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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **BOMBARDELLI , CLAUDIO** **Referencia:** RYC-2011-09661

Area: Ingeniería Mecánica, Naval y Aeronáutica

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Titulo:

Advanced Space Propulsion Methods for Space Debris Removal and Asteroid Deflection

Resumen de la Memoria:

The removal of existing and future space debris cluttering the low earth orbit (LEO) environment as well as the deflection of asteroids in collision course with our planet are among the most important topics of aerospace engineering today. They have been among the main study subjects of the 2009 and 2010 space technology section of the 7th framework programme (FP7) of the European Commission. Among the key technologies to modify both asteroids and space debris orbits a novel solution has been proposed and patented by the candidate during its research activity at UPM. The solution consists of having a highly collimated quasi-neutral plasma beam intercepting a target orbiting body in order to produce the required deorbiting/reorbiting impulse after the heavy (typically xenon) plasma ions reach the surface of the target material and lose their kinetic energy following multiple nuclear collisions in the substrate. The goal of the proposed research activity is to advance in the understanding of the complex dynamical interaction of an orbiting body of given shape irradiated by a collimated quasi-neutral axisymmetric plasma beam with density and axial speed typical of space technology ion and hall-effect thrusters, as a function of the target-beam relative geometry and the role played by electrodynamic tethers used to enhance the system capability. Analytical and numerical tools will be developed to study such interaction and its implication for proximity formation flying dynamics of the target body (i.e. the debris or the asteroid) relative to the spacecraft hosting the ion beam (known as the "ion beam shepherd"). Precision control algorithms to stabilize the target-shepherd separation distance under external perturbations and off-nominal conditions will be studied taking into account the capability of modern space guidance and navigation systems. The results will be employed to assess the feasibility and expected outcome of space-debris deorbiting and asteroid deflection missions based on the proposed solution.

Resumen del Curriculum Vitae:

I obtained a master in Mechanical Engineering (summa cum laude) in 2001 at the University of Padua with a thesis work carried out during an 8-month visit at the Harvard-Smithsonian Center for Astrophysics (CfA) (Cambridge MA, USA) one of the world leading institutions for space science. There I joined the "Special Projects Group" founded by the late Giuseppe Colombo and devoted myself to research on space tethers and advanced space technology. After graduating I went back to CfA working during 7 months as research consultant for the NASA-JPL project "Achieving Formation Stabilization and Reconfiguration by Tethered Spacecraft". I then started a PhD at the University of Padua spending almost the full extent of the doctorate at the Harvard-Cfa after being awarded a Visiting Research Fellowship. In the doctorate years I have worked on two more NASA projects "The Submillimeter Probe for the Evolution of Cosmic Structures (SPECS)" led by NASA GSFC and the "Test of Equivalent Principle in an Einstein Elevator" (founded by NASA Glenn). After obtaining my PhD (highest mark) I was awarded a prestigious postdoctoral research fellowship in space mission analysis at the European Space Agency (ESA) and I spent two years working in the ESA Advanced Concepts Team (ESTEC, Noordwijk, The Netherlands). There I have worked on advanced concepts for space technology and exploration with an international team of researchers with a multidisciplinary background (ranging from biomimetics to artificial intelligence and nanotechnology) and I have been the technical officer of four research projects in collaboration with different European Universities. Two of these projects ("Dynamics and Stability of Tethered Satellites at the Lagrangian Points" and "Asteroid Centrifugal Fragmentation") were initiated by myself. In 2008 I was awarded a Juan de la Cierva research fellowship and I joined the School of Aeronautics of UPM as part of the Tether Dynamics Group (GDT) led by prof J. Peláez. After two years of research activity I have filed one international patent as first inventor and I have won a research proposal from the European Space Agency as Principal Investigator (PI). The project, called "Reversed Electric Propulsion with Electrodynamic Tethers" as part of the ESA-Ariadna call for ideas on Active Space Debris Removal, stemmed from the work presented in the patent application and gave me the opportunity to create an interdisciplinary research group at UPM and to support one PhD student. More recently, I have been included in the international project "Propellantless deorbiting of space debris by bare electrodynamic tethers (BETS)" funded by the 7th framework programme of the European Commission (FP7) and led by prof J. Sanmartín (UPM). I have published 20 articles in international peer-reviewed journals (two of which are in press and one is accepted with revisions), have 3 more under review and have more than 30 presentations in international congresses. Of the 20 journal articles, 10 belong to the 25% higher impact factor in their knowledge area and I am first author in 9 of them. Of the 30 international presentations two of them were invited. I am supervising 3 doctoral theses and I am reviewer of three journals (The Journal of Guidance, Control and Dynamics, the Journal of Celestial Mechanics and the Journal of Spacecraft and Rockets).

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CONVOCATORIA 2011

Nombre: **GUZMAN DE VILLORIA LEBIEDZIEJEWSKI, ROBERTO** **Referencia:** RYC-2011-09506

Area: Ingeniería Mecánica, Naval y Aeronáutica

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Titulo:

Multiscale hierarchical structures

Resumen de la Memoria:

The goal of my lab will be to develop new generations of nano-engineered multiscale hierarchical composites where the nanoscale element would be placed strategically to improve the mechanical and functional properties of the material. The election of my research line is not only because of my affinity and interest in this field. Materials performance is continuously demanded in many fields such us aerospace, energy, automotive¿ as an example, advanced composites and nanocomposites have been identified in the U.S. Air Force highest priority key Potential Capabilities Areas (PCAs) over the next two decades. NASA also is demanding nanocomposite research as can be read in their recent program ¿Research Opportunities in Aeronautics¿. In Europe, nanocomposites and nanotechnology are facing an increasing demand for use in future space applications. It is expected that some classes of nanostructured materials can be flight-qualified (TRL7-8) on a 10-15 year timescale.). These are just few examples to show how nanocomposites, nanotechnology and adaptive materials/structures are increasing their demand for their mechanical and functional properties in mechanical applications. These fields are covered in my research statement as can be seen below:My first line of research is the study of aligned helical carbon nanofibers (CNFs) as a secondary reinforcement for advanced composites combining aligned CNF, polymers and existing advanced fibers. Preliminary studies in random dispersed CNF composites have shown toughness enhancement up to 112% adding small amount of CNFs (approximately 0.34% Vf). Analysis of the reinforcement mechanism reveals the effect of the secondary bonds between the graphitic layers. There is not any analytical model to evaluate the real effect of these reinforcement mechanisms, but a rough estimation of random 1% Vf. CNFs would improve the mode I toughness of a composite around 330%, which it is higher than the state of the art toughness for aligned CNTs architectures. The potential toughness using aligned CNFs architectures has not been explored yet, being theoretically higher than any other existing technology.Other interesting properties aligned-CNFs (A-CNF) are their electrical and thermal conductivity. The role of this helical wrapped structure in their CNF properties is not clear yet. Different electrical and thermal properties are expected such as the distance between the graphene wrapped plies changes, which will be used to create multifunctional composites materials. One of the envisioned applications is non destructive evaluation in composite materials, where the unraveling mechanism of CNFs might be more sensitive than the conventional CNTs piezoresistive behavior. This effect and the CNF Joule heating effect will be tested for damage detection by thermography. However, there are not any measurements to quantify their piezoresistive effect either in individual CNFs or nanocomposites.

Resumen del Curriculum Vitae:

Roberto Guzmán de Villoria, Ph.D.Postdoctoral AssociateMassachusetts Institute of Technology rguzman@mit.eduDepartment of Aeronautics and Astronautics Cell: +1 (857) 654-5406E41-317, 77 Massachusetts Avenue Lab : +1 (617) 253-7214Cambridge, MA 02139Education2003 - 2007 Ph.D. in Mechanical Engineering (Grade Cum Laude; 10 over 10)University of Zaragoza, Spain - Advisor: Prof. Antonio MiraveteThesis title: Optimization of Mechanical and Electrical Properties of Carbon Nanofiber/Epoxy Nanocomposites Scientific communications: 7 peer-reviewed papers, 1 patent application, 4 conference proceedings2003 - 2004 Advanced Studies Diploma (DEA) in Mechanical Engineering, specialty in ¿New Automotive Technologies¿ (Grade A; 9 over 10)University of Zaragoza, Spain1999 - 2002 Master Degree Materials Engineering (Grade A; 9 over 10)University of Salamanca, SpainThesis project: Micromechanics Model of a Micro-composite Material: Pearlitic Steel (Grade A; 9 over 10)1994 - 2000 Master Degree in Physics, specialization in microelectronicsUniversity of Salamanca, SpainProfessional experience2007 -present Post-doctoral Associate Massachusetts Institute of Technology, Aeronautics and Astronautics Department (Cambridge, MA, USA)-Advisor: Prof. B.L. Wardle¿ Developed a novel chemical vapor deposition system to synthesize aligned carbon nanotubes continuously¿ Conceived a non-destructive evaluation method using carbon nanotubes (patent pending) ¿ Performed growth of carbon nanotubes on structural fibers (patent pending)¿ Assisted Prof. Wardle, Director of NECST consortium (10 aeronautics/materials companies), supervised all projects related with the consortium and mentored and trained ten graduate and undergraduate students¿ Represented Prof. Wardle/NECST at sponsor meetings, company presentations and conferencesScientific communications: 10 peer-reviewed papers, 3 patent application, 22 conference proceedings, 19 invited talks2007 -present External consultant in the fields of nanocomposites and new materialsSispra, Composite components company (Zaragoza, Spain)¿ Optimized new materials/components with carbon nanofibers¿ Developed carbon nanofiber/thermoplastic composite fibers by wet-spinning2003 - 2007 Graduate Student/ Research AssistantMechanical Engineering department (Zaragoza, Spain)Advisor: Prof. A. Miravete¿ Developed and characterized the multi-functional (mechanical/electrical) properties of carbon nanotubes/nanofibers composites¿ Created a new prepreg material of carbon nanofibers/epoxy (patent pending) Industrial Research Projects2007 - 2010 Development of Nano-engineered composites. ¿Nano-Engineered Composite aerospace STructures (NECST)¿. Companies: Boeing, Airbus, Lockheed Martin, Embraer, Composites System Technology, Textron, Saab, Toho Tenax, Spirit Aerosystems. PI: B. L. Wardle2007 - 2008 Development of fibers made of carbon nanofiber by wet-spinning, dry-spinning and electro-spinning, ¿Development of new nanocomposite materials¿ (DOMINO project), CENIT. Companies: TOLSA, Grupo Antolin, Sispra, Repol, Acciona, etc. PI: Antonio Miravete2005 - 2007 Development of carbon nanofiber/epoxy composites ¿Optimization of manufacturing process and surface modification of carbon nanofibers for their application in advanced composite materials¿. Company: Grupo Antolin. PI: Antonio Miravete2003 - 2005 Materials selection and finite element simulation. Co