	Luca Ferella	Indirect optimization of long-duration, multi-spiral low-thrust transfers with homotopy
	Edoardo Dell'Aglio	Ballistic capture at Mars: Stability analysis with active control and energy criteria
	Andrea Zuanetti	Integrated monitoring of refugees in the Mediterranean Sea with small satellite constellations
	Andrés Cardozo	Low-thrust space trajectory optimization via direct transcription and collocation
2014	Umberto Monti	Approximate solution methods for bounded nonlinear optimal control problems
	Daniele Dadamo, Michele Petruzziello	Design of an experimental device to recreate LILT environment
	Siddharth Tiwari	Phase change material as a heat sink device for small satellites
	Diogene Dei Tos	Automated trajectory refinement of three-body orbits in the real Solar System model

Table 6: MSc students supervised.

Year	MSc Student	MSc Thesis	Home Uni.
2017	Alvaro Sanz	Preliminary systems design of a stand-alone interplanetary cubesat to Mars	Uni. Carlos III de Madrid
2015	Adrià Batet	Direct optimization of three-dimensional, low-thrust space trajectories with variable path constraints	Uni. Politecnica de Catalunya
2015	Xavi Ros Roca	Computation of Lagrangian coherent structures with application to weak stability boundaries	Uni. Politecnica de Catalunya
2015	Mario Iglesias	Optimization of ballistic capture trajectories in the elliptic restricted three-body problem	Uni. Politécnica de Madrid

Table 7: Visiting MSc students supervised.

Year	MSc student	Thesis
2018	Ilaria Bloise, Marcello Orlandelli	A deep learning approach to autonomous lunar landing
	Jose Ruiz Sarrió	Flexible electrical power system for interplanetary and lunar CubeSats
2017	Giulia Lanave	Waypoints ZEM/ZEV feedback space guidance for multi-spiral, long-duration low-thrust transfers
	Roberto Ruggiero	Waypoints-optimized ZEM/ZEV closed loop guidance for spacecraft rendezvous in relative motion frame
2014	Andrea De Bernardi	Space trajectory optimization with solar electric propulsion models
	Mattia Cattafesta	Modeling and simulation of Rosetta lander Philae solar arrays
2013	Andrea Binci	Simulazione hardware-in-the-loop dei pannelli solari del microsatellite Palamede
	Gioele Zgraggen	Design of an experimental device for the characterization of solar cells in LILT environment
	Martino Miani	A combined dynamic-algebraic method to solve nonlinear optimal control problems with applications
2012	Gianluca Caputo	On-comet attitude determination of Rosetta lander Philae through nonlinear optimal system identification
	Giulio Pinzan	Landing site selection for Rosetta lander Philae through a multidisciplinary approach
2010	Marco Pasta	Station keeping di satelliti geostazionari mediante controllo ottimo nonlineare
	Andrea Minelli	Analogies between astrodynamics and cancer immunotherapy
2009	Federico Zuiani, Dario Ricci	Gravity assist space pruning using Tisserand and shape-based methods
2008	Nicola Hyeraci	Ballistic capture in the elliptic restricted three-body problem with applications to low-thrust interplanetary transfers
	Stefano Brambillasca	Celle solari per missioni verso corpi celesti lontani dal Sole
2006	Giorgio Mingotti	Progettazione di traiettorie per missioni spaziali nel modello dei tre corpi ristretto con propulsione a bassa spinta
	Gabriele Ferri	Trasferimenti Terra-Luna per l'esplorazione lunare
2005	Francesco Cremaschi	Trasferimenti interplanetari a bassa spinta tramite varietà invarianti e neurocontrollori evolutivi

Table 8: MSc students co-supervised.

10.7 Supervision of MSc students at TU Delft

As part of the activities performed at TU Delft, he has supervised 4 MSc students (Table 9).

Year	MSc student	MSc Thesis
2018	Jose Gutierrez	End-to-end assessment of Earth-Mars transfers ending in ballistic capture
2017	Gonçalo Aguiar	Earth–Mars low-thrust transfers with ballistic capture
2017	Ana Cipriano	Orbit design of a lunar meteoroid impact flashes observer
2017	Stefano Bonasera	On lunar collision orbits: New methodologies for Moon-to-Moon transfer design
2017	Mònica Aragay	Characterization of trajectories to collect samples from Europa's plume

Table 9: MSc students supervised at TU Delft.

10.8 Supervision of interns

He has supervised 10 BSc/MSc students for their internship activity.

Year	MSc Student	Topic	Home Uni.
2017	Aalok Parkash	Implementation of efficient ballistic capture techniques in GRATIS	TU Delft
2016	Ana Cipriano	Optimisation of low-thrust space trajectories with direct transcription and collocation	TU Delft
2016	Gonçalo Aguiar	Assessment of ultra low thrust transfer to the saddle point	TU Delft
2016	Yousra Mekkaoui	Challenges in sytem design for deep space cubesats	ISAE ENSMA
2015	Enne Hekma	Development of a toolbox for trajectory optimization for multiple rendezvous debris removal satellite missions	TU Delft
2015	Abishek Agrawal	Development of multi-target active debris removal mission concepts	TU Delft
2009	Siddharth Tiwari	Restricted three-body problem: Families of periodic orbits and their application	Bombay Uni.
2008	Kartik Kumar	Weak capture and the weak stability boundary	TU Delft
2007	Amy Laird	Comparison of propulsion system masses for chemical and solar electric propulsion	Glasgow Uni.
2007	Sharlene Hay	An investigation to define reference orbits for hydrocarbon detection	Glasgow Uni.

Table 10: BSc/MSc interns supervised.

10.9 Organization of internal seminars

He has organized the internal seminars listed below.

2018 K. Kumar, "Integrated Mission Design using Electronic Data Sheets", 21 November 2018

2017 G. Cataldo, "The James Webb Space Telescope: Challenges Addressed Through Model-Based Systems Engineering", 20 December 2017

2017 R. Furfaro, "Shallow and Deep Learning Models for Closed-Loop Space Guidance", 12 December 2017

2017 C. Trenkel, "LISA Pathfinder and Tests of Alternative Gravitational Theories", 13 October 2017

2017 L. Montabone, "The Atmosphere of Mars: What to observe with SmallSat missions?", 11 July 2017

2016 N. Baresi, "Numerical Computation of Quasi-Periodic Invariant Tori and Applications to Astrodynamics", 20 October 2016

2015 C. Bombardelli, "Fundamental Aspects of Ion-Beam Debris Mitigation and Asteroid Deflection", 26 March 2015

2015 E. Belbruno, "Ballistic Capture Transfers: Origins to Current Developments", 5 February 2015

2014 D. Scheeres, "Space Situational Awareness, Active Satellites and Optimal Control", 9 June 2014

10.10 Department roles

2018 Member of the committee for the admission to the PhD in Aerospace Engineering (XXXIV cycle)

2017– Member of the Scientific Committee at the Dept. of Aerospace Science and Technology, Polimi

2017– Member of the permanent PhD Committee in Aerospace Engineering, Polimi

2015–16 Media co-manager (Twitter) of the Dept. of Aerospace Science and Technology, Polimi

11 Teaching activity

He is instructor of classes listed below at BSc, MSc, and PhD levels at the School of Industrial and Information Engineering, Politecnico di Milano (summary in Table 11).

2018– Instructor of the class "Introduction to Space Mission Analysis" (3 ECTS) for BSc students in Aerospace Engineering (taught in Italian)
- Given in AY 2017–2018, 2018–2019

2015– He has created from scratch and taught the class "Modeling and Simulation of Aerospace Systems" (8 ECTS) for MSc students in Space Engineering and Aeronautical Engineering
- Given in AY 2015–2016, 2016–2017, 2017–2018, 2018–2019

2015– He has designed the class "Nonlinear Optimal Control with Applications" (5 ECTS) for PhD students in Aerospace Engineering
- Given in AY 2015–2016, 2016–2017, 2017–2018, 2018–2019

2013–15 Instructor of the class "Numerical Models of Aeronautical Systems" (8 ECTS) for MSc students in Aeronautical Engineering (taught in Italian)
- Given in AY 2013–2014, 2014–2015

11.1 Activity as teaching assistant

He has served as Teaching Assistant in several classes at Politecnico di Milano (in Italian); Table 12.

12 Publications

Dr. Topputo has authored or coauthored 145 publications subdivided in: 39 articles published in international peer-reviewed journals, 6 book chapters, 1 PhD thesis, 72 papers published in proceedings of international congresses, 12 scientific reports, 3 article published on national journals, and 12 papers published in proceedings of national congresses.

12.1 Peer-reviewed journal articles

J41 D. Dei–Tos and *F. Topputo*, "High-Fidelity Trajectory Optimization with Application to Saddle Point Transfers", Journal of Guidance Control and Dynamics, In press

AY	Class	ECTS	Level
2018–2019	Nonlinear Optimal Control with Applications	5	PhD in Aerospace Eng
2018–2019	Modeling and Simulation of Aerospace Systems	8	MSc in Aero, Space Eng
2018–2019	Introduction to Space Mission Analysis	3	BSc in Aerospace Eng
2017–2018	Nonlinear Optimal Control with Applications	5	PhD in Aerospace Eng
2017–2018	Modeling and Simulation of Aerospace Systems	8	MSc in Aero, Space Eng
2017–2018	Introduction to Space Mission Analysis	3	BSc in Aerospace Eng
2016–2017	Nonlinear Optimal Control with Applications	5	PhD in Aerospace Eng
2016–2017	Modeling and Simulation of Aerospace Systems	8	MSc in Aero, Space Eng
2015–2016	Nonlinear Optimal Control with Applications	5	PhD in Aerospace Eng
2015–2016	Modeling and Simulation of Aerospace Systems	8	MSc in Aero, Space Eng
2014–2015	Numerical Models of Aeronautical Systems	8	MSc in Aero Eng
2013–2014	Numerical Models of Aeronautical Systems	8	MSc in Aero Eng

Table 11: Classes of which he has been instructor.

AY	Class	Instructor	Level
2012–2013	Intr. to space mission analysis	M. Massari	BSc in Aerospace Eng
2012–2013	Intr. to space mission analysis	F. Bernelli-Zazzera	BSc in Aerospace Eng
2012–2013	Analytical mechanics	A. Frezzotti	BSc in Aerospace Eng
2011–2012	Atm. & space flight mechanics	M. Massari	BSc in Aerospace Eng
2011–2012	Atm. & space flight mechanics	F. Bernelli-Zazzera	BSc in Aerospace Eng
2011–2012	Analytical Mechanics A	C. Morosi	BSc in Biomedical Eng
2011–2012	Analytical Mechanics	A. Frezzotti	BSc in Aerospace Eng
2010–2011	Atm. & space flight mechanics	M. Massari	BSc in Aerospace Eng
2010–2011	Atm. & space flight mechanics	F. Bernelli-Zazzera	BSc in Aerospace Eng
2010–2011	Analytical Mechanics	A. Frezzotti	BSc in Aerospace Eng
2009–2010	Atm. & space flight mechanics	M. Massari	BSc in Aerospace Eng
2009–2010	Atm. & space flight mechanics	F. Bernelli-Zazzera	BSc in Aerospace Eng
2009–2010	Analytical Mechanics	A. Frezzotti	BSc in Aerospace Eng
2008–2009	Space systems design	M. Lavagna/F. Ongaro	MSc in Aerospace Eng
2008–2009	Aerospace mechanics	A. Frezzotti	BSc in Aerospace Eng
2007–2008	Space systems design	M. Lavagna/F. Ongaro	MSc in Aerospace Eng
2007–2008	Foundation of mechanics	L. Valdettaro	BSc in Mechanical Eng
2007–2008	Foundation of mechanics	C. Morosi	BSc in Mechanical Eng
2006–2007	Foundation of mechanics	L. Valdettaro	BSc in Mechanical Eng
2006–2007	Foundation of mechanics	C. Belli	BSc in Mechanical Eng
2005–2006	Analytical Mechanics	E. Alberti	MSc in Aerospace Eng
2004–2005	Analytical Mechanics	E. Alberti	MSc in Aerospace Eng

Table 12: Classes of which he has been Teaching Assistant.

J40 A. Cipriano, D. Dei–Tos, and *F. Topputo*, "Orbit Design for LUMIO: the Lunar Meteoroid Impacts Observer", Frontiers in Astronomy and Space Science, Vol. 5, pp. 1–23, 2018 DOI: 10.3389/fspas.2018.00029

J39 *F. Topputo*, D. Dei–Tos, M. Rasotto, and M. Nakamiya, "The Sun-Earth Saddle Point: Characterization and Opportunities to Test General Relativity", Celestial Mechanics and Dynamical Astronomy, Vol. 130, Article 33, 2018 DOI: 10.1007/s10569-018-9824-x

J38 D. Dei–Tos, R. Russel, and *F. Topputo*, "Survey of Mars Ballistic Capture Trajectories using Periodic Orbits as Generating Mechanisms", Journal of Guidance Control and Dynamics, Vol. 41, pp. 1227–1242, 2018 DOI: 10.2514/1.G003158

J37 M. Gomroki, *F. Topputo*, F. Bernelli–Zazzera, and O. Tekinalp, "Solving Constrained Optimal Control Problems Using State-Dependent Factorization and Chebyshev Polynomials", Journal of Guidance Control and Dynamics, Vol. 41, pp. 618–631, 2018 DOI: 10.2514/1.G002392

J36 D. Dei–Tos and *F. Topputo*, "On the Advantages of Exploiting the Hierarchical Structure of Astrodynamical Models", Acta Astronautica, Vol. 136, pp. 236–247, 2017 DOI: 10.1016/j.actaastro.2017.02.025

J35 D. Dei–Tos and *F. Topputo*, "Trajectory Refinement of Three-Body Orbits in the Real Solar System Model", Advances in Space Research, Vol. 59, pp. 2117–2132, 2017 DOI: 10.1016/j.asr.2017.01.039

J34 K. Kumar, E. Hekma, A. Agrawal, and *F. Topputo*, "Effect of Perturbations on Debris-to-Debris Orbital Transfers: A Quantitative Analysis", Advances in Space Research, Vol. 59, pp. 1289–1303, 2017 DOI: 10.1016/j.asr.2016.12.015

J33 Z.-F. Luo and *F. Topputo*, "Capability of Satellite-Aided Ballistic Capture", Communications in Nonlinear Science and Numerical Simulation, Vol. 48, pp. 211–223, 2017 DOI: 10.1016/j.cnsns.2016.12.021

J32 K. Oshima, *F. Topputo*, S. Campagnola, and T. Yanao, "Analysis of Medium Energy Transfers to the Moon", Celestial Mechanics and Dynamical Astronomy, Vol. 127, pp. 285–300, 2017 DOI: 10.1007/s10569-016-9727-7

J31 *F. Topputo*, "Fast Numerical Approximation of Invariant Manifolds in the Circular Restricted Three-Body Problem", Communications in Nonlinear Science and Numerical Simulation, Vol. 32, pp. 89–98, 2016 DOI: 10.1016/j.cnsns.2015.08.004

J30 Z.-F. Luo and *F. Topputo*, "Analysis of Ballistic Capture in Sun–Planet Models", Advances in Space Research, Vol. 56, pp. 1030–1041, 2015 DOI: 10.1016/j.asr.2015.05.042

J29 C. Zhang, *F. Topputo*, F. Bernelli–Zazzera, and Y.-S. Zhao, "Low-Thrust Minimum-Fuel Optimization in the Circular Restricted Three-Body Problem", Journal of Guidance Control and Dynamics, Vol. 38, pp. 1501–1510, 2015 DOI: 10.2514/1.G001080

J28 *F. Topputo* and E. Belbruno, "Earth–Mars Transfers with Ballistic Capture", Celestial Mechanics and Dynamical Astronomy, Vol. 121, pp. 329–346, 2015 DOI: 10.1007/s10569-015-9605-8

J27 *F. Topputo*, M. Miani, and F. Bernelli–Zazzera, "Optimal Selection of the Coefficient Matrix in State-Dependent Control Methods", Journal of Guidance Control and Dynamics, Vol. 38, pp. 861–873, 2015 DOI: 10.2514/1.G000136

J26 Z.-F. Luo, *F. Topputo*, F. Bernelli–Zazzera, and G.-J. Tang, "Constructing Ballistic Capture Orbits in the Real Solar System Model", Celestial Mechanics and Dynamical Astronomy, Vol. 120, pp. 433–450, 2014 DOI: 10.1007/s10569-014-9580-5

J25 *F. Topputo* and C. Zhang, "Survey of Direct Transcription for Low-Thrust Space Trajectory Optimization with Applications", Abstract and Applied Analysis, Vol. 2014, pp. 1–15, 2014 DOI: 10.1155/2014/851720

J24 F. Pappalardo, M. Pennisi, A. Ricupito, *F. Topputo*, and M. Bellone, "Induction of T Cell Memory by a Dendritic Cell Vaccine: A Computational Model", Bioinformatics, Vol. 30, pp. 1884–1891, 2014 DOI: 10.1093/bioinformatics/btu059

J23 *F. Topputo* and F. Bernelli–Zazzera, "Approximate Solutions to Nonlinear Optimal Control Problems in Astrodynamics", ISRN Aerospace Engineering, Vol. 2013, pp. 1–7, 2013 DOI: 10.1155/2013/950912

J22 *F. Topputo*, "On Optimal Two-Impulse Earth–Moon Transfers in a Four-Body Model", Celestial Mechanics and Dynamical Astronomy, Vol. 117, pp. 279–313, 2013 DOI: 10.1007/s10569-013-9513-8

J21 N. Hyeraci and *F. Topputo*, "The Role of True Anomaly in Ballistic Capture", Celestial Mechanics and Dynamical Astronomy, Vol. 116, pp. 175–193, 2013 DOI: 10.1007/s10569-013-9481-z

J20 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Transfers to Distant Periodic Orbits around the Moon Via their Invariant Manifolds", Acta Astronautica, Vol. 79, pp. 20–32, 2012 DOI: 10.1016/j.actaastro.2012.04.022

J19 E. Belbruno, M. Gidea, and *F. Topputo*, "Geometry of Weak Stability Boundaries", Qualitative Theory of Dynamical Systems, Vol. 12, pp. 1–14, 2012 DOI: 10.1007/s12346-012-0069-x

J18 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Efficient Invariant-Manifold, Low-Thrust Planar Trajectories to the Moon", Communications in Nonlinear Science and Numerical Simulation, Vol. 17, pp. 817–831, 2012 DOI: 10.1016/j.cnsns.2011.06.033

J17 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Optimal Low-Thrust Invariant Manifold Trajectories Via Attainable Sets", Journal of Guidance Control and Dynamics, Vol. 34, pp. 1644–1655, 2011 DOI: 10.2514/1.52493

J16 A. Minelli, *F. Topputo*, and F. Bernelli–Zazzera,"Controlled Drug Delivery in Cancer Immunotherapy: Stability, Optimization, and Monte Carlo Analysis", SIAM Journal on Applied Mathematics, Vol. 71, pp. 2229–2245, 2011 DOI: 10.1137/100815190

J15 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Earth–Mars Transfers with Ballistic Escape and Low-Thrust Capture", Celestial Mechanics and Dynamical Astronomy, Vol. 110, pp. 169–188, 2011 DOI: 10.1007/s10569-011-9343-5

J14 N. Hyeraci and *F. Topputo*, "Method to Design Ballistic Capture in the Elliptic Restricted Three-Body Problem", Journal of Guidance Control and Dynamics, Vol. 33, pp. 1814–1823, 2010 DOI: 10.2514/1.49263

J13 E. Belbruno, M. Gidea, and *F. Topputo*, "Weak Stability Boundary and Invariant Manifolds", SIAM Journal on Applied Dynamical Systems, Vol. 9, pp. 1061–1089, 2010 DOI: 10.1137/090780638

J12 R. Armellin, P. Di Lizia, *F. Topputo*, M. Lavagna, F. Bernelli–Zazzera, and M. Berz, "Gravity Assist Space Pruning Based on Differential Algebra", Celestial Mechanics and Dynamical Astronomy, Vol. 106, pp. 1–24, 2010 DOI: 10.1007/s10569-009-9235-0

J11 *F. Topputo* and E. Belbruno, "Computation of Weak Stability Boundaries: Sun-Jupiter System", Celestial Mechanics and Dynamical Astronomy, Vol. 105, pp. 3–17, 2009 DOI: 10.1007/s10569-009-9222-5

J10 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Low-Energy, Low-Thrust Transfers to the Moon", Celestial Mechanics and Dynamical Astronomy, Vol. 105, pp. 61–74, 2009 DOI: 10.1007/s10569-009-9220-7

J9 A. Owis, *F. Topputo*, and F. Bernelli–Zazzera, "Radially Accelerated Optimal Feedback Orbits in Central Gravity Field with Linear Drag", Celestial Mechanics and Dynamical Astronomy, Vol. 103, pp. 1–16, 2009 DOI: 10.1007/s10569-008-9161-6

J8 *F. Topputo*, E. Belbruno, and M. Gidea, "Resonant Motion, Ballistic Escape, and their Applications in Astrodynamics", Advances in Space Research, Vol. 42, pp. 6–17, 2008 DOI: 10.1016/j.asr.2008.01.017

J7 *F. Topputo*, A. Owis, and F. Bernelli–Zazzera, "Analytical Solution of Optimal Feedback Control for Radially Accelerated Orbits", Journal of Guidance, Control and Dynamics, Vol. 31, pp. 1352–1359, 2008 DOI: 10.2514/1.33720

J6 E. Belbruno, *F. Topputo*, and M. Gidea, "Resonance Transition Associated to Weak Capture in the Restricted Three-Body Problem", Advances in Space Research, Vol. 42, pp. 18–39, 2008 DOI: 10.1016/j.asr.2008.01.018

J5 *F. Topputo*, A. Owis, and F. Bernelli–Zazzera, "Solution of a Class of Optimal Feedback Control Problems", Automatic Control in Aerospace, Vol. 1, pp. 1–7, 2008 ISSN: 1974-5168

J4 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Combined Optimal Low-Thrust and Stable-Manifold Trajectories to the Earth–Moon Halo Orbits", American Institute of Physics, Vol. 886, pp. 100–112, 2007 DOI: 10.1063/1.2710047

J3 R. Armellin and *F. Topputo*, "A Sixth-Order Accurate Scheme for Solving Two-Point Boundary Value Problems in Astrodynamics", Celestial Mechanics and Dynamical Astronomy, Vol. 96, pp. 289–309, 2006 DOI: 10.1007/s10569-006-9047-4

J2 *F. Topputo*, M. Vasile, and F. Bernelli–Zazzera, "Earth-to-Moon Low Energy Transfers Targeting L_1 Hyperbolic Transit Orbits", Annals of the New York Academy of Sciences, Vol. 1065, pp. 55–76, 2005 DOI: 10.1196/annals.1370.025

J1 *F. Topputo*, M. Vasile, and F. Bernelli–Zazzera, "Low Energy Interplanetary Transfers Exploiting Invariant Manifolds of the Restricted Three-Body Problem", The Journal of the Astronautical Sciences, Vol. 53, pp. 353–372, 2005 ISSN: 0021-9142

12.2 Book chapters

B6 *F. Topputo* and M. Massari, "Modeling and Optimization of Hybrid Transfers to Near-Earth Objects", in Modeling and Optimization with Case Studies, G. Fasano and J. Pintèr Editors, Springer, New York, pp. 425–442, 2017 DOI: 10.1007/978-3-319-41508-6_16

B5 *F. Topputo*, P. Di Lizia, and C. Tardioli, "An Introduction to Optimal Control Problem and Space Trajectory Optimisation with some Applications", in Asteroid and Space Debris Manipulation: Advances from the Stardust Research Network, M. Vasile and E. Minisci Editors, AIAA, pp. 203–245, 2016, DOI: 10.2514/5.9781624103247.0203.0246

B4 M. Gomroki, *F. Topputo*, O. Tekinalp, and F. Bernelli–Zazzera, "Two ASRE Approaches with Application to Spacecraft Coulomb Formations", in Astrodynamics Network AstroNet-II, G. Gómez and J. Masdemont Editors, Springer, New York, pp. 109–120, 2016 DOI: 10.1007/978-3-319-23986-6_8

B3 P. Di Lizia, R. Armellin, *F. Topputo*, F. Bernelli–Zazzera, and M. Berz, "Global Optimization of Interplanetary Transfers with Deep Space Maneuvers using Differential Algebra", in Modeling and Optimization in Space Engineering, G. Fasano and J. Pintèr Editors, Springer, New York, pp. 187–213, 2012 DOI: 10.1007/978-1-4614-4469-5_8

B2 *F. Topputo* and E. Belbruno, "Optimization of Low-Energy Transfers", in Modeling and Optimization in Space Engineering, G. Fasano and J. Pintèr Editors, Springer, New York, pp. 389–404, 2012 DOI: 10.1007/978-1-4614-4469-5_16

B1 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "A Method to Design Efficient Low-Energy, Low-Thrust Transfers to the Moon", in Nonlinear Dynamics of Complex Systems: Applications in Physical, Biological and Financial Systems, T. Machado, D. Baleanu, and A. Luo Editors, Springer, New York, pp. 15–38, 2011 DOI: 10.1007/978-1-4614-0231-2_2

12.3 PhD thesis

T1 *F. Topputo*, "Low-Thrust, Non-Keplerian Orbits: Analysis, Design, and Control", PhD Thesis, Politecnico di Milano, March 2007

12.4 Papers in conference proceedings

C81 R. Furfaro, I. Bloise, M. Orlandelli, P. Di Lizia, *F. Topputo*, and R. Linares, "A Recurrent Deep Architecture for Quasi-Optimal Feedback Guidance in Planetary Landing", IAA SciTech Forum on Space Flight Mechanics and Space Structures and Materials, Moscow, Russia, 13–15 November, 2018

C80 G. Aguiar and *F. Topputo*, "A Technique for Designing Earth-Mars Low-Thrust Transfers Culminating in Ballistic Capture", 7$^{\text{th}}$ International Conference on Astrodynamics Tools and Techniques (ICATT), Oberpfaffenhofen, Germany, 6–9 November 2018

C79 *F. Topputo*, D. Dei Tos, K. Mani, S. Ceccherini, C. Giordano, V. Franzese, and Y. Wang, "Trajectory Design in High-Fidelity Models", 7$^{\text{th}}$ International Conference on Astrodynamics Tools and Techniques (ICATT), Oberpfaffenhofen, Germany, 6–9 November 2018

C78 P. Sundaramoorthy, *F. Topputo*, M. Massari, J. Biggs, P. Di Lizia, D. Dei Tos, K. Mani, S. Ceccherini, V. Franzese, A. Cervone, S. Speretta, S. Mestry, R. Noomen, A. Ivanov, D. Labate, A. Jochemsen, R. Furfaro, V. Reddy, K. Jacquinot, R. Walker, J. Vennekens, A. Cipriano , S. Pepper, M. van de Poel, "System Design of LUMIO: A CubeSat at Earth–Moon L_2 for Observing Lunar Meteoroid Impacts", 69$^{\text{th}}$ International Astronautical Congress (IAC 2018), Paper IAC-18-B4.8.5, Bremen, Germany, 1–5 October 2018

C77 V. Franzese, S. Ceccherini, K. Mani, P. Di Lizia, *F. Topputo*, "Feasibility Assessment of Autonomous Optical Navigation in LUMIO Mission", 69$^{\text{th}}$ International Astronautical Congress (IAC 2018), Paper IAC-18-C1.6.13, Bremen, Germany, 1–5 October 2018

C76 *F. Topputo*, M. Massari, J. Biggs, P. Di Lizia, D. Dei Tos, K. Mani, S. Ceccherini, V. Franzese, A. Cervone, P. Sundaramoorthy, S. Speretta, S. Mestry, R. Noomen, A. Ivanov, D. Labate, A. Jochemsen, R. Furfaro, V. Reddy, K. Jacquinot, R. Walker, J. Vennekens, A. Cipriano, D. Koschny, "LUMIO: Charazterizing Lunar Meteoroid Impacts with a CubeSat", 69$^{\text{th}}$ International Astronautical Congress (IAC 2018), Paper IAC-18-A3.2A.7, Bremen, Germany, 1–5 October 2018

C75 D. Dei Tos, *F. Topputo*, M. Massari, J. Biggs, A. Cipriano, "On the Sophisticated Orbit Design of the Lunar Meteoroid Impacts Observer CubeSat", 69$^{\text{th}}$ International Astronautical Congress (IAC 2018), Paper IAC-18-C1.8.11, Bremen, Germany, 1–5 October 2018

C74 K. Mani, *F. Topputo*, and A. Cervone, "Chemical Propulsion System Design for 16U Interplanetary CubeSat', 69$^{\text{th}}$ International Astronautical Congress (IAC 2018), Paper IAC-18-C4.6.2, Bremen, Germany, 1–5 October 2018

C73 R. Furfaro, I. Bloise, M. Orlandelli, R. Linares, *F. Topputo*, and P. Di Lizia, "Deep Learning for Autonomous Lunar Landing", 2018 AAS/AIAA Astrodynamics Specialist Conference, Paper AAS 18-363, Snowbird, Utah, USA, 19–23 August 2018

C72 S. Speretta, A. Cervone, P. Sundaramoorthy, R. Noomen, S. Mestry, A. Cipriano, *F. Topputo*, J. Biggs, P. Di Lizia, M. Massari, K. Mani, D. Dei–Tos, S. Ceccherini, V. Franzese, A. Ivanov, D. Labate, L. Tommasi, A. Jochemsen, J. Gailis, R. Furfaro, V. Reddy, J. Vennekens, and R. Walker, "LUMIO: Achieving Autonomous Operations for Lunar Exploration with a CubeSat", SpaceOps 2018 Conference and Exhibition, Marseille, France, 28 May-1 June 2018

C71 *F. Topputo*, M. Massari, J. Biggs, P. Di Lizia, D. Dei–Tos, K. Mani, S. Ceccherini, V. Franzese, A. Cervone, P. Sundaramoorthy, S. Speretta, S. Mestry, R. Noomen, A. Ivanov, D. Labate, A. Jochemsen, R. Furfaro, V. Reddy, K. Jacquinot, R. Walker, J. Vennekens, and A. Cipriano, "LUMIO: A CubeSat at Earth–Moon L2, 4S Symposium, Sorento, Italy, 28 May-1 June 2018

C70 K. Mani, *F. Topputo*, and A. Cervone, "Dual Chemical-Electric Propulsion Systems Design for Interplanetary CubeSats", Space Propulsion Conference 2018, Seville, Spain, 14–18 May 2018

C69 V. Franzese, P. Di Lizia, and *F. Topputo*, "Autonomous Optical Navigation for LUMIO Mission", AIAA SciTech Forum, Kissimmee, Florida, January 8-12, 2018

C68 *F. Topputo*, D. Dei–Tos, M. Rasotto, and F. Renk, "Design and Feasibility Assessment of Ultra Low Thrust Trajectories to the Sun–Earth Saddle Point", AIAA SciTech Forum, Kissimmee, Florida, January 8-12, 2018

C67 K. Drozd, R. Furfaro, and *F. Topputo*, "Application of ZEM/ZEV Guidance for Closed-Loop Transfer in the Earth-Moon System", AIAA SciTech Forum, Kissimmee, Florida, January 8-12, 2018

C66 S. Ceccherini and *F. Topputo*, "System-Trajectory Optimization of Hybrid Transfers to the Geostationary Orbit", AIAA SciTech Forum, Kissimmee, Florida, January 8-12, 2018

C65 R. Furfaro, G. Lanave, *F. Topputo*, M. Lovera, and R. Linares, "Waypoint-Based ZEM/ZEV Feedback Guidance: Applications to Low-Thrust Interplanetary Transfer and Orbit Raising", Advances in the Astronautical Sciences, Vol. 162, pp. 333–348, 2017

C64 R. Furfaro, R. Ruggiero, *F. Topputo*, M. Lovera, and R. Linares, "Waypoint-Optimized Closed-Loop Guidance for Spacecraft Rendezvous in Relative Motion", Advances in the Astronautical Sciences, Vol. 162, pp. 2651–2666, 2017

C63 J.-L. Gonzalo, C. Bombardelli, and *F. Topputo*, "Unified Formulation for Element-Based Indirect Trajectory Optimization", 26th International Symposium on Space Flight Dynamics, Matsuyama, Japan, 3–9 June 2017

C62 J.-L. Gonzalo, *F. Topputo*, and R. Armellin, "Indirect Optimization of End-of-Life Disposal for Galileo Constellation Using Low Thrust Propulsion", 26th International Symposium on Space Flight Dynamics, Matsuyama, Japan, 3–9 June 2017

C61 *F. Topputo*, D. Dei–Tos, M. Rasotto, and F. Renk, "Design and Validation of Ultra Low Thrust Transfers to the Sun–Earth Saddle Point with Application to LISA PathFinder Mission Extension", 26th International Symposium on Space Flight Dynamics, Matsuyama, Japan, 3–9 June 2017

C60 D. Dei–Tos, R. Russel, and *F. Topputo*, "Survey of Mars ballistic Capture Trajectories Using Periodic Orbits", Advances in the Astronautical Sciences, Vol. 160, pp. 1625–1644, 2017

C59 K. Oshima, *F. Topputo*, and T. Yanao, "Global Search for Low-Energy Transfers to the Moon with Long Transfer Time", Advances in the Astronautical Sciences, Vol. 160, pp. 577–594, 2017

C58 K. Oshima, *F. Topputo*, and T. Yanao, "Pareto-Optimal, Low-Energy Transfers to the Moon Using Impulsive Delta-V", 26th Workshop on JAXA Astrodynamics and Flight Mechanics, Kamakura, Japan, 25-26 July 2016

C57 A. Zuanetti, *F. Topputo*, and M. Massari, "Integrated Monitoring of Refugees in the Mediterranean Sea with Small Satellite Constellations", 67th International Astronautical Congress (IAC 2016), Vol. 7, pp. 4486–4494, 2016

C56 R. Furfaro, *F. Topputo*, J. Mueting, S. Casotto, and J. Simo, "Analysis and Performance Evaluation of the ZEM/ZEV Guidance and its Sliding Robustification for Autonomous Rendezvous in Relative Motion", 67th International Astronautical Congress (IAC 2016), Vol. 8, pp. 5094–5102, 2016

C55 S. Ceccherini, L. Ferella, and *F. Topputo*, "Assessment of Hybrid Propulsion for Geostationary Transfer Orbit: A Mission Design Approach", 67th International Astronautical Congress (IAC 2016), Vol. 8, pp. 5190–5204, 2016

C54 M. Gianinetto, M. Aiello, A. Marchesi, *F. Topputo*, M. Massari, R. Lombardi, F. Banda, and S. Tebaldini, "OBIA Ship Detection with Multispectral and SAR Images: A Simulation for Copernicus Security Applications", Geoscience and Remote Sensing Symposium (IGARSS), 2016 IEEE International, pp. 1229–1232, 2016

C53 *F. Topputo*, D. Dei–Tos, D. Filippetto, M. Massari, P. Di Lizia, J.-L. Gonzalo, H. Urrutxua, C. Bombardelli, A. Colagrossi, V. Pesce, D. Pastor-Moreno, A. Rivolta, and A. Rocchi, "GTOC8: Results and Methods of Polimi-UPM", Advances in the Astronautical Sciences, Vol. 158, pp. 4301–4308, 2016

C52 K. Kumar, *F. Topputo*, A. Agrawal, and E. Hekma, "Initial Results for Preliminary Trajectory Design of Multi-Target Active Debris Removal Mission using the Atom Solver", Advances in the Astronautical Sciences, Vol. 158, pp. 1677–1694, 2016

C51 J. Mueting, R. Furfaro, *F. Topputo*, and J. Simo, "Optimal Sliding Guidance for Earth–Moon Halo Orbit Station-Keeping Transfer and Rendezvous", Advances in the Astronautical Sciences, Vol. 158, pp. 971–987, 2016

C50 K. Oshima, *F. Topputo*, S. Campagnola, and T. Yanao, "Medium-Energy, Retrograde, Ballistic Transfer to the Moon", Advances in the Astronautical Sciences, Vol. 158, pp. 745–763, 2016

C49 *F. Topputo*, M. Massari, R. Lombardi, M. Gianinetto, A. Marchesi, M. Aiello, S. Tebaldini, and F. Banda, "Space Shepherd: Using Space Assets to Monitor, Track, and Search-and-Rescue Illegal Immigrants in the Mediterranean Sea", 66th International Astronautical Congress (IAC 2015), Vol. 14, pp. 11422–11431, 2015

C48 K. Kumar, M. Jankovic, N. Ortiz–Gomez, J. Romero–Martin, *F. Topputo*, S. Walker, F. Kirchner, and M. Vasile, "Agora: Mission to demonstrate technologies to actively remove Ariane rocket bodies", 66th International Astronautical Congress (IAC 2015), Vol. 3, pp. 2280–2295, 2015

C47 D. Dei–Tos and *F. Topputo*, "On the advantages of using a strict hierarchy to model astrodynamical problems", 66th International Astronautical Congress (IAC 2015), Vol. 7, pp. 5479–5490, 2015

C46 M. Jankovic, K. Kumar, N. Ortiz–Gomez, J. Romero–Martin, F. Kirchner, *F. Topputo*, S. Walker, and M. Vasile, "Robotic Systems for Active Debris Removal: Equipments, State-of-the-Art, and Concept Architecture of the Rendez Vous and Capture (RVC) Control System", 5th CEAS Air & Space Conference, Delft, The Netherlands, 7–11 September 2015

C45 *F. Topputo*, M. Massari, R. Lombardi, M. Gianinetto, A. Marchesi, M. Aiello, S. Tebaldini, and F. Banda, "Space Shepherd: Search and Rescue of Illegal Immigrants in the Mediterranean Sea through Satellite Imagery", Geoscience and Remote Sensing Symposium (IGARSS), 2015 IEEE International, pp. 4852–4855, 2015

C44 *F. Topputo*, "Advances in Ballistic Capture Orbits Computation with Applications", Advances in the Astronautical Sciences, Vol. 155, pp. 3087–3098, 2015

C43 H. Zhang, *F. Topputo*, R. Zhang, C. Zhang, and C. Han, "A Modified UPE Method to Design Two-Impulse Earth-Moon Transfers in a Four-Body Model", Advances in the Astronautical Sciences, Vol. 155, pp. 2377–2392, 2015

C42 C. Zhang and *F. Topputo*, "Earth-to-Halo Low-Thrust Minimum Fuel Optimization with Optimized Launch Conditions", Advances in the Astronautical Sciences, Vol. 155, pp. 1271–1286, 2015

C41 *F. Topputo* and R.-Y. Zhang, "Approximation of Invariant Manifolds by Cubic Convolution Interpolation", Advances in the Astronautical Sciences, Vol. 155, pp. 283–292, 2015

C40 E. Belbruno and *F. Topputo*, "Ballistic Capture Transfers from the Earth to Mars", Advances in the Astronautical Sciences, Vol. 155, pp. 293–310, 2015

C39 D. Dei–Tos and *F. Topputo*, "Automated Trajectory Refinement of Three-Body Orbits in the Real Solar System Model", Advances in the Astronautical Sciences, Vol. 155, pp. 263–282, 2015

C38 Z.-F. Luo, *F. Topputo*, F. Bernelli–Zazzera, and G.-J. Tang, "The Role of Dynamical Models in Ballistic Capture: The Perturbed Sun-Planet Case", Advances in the Astronautical Sciences, Vol. 153, pp. 1–21, 2015

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C36 J. Dinius, R. Furfaro, *F. Topputo*, and S. Selnick, "Near Optimal Feedback Guidance Design and the Planar Restricted Three-Body Problem", Advances in the Astronautical Sciences, Vol. 152, pp. 575–584, 2014

C35 *F. Topputo*, "Trade-Off between Cost and Time in Lunar Transfers: A Quantitative Analysis", Advances in the Astronautical Sciences, Vol. 152, pp. 3705–3719, 2014

C34 G. Pinzan, *F. Topputo*, and F. Bernelli–Zazzera, "A Multidisciplinary Approach to Landing Site Selection for Small Body Missions", 64^{th} International Astronautical Congress (IAC 2013), Vol. 2, pp. 1511–1533, 2013

C33 C. Zhang, *F. Topputo*, F. Bernelli–Zazzera, and Y.S. Zhao, "An Exploration of Numerical Methods for Low-Thrust Trajectory Optimization in n-Body Models", 64^{th} International Astronautical Congress (IAC 2013), Vol. 7, pp. 4971–4977, 2013

C32 *F. Topputo*, R. Zhang, F. Bernelli–Zazzera, and J. Luo, "Numerical Approximation of Invariant Manifolds in the Restricted Three-Body Problem", 64^{th} International Astronautical Congress (IAC 2013), Vol. 7, pp. 5635–5640, 2013

C31 G. Mingotti, *F. Topputo*, and M. Massari, "Hybrid Propulsion Transfers for Mars Science Missions Advances", Advances in the Astronautical Sciences, Vol. 148, pp. 2859–2874, 2013

C30 M. Massari, *F. Topputo*, and G. Mingotti, "Alternative Hybrid Propulsion Transfers for MarcoPolo NEO Sample Return Mission", Advances in the Astronautical Sciences, Vol. 148, No. 4, pp. 3353–3367, 2013

C29 *F. Topputo*, G. Mingotti, and F. Bernelli–Zazzera, "Enhancing Planetary Exploration by Using Hybrid Propulsion Transfers", 63rd International Astronautical Congress (IAC 2012), Vol. 7, pp. 5483–5491, 2012

C28 K. Post, E. Belbruno, and *F. Topputo*, "Efficient Cis-Lunar Trajectories", Global Space Exploration Conference, Washington, DC, USA, 22–24 May 2012

C27 *F. Topputo* and F. Bernelli–Zazzera, "A Method to Solve Nonlinear Optimal Control Problems in Astrodynamics", 1st IAA Conference on Dynamics and Control of Space Systems, Porto, Portugal, 19–21 March 2012

C26 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Hybrid Propulsion Transfers to the Moon", 1st IAA Conference on Dynamics and Control of Space Systems, Porto, Portugal, 19–21 March 2012

C25 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Attainable Sets in Space Mission Design: A Method to Define Low-Thrust, Invariant Manifold Trajectories", Advances in the Astronautical Sciences, Vol. 143, pp. 1–16, 2012

C24 *F. Topputo* and F. Bernelli–Zazzera, "Optimal Low-Thrust Station Keeping of Geostationary Satellites", Proceedings of the 3rd CEAS Air&Space Conference, pp. 1917-1925, 2011

C23 *F. Topputo*, F. Bernelli–Zazzera, A. Ercoli–Finzi, and F. Lazzari, "Solar Array Simulators for Low Power Space Missions", Proceedings of the 3rd CEAS Air&Space Conference, pp. 243–250, 2011

C22 *F. Topputo*, F. Bernelli–Zazzera, and A. Ercoli-Finzi, "Power Production for Small Body Landers: Post Launch Activities On Philae Power Subsystem", 62nd International Astronautical Congress, Vol. 2, pp. 1333–1340, 2011

C21 *F. Topputo* and A. Ercoli-Finzi, "Optimal Bi-Impulsive Earth-Moon Transfers", 62nd International Astronautical Congress, Vol. 6, pp. 4621–4629, 2011

C20 N. Hyeraci and *F. Topputo*, "Ballistic Capture in the Elliptic Restricted Three-Body Problem with Applications", New Trends in Astrodynamics and Applications VI, New York City, USA, 6–8 June 2011

C19 G. Mingotti and *F. Topputo*, "Ways to the Moon: A Survey", Advances in the Astronautical Sciences, Vol. 140, pp. 2531–2548, 2011

C18 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Invariant-Manifold, Low-Thrust Transfers to Low Mars Orbits", 61st International Astronautical Congress, Vol. 13, pp. 10784–10796, 2010

C17 *F. Topputo*, F. Bernelli–Zazzera, and A. Ercoli-Finzi, "On-Comet Power Production: the Case of Rosetta Lander Philae", Proceedings of the European Planetary Science Congress 2010, Rome, Italy, 19–24 September 2010

C16 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Efficient Invariant-Manifold, Low-Thrust Planar Trajectories to the Moon", 3rd Conference on Nonlinear Science and Complexity, Ankara, Turkey, 28–31 July 2010

C15 R. Armellin, P. Di Lizia, M. Lavagna, M. Massari, *F. Topputo*, N. Felipe, and G. Ortega, "Tools for Trajectory Statistical Analysis", 4th International Conference on Astrodynamics Tools and Techniques, Madrid, Spain, 3–6 May 2010

C14 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Exploiting Distant Periodic Orbits and Their Invariant Manifolds to Design Novel Space Trajectories to the Moon", Advances in the Astronautical Sciences, Vol. 136, pp. 265–284, 2010

C13 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Dynamical Systems, Optimal Control and Space Trajectory Design", CelMec V: A Meeting on Celestial Mechanics, Viterbo, Italy, 6–12 September 2009

C12 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Numerical Methods to Design Low-Energy, Low-Thrust Sun-Perturbed Transfers to the Moon", 49^{th} Israel Annual Conference on Aerospace Sciences, Tel Aviv/Haifa, Israel, 4–5 March 2009

C11 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "A Hybrid Propulsion Approach to Design Earth-to-Moon Transfers with Ballistic Capture", New Trends in Astrodynamics and Applications V, Milano, Italy, 30 June–2 July 2008

C10 *F. Topputo*, E. Belbruno, and M. Gidea, "Resonance and Escape Dynamics Associated with Weak Capture in the Restricted Three-Body Problem", New Trends in Astrodynamics and Applications IV, Princeton University, Princeton, NJ, USA, 27–29 June 2007

C9 A. Owis, *F. Topputo*, and F. Bernelli–Zazzera, "Feedback Optimal Control in Low-Thrust Interplanetary Trajectory Design", 12^{th} International Conference on Aerospace Science and Aviation Technology, Cairo, Egypt, 29–31 May 2007

C8 A. Owis, *F. Topputo*, and F. Bernelli–Zazzera, "Feedback Optimal Control in Low-Thrust Interplanetary Trajectory Design with Drag", 38^{th} Annual AAS Meeting of the Division on Dynamical Astronomy, Ann Arbor, MI, USA, 6–10 May 2007

C7 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Optimal Low-Thrust, Stable Manifolds Trajectories to the Earth–Moon Halo Orbits", New Trends in Astrodynamics and Applications III, Princeton University, Princeton, NJ, USA, 16–18 August 2006

C6 R. Armellin and *F. Topputo*, "An Optimal $h6$ Scheme for Solving TPBVP in Astrodynamics", Celmec IV, A Meeting on Celestial Mechanics, Viterbo, Italy, 11–16 September 2005

C5 *F. Topputo*, M. Vasile, and F. Bernelli–Zazzera, "Earth-to-Moon Low Energy Transfers Targeting L_1 Hyperbolic Transit Orbits", New Trends in Astrodynamics and Applications II, Princeton University, Princeton, NJ, USA, 3–5 June 2005

C4 *F. Topputo*, M. Vasile, and F. Bernelli Zazzera, "Interplanetary and Lunar Transfers Using Libration Points", Proceeding of the 18^{th} International Symposium on Space Flight Dynamics, pp. 583–588, 2004

C3 *F. Topputo*, M. Vasile, and A. Ercoli-Finzi, "Combining Two and Three-Body Dynamics for Low Energy Transfer Trajectories of Practical Interest", 55^{th} International Astronautical Congress, Vol. 1, pp. 584–596, 2004

C2 *F. Topputo*, M. Vasile, and F. Bernelli–Zazzera, "A Hybrid Optimization of the Low Energy Interplanetary Transfers associated to the Invariant Manifolds of the Restricted Three-Body Problem", 55^{th} International Astronautical Congress, Vol. 1, pp. 524–535

C1 *F. Topputo*, M. Vasile, and A. Ercoli-Finzi, "An Approach to the Design of Low Energy Interplanetary Transfers Exploiting Invariant Manifolds of the Restricted Three-Body Problem", Advances in the Astronautical Sciences, Vol. 119, pp. 2229–2248, 2004

12.5 Scientific reports

R12 S. Ceccherini and *F. Topputo*, "Methodology for System-Trajectory Optimization of Hybrid Transfers to the Geostationary Orbit", Space SHIP Final Report, Regione Lombardia Grant 5744-2015, January 2018

R11 *F. Topputo*, M. Massari, J. Biggs, D. Dei–Tos, S. Ceccherini, K. Mani, V. Franzese, A. Cervone, P. Sundaramoorthy, S. Mestry, S. Speretta, A. Cipriano, A. Ivanov, D. Labate, A. Jochemsen, Q. Leroy, R. Furfaro, K. Jacquinot, "LUMIO: Lunar Meteoroid Impacts Observer", Final Report, ESA/ESTEC Contract No. 4000120225/17/NL/GLC/as, November 2017

R10 *F. Topputo*, D. Dei–Tos, and M. Rasotto, "Feasibility of Ultra Low Thrust Transfers in L_1/L_2 Sun–Earth–Moon Systems", Final Report, ESA/ESOC Contract No. 4000118201/16/F/MOS, August 2017

R9 *F. Topputo*, M. Massari, R. Lombardi, M. Gianinetto, A. Marchesi, M. Aiello, S. Tebaldini, and F. Banda, "Space Shepherd: Using Space Systems to Save Human Lives", Politecnico di Milano, Department of Aerospace Science and Technology, Scientific Report DSTA-SR 16-01, January 2016

R8 C. Zhang and *F. Topputo*, "Space Trajectory Optimization via Direct Transcription and Collocation: A Note for Practical Implementation", Department of Aerospace Science and Technology, Politecnico di Milano, Report DSTA-SR 13-02, September 2013

R7 *F. Topputo*, R. Long, G. Mingotti, and M. Massari, "Hybrid Propulsion Transfer Strategies", Final Report, ESA/ESTEC Contract No. 105465/12/NL/AF, April 2013

R6 *F. Topputo* and P. Di Lizia, "Predictive Control of Industrial Plants", Final Report, Sanofi-Aventis Contract ET.SER 127/09MP, October 2011

R5 *F. Topputo*, "Remote Monitoring of Migrants Vessels in the Mediterranean Sea", Final Report, Ce.Mi.S.S. (Ministry of Defence) Contract, December 2009

R4 F. Bernelli–Zazzera, M. Lavagna, R. Armellin, P. Di Lizia, *F. Topputo*, M. Berz, K. Makino, and R. Jagasia, "Orbital Prediction via Differential Algebra and Taylor Models", Final Report, ESA/ESTEC Contract No. 20271/06/NL/HI, March 2009

R3 F. Bernelli–Zazzera, M. Berz, M. Lavagna, R. Armellin, P. Di Lizia, and *F. Topputo*, "Global Trajectory Optimization: Can we Prune the Solution space when Considering Deep Space Maneuvers?", Final Report, ESA/ESTEC Contract No. 20271/06/NL/HI, December 2007

R2 R. Armellin, F. Bernelli–Zazzera, A. Brambilla, A. Davighi, P. Di Lizia, A. Ercoli–Finzi, G. Giardini, M. Grasso, M. Lavagna, M. Massari, G. Sangiovanni, *F. Topputo*, "Nuclear Multimodule ISRU Mission, Lunar Exploration Architecture", Final Report, Alcatel–Alenia Space Contract, May 2006

R1 F. Bernelli–Zazzera, *F. Topputo*, and M. Massari, "Assessment of Mission Design Including Utilization of Libration Points and Weak Stability Boundaries", Final Report, ESA/ESTEC Contract No. 18147/04/NL/MV, June 2004

12.6 Articles in national journals

NJ4 G. Infantolino, P. Di Lizia, *F. Topputo*, and F. Bernelli–Zazzera, "On-Board Telemetry Monitoring via Support Vector Machine with Application to Philae Solar Generator", Aerotecnica Missili *&* Spazio, in press

NJ3 *F. Topputo*, G. Caputo, and F. Bernelli–Zazzera, and G.-J. Tang, "Philae Attitude Determination through Nonlinear Optimal Identification of Solar Arrays Telemetry", Aerotecnica Missili & Spazio, Vol. 93, pp. 68–74, 2014

NJ2 *F. Topputo* and F. Bernelli–Zazzera, "Simulation of Low-Intensity, Low-Temperature Solar Arrays with Software and Hardware Tools", Aerotecnica Missili & Spazio, Vol. 92, pp. 94–100, 2013

NJ1 *F. Topputo*, A. Owis, and F. Bernelli–Zazzera, "Analytical Solution of the Feedback Optimal Control in Low-Thrust Transfers", Aerotecnica, Missili e Spazio, Vol. 86, pp. 185–194, 2007

12.7 Papers in national conference proceedings

NC12 G. Infantolino, P. Di Lizia, *F. Topputo*, and F. Bernelli–Zazzera, "On-Board Telemetry Monitoring via Support Vector Machine with Application to Philae Solar Generator", 24$^{\text{th}}$ Conference of the Italian Association of Aeronautics and Astronautics (AIDAA 2017), Palermo–Enna, Italy, 18–22 September 2017

NC11 V. Franzese, K. Mani, and *F. Topputo*, "Autonomous Optical Navigation for Interplanetary CubeSats", 24$^{\text{th}}$ Conference of the Italian Association of Aeronautics and Astronautics (AIDAA 2017), Palermo–Enna, Italy, 18–22 September 2017

NC10 R. Lombardi, M. Massari, and *F. Topputo*, "Scheduling Satellite Observations to Monitor Illegal Immigration in the Mediterranean Sea", 23$^{\text{rd}}$ Conference of the Italian Association of Aeronautics and Astronautics, Torino, Italy, 17–19 November 2015

NC9 Z.-F. Luo, *F. Topputo*, F. Bernelli–Zazzera, and G.-J. Tang, "Analysis of Ballistic Capture Orbits in the Real n-Body Problem", AIDAA XXII Conference, Napoli, Italy, 9–12 September 2013

NC8 G. Caputo, *F. Topputo*, and F. Bernelli–Zazzera, "On-Comet Attitude Reconstruction of Rosetta Lander Philae through Solar Arrays Telemetry", AIDAA XXII Conference, Napoli, Italy, 9–12 September 2013

NC7 *F. Topputo* and F. Bernelli–Zazzera, "Simulation of Low-Intensity, Low-Temperature Solar Arrays with Software and Hardware Tools", AIDAA XXII Conference, Napoli, Italy, 9–12 September 2013

NC6 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "Low-Thrust and Invariant-Manifold Trajectories to the Earth–Moon Halo Orbits", XX Congresso Nazionale AIDAA, Milano, Italy, 29 June–3 July 2009

NC5 S. Brambillasca, *F. Topputo*, A. Ercoli-Finzi, and R. Campesato, "LILT Measurements on Silicon Solar Cells of Rosetta Lander Philae", XX Congresso Nazionale AIDAA, Milano, Italy, 29 June–3 July 2009

NC4 M. Massari, R. Armellin, P. Di Lizia, and *F. Topputo*, "Reaching NEOs: Solution for the Second Global Trajectory Optimization Competition", XIX Congresso Nazionale AIDAA, Forlì, Italy, 17–21 September 2007

NC3 G. Mingotti, *F. Topputo*, and F. Bernelli–Zazzera, "A Method to Design Sun-Perturbed Earth-to-Moon Low-Thurst Transfxers with Ballistic Capture", XIX Congresso Nazionale AIDAA, Forlì, Italy, 17–21 September 2007

NC2 *F. Topputo*, A. Owis, and F. Bernelli–Zazzera, "Analytical Solution of the Feedback Optimal Control in Low-Thrust Transfers", XIX Congresso Nazionale AIDAA, Forlì, Italy, 17–21 September 2007

NC1 F. Cremaschi, *F. Topputo*, G. Sangiovanni, and M. Vasile, "Low-Thrust Interplanetary Transfers through Invariant Manifolds and an Evolutionary Neurocontrol", XVIII Congresso Nazionale AIDAA, Volterra, Italy, 19–22 September 2005

13 Invited talks, seminars, and lectures

13.1 Plenary talks

He has been invited to international conferences to give the plenary talks listed below.

2018 Plenary talk on "LUMIO: A CubeSat at Earth–Moon L_2", 4S Symposium, Sorrento, Italy, 29 May 2018 [Invited by Prof. Paolo Tortora, member of the organizing committee]

2016 Plenary talk on "Engineering Solutions in Stardust" given at the Global Networking Forum event on "Stardust: A Fresh Look at Planetary Defense and Space Debris Removal", held at the 67$^{\text{th}}$ International Astronautical Congress, Guadalajara, Mexico, 30 September 2016 [Invited by Prof. Massimiliano Vasile, organizer of the event]

2014 Plenary talk on "Recent Advances in Ballistic Capture", Brazilian Colloquium on Orbital Dynamics, Aguas de Lindoia, Brazil, 3 December 2014 [Invited by Dr. Elbert Macau, member of the organizing committee]

13.2 Invited talks

He has been invited to international conferences to give the talks listed below.

2018 Invited talk on "Orbit Design of LUMIO, A Lunar Meteoroid Impacts Observer", Panel on Satellite Dynamics (PSD.1), COSPAR Scientific Assembly 2018, Pasadena, CA, USA, 14–22 July 2018 [Invited by Dr. Heike Peter and Dr. Jose Van Den IJssel, organizer of the PSD.1]

2016 Invited talk on "Space Shepherd: Monitoring Refugees in the Mediterranean Sea", SpaceUp Milan, Milano, 6 November 2016 [Invited by Dr. Elena Carpanelli, member of the organizing committee]

2015 Invited talk on "Space Shepherd: Monitoring Immigration in the Mediterranean Sea through Satellite Imageries" given at the European Aerospace Students Meeting for Experimental Rocketry, Milan, Italy, 23 October 2015 [Invited by Ruben Di Battista, member of the organizing committee]

2015 Invited talk on "Computation of Ballistic Capture Orbits and Applications", Astronet–II International Final Conference, Tossa de Mar, Spain, 16 June 2015 [Invited by Prof. Franco Bernelli, co-organizer of the conference]

2009 Invited talk on "Dynamical Systems, Optimal Control, and Space Trajectory Design", CelMec V: An International Meeting on Celestial Mechanics, Viterbo, Italy, 8 September 2009 [Invited by Prof. Alessandra Celletti, member of the organizing committee]

13.3 Seminars

He has been invited to give the seminars listed below.

2017 Invited seminar on "Ballistic Capture and Application", Tsinghua University, Beijing, 2 November 2017 [Invited by Prof. Hexi Baoyin, organizer of the seminar]

2017 Invited seminar on "LUMIO: Lunar Meteoroid Impacts Observer", given during a short course on Space Mission Analysis held at Dong Fang Hong Satellite Co., Ltd., Beijing, Beijing, 31 October 2017 [Invited by Dr. Hao Huang, organizer of the course]

2015 Invited seminar on "Ballistic Capture of Asteroids in Earth Orbit", Stardust 3$^{\text{rd}}$ Training School on Science and Technology Challenges of Space Debris Removal and Asteroid Deflection, Universidad Internacional Menéndez Pelayo, Santander, Spain, 10 July 2015 [Invited by Dr. Claudio Bombardelli,

organizer of the school]

2015 Invited seminar on "Ballistic Capture Dynamics and Applications", Augsburger Mathematisches Kolloquium, Institut für Mathematik, Universität Augsburg, Augsburg, Germany, 21 April 2015 [Invited by Prof. Urs Frauenfelder]

2014 Invited seminar on "Past and Current Research Activities", Astrodynamics Workshop, IEEC, Barcelona, Spain, 4 February 2014 [Invited by Prof. Gerard Gómez]

2013 Invited seminar on "Overview of Optimal Control Methods with Applications", Stardust Opening Training School, University of Strathclyde, Glasgow, UK, 21 November 2013 [Invited by Prof. Massimiliano Vasile, co-organizer of the school]

2010 Invited seminar on "Optimal Control Problems and Local Optimization", Cairo University, Cairo, Egypt, 17 June 2010 [Invited by Dr. Ashraf Owis]

2007 Invited seminar on "The Restricted Three-Body Problem in Space Missions", Seminari di Cultura Matematica, Department of Mathematics, Politecnico di Milano, Milan, Italy, 18 April 2007 [Invited by Prof. Giulio Magli]

13.4 Lectures

He has been invited to give the lectures listed below.

2017, 18 Invited guest lecture on "Advanced Three-Body Dynamics" within the MSc class Astrodynamics-II, TU Delft, Aerospace Engineering Faculty, 9 March 2017 and 19 March 2018 [Invited by Dr. Eelco Doornbos, instructor of the class]

2018 Invited guest lecture on "Orbit Design of LUMIO, a Lunar Meteoroid Impact Observer", MSc class on Spacecraft Orbital Dynamics and Control, University of Bologna, Forlì, 6 June 2018 [Invited by Dr. Marco Zannoni, instructor of the class]

2017 Invited lectures on "Launch dynamics and launch windows", "Low-thrust trajectories", and "n-body dynamics", Training course for HIWING Technology Academy, Politecnico di Milano, Milano, Italy, 20 November–1 December 2017 [Invited by Prof. Franco Bernelli, organizer of the course]

2008 Invited lecture on "Low Energy Interplanetary Transfers Combining Dynamical Systems and Optimal Control", Roundtable AMEBA: Advanced Mathematical Efficiency in Biology and Astrodynamics, Science and Technology Department, French Embassy, London, 1 December 2008 [Invited by Dr. Alexei Tsygvintsev, organizer of the event]

2007 Lecture on "n-Body Dynamics with Applications to the Design of Low Energy Transfers", Introductory Course on Astrodynamics, Thales–Alenia Space, Turin, Italy, 22 February 2007 [Invited by Dr. Giorgio Fasano, organizer of the course]

14 Media mentions, Outreach

14.1 Media mentions

2016 Featured interview on the Space Shepherd project within the show "Tutta colpa di Galileo" broadcasted on Italia 1; Link to the interview. The show is also on Netflix (E3S2).

2016 Featured interview on the Space Shepherd project for the radio show "Si può fare" on Radio 24 (moderators: Alessio Maurizi, Carlo Gabardini); Link to the interview (min 26–40).

2016 Interviewed by the newspapers La Repubblica, Il Corriere, and Il Sole 24 Ore on the monitoring of refugees in the Mediterranean Sea; Link 1, Link 2, Link 3

2016 Interviewed as "Expert of the week" on the monitoring of refugees via satellite imageries, Politecnico di Milano; Link

2015 Interviewed by La Stampa on the cost and time frame for the first human mission to Mars; Link

2015 Interviewed as "Expert of the week" on the European mini-shuttle, Politecnico di Milano; Link 1, Link2

2015 Interviewed by ilsussidiario.net on new ways to reach Mars exploiting ballistic capture; Link

2014 Interviewed by Scientific American for the story "A New Way to Reach Mars Safely, Anytime and on the Cheap"; Link. Italian translation on Le Scienze; Link

14.2 Outreach

2015 Invited guest at "Festival della Scienza" (Genova) for the talk "Marte, l'ultima frontiera" (moderator: Fabio Pagan); Link

2015 Invited guest at "Meet Me Tonight" with a talk on "Biglietto di sola andata per Marte", Civico Planetario di Milano Ulrico Hoepli; Link

2015 Invited talk at Museo Nazionale di Scienza e Tecnologia Leonardo Da Vinci on "La sonda Rosetta, primi risultati scientifici" (moderator: Luca Reduzzi); Link

2015 Invited guest at "Wired Next Fest" with a talk on "Vado a vivere su Marte" (moderator: Andrea Gentile); Link

2014 Invited guest at "Open Night: Notte Europea dei Ricercatori" with a talk on "Il futuro dello spazio tra scienza e fantascienza" at Museo Nazionale di Scienza e Tecnologia Leonardo Da Vinci (moderator: Silvia Rosa Brusin); Link

2012 Teacher of the class "Learning Week: Esplorare l'universo" organized by Fondazione Clerici and funded by Regione Lombardia

2011 Has edited the entry "Space Manifold Dynamics" on scholarpedia.org

2010 Teacher of the class "Learning Week: Esplorare l'universo" organized by Fondazione Clerici and funded by Regione Lombardia

2006–12 Has created from scratch and has been responsible of the website astrodynamics.eu

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