



AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2016

Turno de acceso general

Nombre: PETRAKOPOULOU , FONTINA (FOTEINI KONSTANT

Referencia: RYC-2016-20971

Área Científica: Ingeniería Mecánica, Naval y Aeronáutica

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Título:

Analysis and optimization of energy conversion systems

Resumen de la Memoria:

I received my undergraduate degree in Mechanical Engineering from the Technical University of Crete (2005) and my Ph.D. in Energy Engineering from the Technical University of Berlin (2010). For my dissertation I worked on a novel multi-criteria comparative evaluation of zero-emission natural gas plants using exergy-based methods. This work helped to significantly advance our knowledge on CO₂ capture technologies, the structural requirements for their incorporation in existing and future power plants and their thermodynamic, economic and environmental strengths and weaknesses. I realized my dissertation within a Marie Curie Research Training Network that gave me the opportunity to collaborate with 52 professors and researchers from all over the world and create a valuable scientific network. My Ph.D. dissertation was chosen as one of the three best in Germany by RWE AG. Since 2010, I have been awarded three Marie Curie Fellowships in succession as the principal investigator (one Intra-European Fellowship IEF and two COFUND Fellowships). Supporting my research via external funding sources has given me the unique opportunity to realize research in an independent manner and gain experience in leading complex multi-disciplinary projects, as well as managing actions and funds.

In the last five years I have collaborated with four well established universities and one newly funded research center in Germany, Spain and Greece, where I initiated new research lines combining my expertise with the strengths of each center. I currently hold the position of CONEX Experienced Professor at the University Carlos III of Madrid. I am proficient in using state-of-the-art software for the simulation and evaluation of advanced energy conversion systems based on conventional and renewable energy technologies. I have also worked with and developed complex optimization tools (during my academic work and consulting activities) for trade-off scenarios among multiple criteria and I was the first one to apply advanced-exergy based methods to complex energy conversion systems for emission reduction and efficiency maximization. These methods have advanced the state-of-the-art of optimization methods in the energy field and have opened a new path toward the multi-criteria evaluation of complex energy systems.

I have published 28 peer-reviewed papers (23 as the first author and 1 of which as the sole author) (h-index: 11, according to Scopus), 2 chapters in books and 7 technical reports. I have also taught courses on thermodynamics, heat transfer and optimization of thermodynamic systems, co-authored 2 sets of lecture notes and supervised a large number of students (currently 1 PhD student). I have participated in 35 international conferences and workshops and in 11 research projects (European and industry funded). Since 2013, I have been a member of the scientific committee and section co-chair in one international conference. Lastly, I have had the honor to receive an award for the best paper at an international conference and to be invited to present my work in two international conferences and one educational Seminar.

Resumen del Currículum Vitae:

CURRENT POSITION

2015-present CONEX experienced professor, University Carlos III of Madrid, Spain

PREVIOUS POSITIONS

2013-2015 Research associate, National Technical University of Athens, Greece

2013-2014 Lecturer, Technical University of Crete, Greece

2011-2013 Post-doctoral researcher, Institute IMDEA Energy, Spain

2012 Consulting activities, Shell Global Solutions International BV, Germany

11/2009 Consulting activities, Nagarjuna Fertilizers and Chemicals Limited, Germany

2006-2010 Pre-doctoral research assistant, Technical University of Berlin, Germany

2005-2010 Teaching assistant, Technical University of Berlin, Germany

EDUCATION

2006-2010 Ph.D. in Energy Engineering, Technical University of Berlin, Germany

2000-2005 Diploma studies in Mechanical Engineering, Technical University of Crete, Greece

FELLOWSHIPS, AWARDS & PRIZES

2015-2018 Marie Curie Action COFUND CONEX Fellowship, European Commission

2013-2015 Marie Curie Intra-European Fellowship GENERGIS, European Commission



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2012 Awards of Best Presentations, 1st Workshop of IMDEA Energy
2012 Who's Who in the World (30th Pearl Anniversary Edition)
2011-2013 Marie Curie Action COFUND Fellowship, European Commission
2011 Prize of the Future, RWE AG, Finalist, among the three best Ph.D. theses in Germany
2010 Stipend for completing the Dissertation studies from the Technical University of Berlin
2009 Best paper delivered at the International Conference on Optimization Using Exergy-Based Methods and Computational Fluid Dynamics
2006-2009 Marie Curie ITN Early-Stage Researcher Fellowship, European Commission

TEACHING EXPERIENCE

- Thermal engineering (in English), University Carlos III de Madrid
- Energy & Water (in English), University Carlos III de Madrid
- Heat Transfer (in Greek), Technical University of Crete
- Design, Analysis and Optimization of Energy Conversion Systems (in German), Technical University of Berlin
- Advanced Computational Training in Energy Engineering (in German), Technical University of Berlin
- Co-supervisor of 18 Bachelor & Master Theses
- Principal supervisor of a collaborative doctoral thesis between UPM & UC3M

RESEARCH ACTIVITIES

- Participation in 11 integrative research projects funded by public and private sectors
- PI in 3 European Projects
- 28 peer-reviewed papers in scientific journals (23 as the first author, from which 1 as sole author) with an h-index of 14 (Google Scholar), 13 (Research Gate), 11 (Scopus)
- Participation in 35 international conferences and 14 seminars/workshops
- 15 peer-reviewed papers in conference proceedings
- 2 chapters in books
- 2 sets of lecture notes
- 7 technical reports

ORGANISATION OF INTERNATIONAL CONFERENCES

2013-2017 Member of the Organizing Committee and co-chair of the topic "Energy technologies and sustainability" of the International Conference on Environmental Science and Technology

INVITED PRESENTATIONS & LECTURES

- Invited lecture at the Renewable energy seminar, University Carlos III of Madrid, Spain
- Invited presentation at the International Seminar on Perspectives for Near-Term CCS Development and Capacity Building for Emerging Economies, Porto Alegre, Brazil
- Invited presentation at the 2nd Petrobras International Seminar on CO₂ capture and geological storage, Salvador, Brazil



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Título:

Advanced Methods for Space Situational Awareness

Resumen de la Memoria:

I obtained an MSc in Aerospace Engineering (summa cum laude) in 2003 from Politecnico di Milano (PoliMi) with a thesis project on the optimisation of formation flying reconfiguration manoeuvres. Space trajectory optimisation was the main focus of my PhD studies (2004-2007, Aerospace Engineering, PoliMi) aimed at the multidisciplinary optimisation of aero-assisted manoeuvres. During the PhD I extended my research portfolio by studying simplified methods for the aerothermodynamics of hypersonic vehicles (4-month research visit at the Aerospace Department of University of Maryland, supervisor Dr Mark Lewis) and the application of Taylor Differential Algebra (DA) to trajectory sensitivity/stability analysis (5-month research visit at the Physics and Astronomy Department of Michigan State University, supervisor Prof Martin Berz). From 2007 to 2013 I was postdoctoral research fellow at PoliMi working mainly on the development of algorithms and tools for space situational awareness (SSA), including: space objects observation; uncertainty propagation; orbit determination; conjunction identification and collision probability computation; and end-of-life disposal optimisation. I strengthened my collaboration with Prof Martin Berz by spending two funded research periods with his research group in 2009 and 2011. As postdoc I acted as teaching assistant for courses at graduate and undergraduate level and I co-supervised several MSc theses and 3 PhD candidates. Following my entrepreneurial character I co-founded Dinamica in 2008, a small enterprise active in the field of astrodynamics. For Dinamica I contributed to the compilation of the technical, management and financial sections of successful proposals about different aspects of the space debris problem. While still a postdoc at PoliMi, at Dinamica I gained experience as PI and co-PI of different research studies. In October 2013 I became lecturer Astronautics at the University of Southampton (UoS). At UoS I continued my research in the field of SSA as PI of two studies (with the European Space Agency and Dstl) and I contributed in the teaching activity of the Astronautics group both at undergraduate and graduate level. In addition, I was the main supervisor of two third-year individual projects and one MSc candidate; and I started the supervision of three PhD candidates (one as co-supervisor). In March 2015 I took a two-year research leave from UoS as I was awarded a prestigious Marie Curie Intra European Fellowship receiving a score of 96.20/100. I joined the Universidad de la Rioja (UR) to carry out this fellowship in collaboration with Dr Juan Félix San Juan and Dr Martín Lara. The research is focused on the implementation of innovative orbit propagation techniques for application in SSA. In July 2016 I became Senior Lecturer (i.e. Associate Professor) in in Spacecraft Dynamics at Surrey Space Centre, University of Surrey (Surrey), where I am leading the astrodynamics group (6 PhD students). Overall, I have authored or co-authored 29 peer-reviewed journal articles and I have 68 documents indexed in Scopus. I have presented my works at 24 international conferences, 7 times as invited speaker. I am a regular reviewer for the main journals in aerospace engineering, I am Fellow in the Higher Education Academy, and I have the Italian national habilitation as Associate Professor.

Resumen del Currículum Vitae:

2008 - NEO Encounter 2029. In this 27k € study for the European Space Agency (ESA) I proposed a new method for the analysis of hazardous close encounters of near earth objects (NEO) with our planet. This was based on a high-order expansion of the flow of the dynamics combined with an advanced Monte Carlo simulation. The study achieved and surpassed all the expected objectives, and the results were published on *Celestial Mechanics and Dynamical Astronomy*, 107(4), 2010, 451-470. The methods were further developed and applied to the space debris problem in the PhD project of Dr A. Morselli, which I co-supervised. The innovative content of this work triggered the interest of ESA in Differential Algebra (DA).

2012 - CO-II Architectural Design. As a result of my studies on NEO orbit determination (OD), I was involved in a project for the definition of the architecture of ESA-SSA NEO segment (35k €). The algorithms I developed for OD and conjunction identification were used to critically analyse architecture requirements, to support the architecture preliminary design, and to assess its performances. The experience gained led me to promote and co-organise the Italian Workshop on SSA held at the Italian Space Agency in July 2012 (more than 50 participants, including ESA SSA representatives).

2013 - End-of-Life Disposal Concepts for Lagrange-Points and HEO Missions. Dinamica was assigned this 200k € contract by ESA. I was responsible for building the consortium (3 partners) and for leading the proposal. I was the PI of this activity and the remarkable results achieved granted the team a 4-month (40k €) extension. In this framework I devised an end-of-life re-entry disposal option for INTEGRAL spacecraft based on long-term effect of luni-solar perturbations (*Advances in Space Research*, 56(3), 2015, 479-493). ESA later implemented a similar disposal strategy with predicted re-entry in 2029. The results of the research were reported on many news website including Time.com.

2015 - Technology for Improving Re-Entry Predictions of European Upper Stages through Dedicated Observations. In this ESA activity (250k



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2) Dinamica is leading a consortium with University of Southampton (UoS) and the Centre National de la Recherche Scientifique. I was in charge of the consortium definition and I led the writing of the proposal. Currently I am acting as PI for UoS and as consultant for Dinamica. The results achieved so far are significant: the goal of reducing the re-entry prediction error to less than 20% of the time to re-entry has been achieved, relying solely on publicly available orbit data. The team will present the research outcomes at two international conferences in 2016.

2015 - Merging Lie perturbation theory and DA to address space debris challenges. This is the title of the Marie Curie Intra-European Fellowship (MC-IEF) I am currently carrying out at Universidad de la Rioja as a very experienced researcher. This is the most significant achievement of my career due to the high competitiveness of the framework (~14% success rate), the score I received (96.2/100), and the funding (230k € individual funding). This success prompted me to lead a MC Innovative Training Network proposal on space surveillance and tracking (18 partners and total budget of 4M €). This proposal was submitted for evaluation to the European Commission on January 10, 2017.



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Título:

Efficient methods for multibody system dynamics

Resumen de la Memoria:

Multibody system (MBS) dynamics is an area of Mechanical Engineering that studies the motion of systems composed of rigid or flexible links connected by joints. The behaviour of a wide array of mechanical systems, ranging from biomechanics to robotics, can be predicted and analyzed with MBS dynamics techniques, thus shortening product development cycles and reducing the need for physical prototypes in industry. My research trajectory comprises 12 years of expertise in this field, during which I have both worked on the theoretical foundations of MBS dynamics and developed techniques and software tools for industrial applications.

I have conducted research in six different institutions in Europe and North America. I received my PhD degree from Universidade da Coruña in 2010, with a thesis on efficient MBS implementations, made possible thanks to a FPU fellowship. Algebra implementations, parallelization, and co-simulation were identified as key factors for the effective use of MBS software tools in demanding applications, such as those requiring real-time execution; a registered software library was implemented following the research conclusions. This library is currently in use and has been used to obtain results for 10 journal papers and 5 research projects.

Between 2010 and 2014 I did a postdoctoral research stage at McGill University, during which I worked with the Canadian Space Agency and MDA Space Missions. I applied MBS methodologies to the operation of planetary exploration rovers in challenging environments involving interactions with soft soil, non-smooth dynamics, and redundant and non-holonomic kinematic constraints. The software library that I developed during this project is currently being used by the Robotics division at MDA.

In 2014 I started to work as Juan de la Cierva fellow at Universidade da Coruña. I keep on conducting fundamental research on MBS dynamics, developing new dynamics formulations and linearization methods. I have successfully applied these methods to the solution of problems in biomechanics, simulation of fishing gears, and vehicle dynamics. At the same time, I have started a new line of research in real-time co-simulation of multi-physics systems, aimed at enabling the testing of automotive components in virtual benches through the use of System-In-The-Loop technology. In the projects that I am currently leading I collaborate, among others, with researchers from McGill University and University of Windsor (Canada), Politecnico di Milano (Italy), Siemens Industry Software (Belgium).

Resumen del Currículum Vitae:

My CV summarizes the results 12 years of research in the fields of multibody system dynamics, mobile robotics, and computer simulation and analysis of mechanical systems.

I received a degree in Mechanical Engineering from the University of Navarra (2004) and a European PhD from the University of A Coruña (UdC, 2010), which was supported by a FPU doctoral scholarship and included two international research stays. I received the National Award to the best University Students in Mechanical Engineering (Premio Nacional de Terminación de Estudios Universitarios) and the Award to the best PhD thesis in Mechanical Engineering (Premio Extraordinario de Doctorado) from UdC. Between 2010 and 2014 I worked as a postdoctoral fellow with Profs. J. Kövecses and J. Angeles at the Centre for Intelligent Machines of McGill University (Canada), leading a research team in mobile robotics for space exploration. Since 2014 I hold a Juan de la Cierva fellowship at the Laboratorio de Ingeniería Mecánica (LIM) of UdC. During my professional career I have worked in 5 competitive, publicly funded research projects in Canada (collaborating with institutions such as the Canadian Space Agency, MDA Space Missions, and Maplesoft) and 4 more in Spain, all of them related to multibody dynamics and mobile robotics; additionally, I am also a participant in 2 recently granted national projects in Spain and 2 non-competitive contracts with companies in Spain.

I have authored 16 JCR-indexed scientific papers, 1 book chapter published by Springer, and 35 contributions to international conferences, including ICRA and IROS. I have developed 3 software libraries for the analysis and simulation of multibody systems, 2 of them registered in Spain; the third one is currently being used by the robotics division of MDA Space Missions. I have been appointed a reviewer for 13 JCR-indexed journals and several international conferences.

My research work has enabled me to establish strong connections with relevant researchers and teams worldwide. I have collaborated with teams at McGill University (Canada), Lappeenranta University of Technology (Finland), Politecnico di Milano (Italy), KU Leuven and Siemens Industry Software (Belgium), and the Technical University of Catalonia (Spain); this work resulted in all cases in joint journal



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publications. I have worked in the organization of international conferences (ASME, Euromech), have been named chairman of 4 international conference sessions (IMSD, ECCOMAS Multibody), and delivered invited presentations at McGill University and MDA Space Missions. I have also been a member of 3 PhD thesis committees, one of them in Finland.

My teaching experience comprises more than 580 hours of lecturing in graduate and undergraduate courses, taught in Spain and Canada, with very favourable ratings by my students. I have been the instructor of 3 courses on Mechanics and Robotics at McGill University. In 2015 I was awarded the Spanish national accreditation as Associate Professor (Profesor Titular de Universidad).