AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

Nombre: **MARTINEZ PEDRERO, FERNANDO**
Referencia: RYC-2015-18495
Área Científica: Ingeniería Mecánica, Naval y Aeronáutica
Correo Electrónico: fmpedrero@ecm.ub.edu

Título:

Interfacial and colloidal systems for the realization of new technological applications

Resumen de la Memoria:

Throughout my scientific career I have tried to find the balance between fundamental research, the understanding of the intimate mechanisms behind of processes taking place at a micro-scale, and the design of new and useful procedures and devices. To that end, I have worked in 3 different National Universities, in a very well renowned foreign Engineering Center of Research and I have collaborated with Michelin, one of the world's top Companies in the sector.

I did my Ph.D. in the Applied Physics Department of the University of Granada. My research was focused on the study of colloidal suspensions of para- and ferro-magnetic microparticles. These systems are widely employed in Industry, in the manufacture of new and active visco-elastic or self-healing materials. They are also employed as active agents with applications in the drug vectorization or in hyperthermia treatments, addressed to the elimination of cancerous cells. We analyzed different aspects concerning the field induced aggregation mechanism, that is a fundamental issue in the most part of the previously reported applications. During this period, I started a collaboration with the group of Jerome Bibette, in the Ecole Superieur de Phisique et Chemie Industrielle (Paris), one of the most prestigious French Grandes Ecoles of Engineering. We published 7 peer-reviewed Articles and 1 Book chapter.

Later, I continue the collaboration with the professor Bibette, in cooperation with Michelin. We studied and proposed new mechanisms to obtain natural and synthetic rubber mixtures homogeneously doped with Silica and Carbon Black nanoparticles. These composites were obtained through sol-gel techniques, in the presence of anionic surfactants and other surface active agents. We published 5 Patents and 1 peer-reviewed Article.

After, I did a second postdoc in the Chemistry-Physics Department of the Universidad Complutense de Madrid, starting a collaboration with the Laboratory of Complex Systems, Department of Fundamental Science (UNED). Here, we designed and built an interfacial rheometer having at least a 10-fold-lower resolution limit as compared to the commercial rheometers. We also studied different sublimation processes occurring in quasi 2D structures made up of superparamagnetic particles and in binary mixtures. We published 4 peer-reviewed Articles and 1 Patent.

Currently, I am working in the Magnetic Soft Matter Group, in the Department of Structure and Constituents of Matter (Universidad de Barcelona, UB). We have designed new micro-swimmers made up of magnetic micro-particles that allow steering the matter at a microscopic scale. We have published 5 peer-reviewed Articles. Currently, I collaborate with many different groups from Spain, Germany, Slovenia and Norway.

Resumen del Currículum Vitae:

My research activity is devoted to the understanding of different interfacial and colloidal systems for the realization of new technological applications.

The fruit of an intense scientific activity can be summarized in:

- 17 peer-reviewed Articles, two of them in press, the 75% belonging to first Quartile Journals in their category, including Physical Review Letters (x1), Scientific Reports (x1), Lab on a Chip (x1), Langmuir (x3), Soft Matter (x2) and Advances in Colloids and Interface Science (x1).

- The authorship of 6 patents. One of the patents has already been licensed to Michelin.

- The publication of 1 book chapter.

- 23 national and international conference contributions, exposing 7 oral presentations invited by different relevant scientific institutions.

I have had a leading role in the developed research. I am the first author in 14 of the 17 articles and also in the book chapter. In 5 of the 6 patents I appear as second author, but de facto I was the unique responsible of the experimental labor.

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

I have been member of 5 R&D&I projects since 2005. One of them, an Integrated Action, arose from the collaboration that I established with the group of the professor Jerome Bibette in the ESPCI.

I have spent more than 24 months abroad, in different research institutions (France and Italy), and more than 45 months in centers different to the proposed host University. I have gained three postdoctoral positions, prevailing over other candidates in their corresponding competitive calls.

I have also been the recipient of different grants, comprising an Introductory Research Grant, a FPI grant, a short time mobility fellowship, enjoyed during the PhD and a contract of Young Doctors PICATA, financed by the CEI Campus Moncloa.

I have the credentials of ﷺProfesor Ayudante Doctor﷽, ﷺProfessor Contratado Doctor﷽ and ﷺProfesor de Universidad Privada﷽, awarded by the National Agency for Quality Assessment and Accreditation of Spain.

I have the experience in training and supervising 3 national and international pre-doctoral students, being the tutor of one Master﷽s Thesis.

I have been contacted for reviewing several manuscripts for Physical Review Letters and Optical Letters.

I have taught for more than 140 hours in different undergraduate courses, including General Chemistry and Chemical Physics (1st and 2nd year students, Universidad Complutense de Madrid) and a practical module of Physics in Building Engineering (Universidad de Granada).

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

Nombre: **NOAILLY , JEROME**
Referencia: RYC-2015-18888
Área Científica: Ingeniería Mecánica, Naval y Aeronáutica
Correo Electrónico: jerome.noailly@upf.edu

Título:

System of models for spatiotemporal exploration of joint diseases in the musculoskeletal system

Resumen de la Memoria:

Low back pain affects about 25% of the EU-27 active population but its origins are unclear. While radiological evidences do not correlate with pain, recent mechanobiology concepts hint that morphological changes may be a late response to early and persistent cell stimulations. The proposed research will test such view by predicting in silico early load distributions and late tissue changes with methods transferrable to the clinical field.

For the first time, a lumbar spine finite element model will integrate constitutive models that rely on medical imaging to obtain subject-specific tissue properties. In intervertebral discs (IVD), while collagen bundles resist tractions, the negatively charged proteoglycans generate Donnan pressures that keep compressive strength. Thus, IVD will be modelled as collagen fibre-reinforced composites with Donnan theory-based osmoviscoelastic matrices. Constituent densities determine the model parameters and can be derived from MRI. As for bone, homogenization schemes will be applied to turn the "universal" properties of collagen, hydroxyapatite, and water into specific mechanical properties at various length scales. These models will incorporate nano-to-micro scale bone composition into large-scale vertebra models where properties can be derived from CT. Experiments will be used to calibrate the functions that link model parameter values with medical image signals

Further step is to couple the composition-based tissue models with cell activity to simulate degenerative progressions. IVD degenerative proteoglycan and collagen changes are well documented. Tissue parameters will bridge IVD loading with the mechanical and physico-chemical conditions local to the cells. Beyond certain thresholds, predicted cell environment will affect matrix synthesis, cell viability, or cell phenotype, reflected by changes in the IVD model parameters. Nutrient transport from the endplate to the IVD will be also simulated. Endplate sclerosis, captured through a mechanoregulation model based on interstitial fluid flow and solid shear strains, may limit nutrient availability and incrementally affect cell activity. Strain energy-driven bone adaptation models will eventually predict vertebral bone changes due to altered IVD behaviour.

For clinical relevance, simulations must include realistic mechanical boundary loads. Single-level moments, often used to simulate spine motions, cannot describe the level-dependent in vivo loads induced by muscles. Kinematical muscle force calibration models were proposed, but only delivered discrete force values for predetermined motions. Using Hill theory, different models can predict passive and active muscle forces, depending on muscle stretching and calcium-regulated activation. But low back musculature was never modelled as such. Thus, a Hill theory-based predictive model will be coupled with kinematical models able to estimate level-by-level lumbar muscle forces. Such coupling will allow linking together muscle MRI/EMG signals from kinematical activity with the predictive muscle model parameters.

After integration within a single lumbar spine model, final parameter calibration and sensitivity studies will determine the overall precision of the predictions. The integrated model will be also tested for its ability to reproduce matching sets of in vivo measurements and known pathologies.

Resumen del Currículum Vitae:

I hold a Bachelor degree in Physical Chemistry physicist, an Engineer and a Master degree in Material Science, and a Master degree in Acoustics. In 2002, I started a PhD on spine computational biomechanics at the Universitat Politècnica de Catalunya, Barcelona (UPC), Spain. In 2006 I was awarded a Marie Skłodowska-Curie fellowship, and worked in computational mechanobiology and hydrogel mechanics for cartilage tissue engineering at the AO Foundation (Davos, Switzerland) and at the Eindhoven University of Technology (The Netherlands). In 2009, I went back to Barcelona with a Marie Skłodowska-Curie reintegration grant, and retook spine modelling activities at the Institute for Bioengineering of Catalonia (IBEC), Barcelona, Spain. The same year, I won the Best PhD Thesis award in engineering from the UPC. From 2012 to 2015, I was the head of the Biomechanics and Mechanobiology group at IBEC, being responsible for four to five contracted researchers, before I relocated my team at the Universitat Pompeu Fabra (UPF), where I am the principal investigator of the Multiscale and Computational Biomechanics and Mechanobiology (MBIOMM) research team. I have been supervising three PhD theses (two have been defended) and more than 13 master theses/final year projects. In 2014 one of my PhD students won the best PhD Thesis award in Engineering from the UPC. I have more than 90 contributions to congresses, two chapters in book series, and have published 22 articles in international journals, including high-ranking journals such as MRS Bulletin, Lab on a Chip, Materials Letters, PLoS Computational Biology, Journal of the Mechanical Behavior of Biomedical Materials, Biomechanics and Modeling in Mechanobiology,

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

or Osteoarthritis and Cartilage. In 2014 and 2015, I was selected to give a total of six invited, keynote, and plenary talks at the World Congress of Biomechanics, the World Congress on Computational Mechanics, the VPH Conference, the EMI Conference, and the Congress of the European Society of Biomechanics, about my work in spine modelling. My 5-years mean research impact in 2015 was at least 40% higher than the mean international impacts in the fields related to my research, i.e. Engineering, Materials Science, Clinical Medicine, and Biology & Biochemistry. I have taught materials technology and mechanics at the UPC, and continuum mechanics, Biomaterials and musculoskeletal system modelling at the UPF, Barcelona, Spain. I am an active member of the European Society of Biomechanics (ESB), president of the National Spanish Chapter of the ESB, and co-chair of the PhD Committee at the Virtual Physiological Human Institute (VPHI). From 2012 to 2014, I have also been the legal representative of IBEC at the VPHI. I was Principal Investigator (PI) for the FP7 European project MySpine, and I have participated to a total of six European projects. From 2013 to 2015, I have been the promoter and the PI of three research contracts with both hospitals and companies.

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

Nombre: **ROCA NAVARRO, FRANCISCO JAVIER**
Referencia: RYC-2015-18427
Área Científica: Ingeniería Mecánica, Naval y Aeronáutica
Correo Electrónico: xevi.roca@gmail.com

Título:

HIGH-FIDELITY FLOW SIMULATION ON COMPLEX GEOMETRIES

Resumen de la Memoria:

I am a Marie Sklodowska-Curie Fellow (score: 98.6%) responsible of the mesh generation group at the Barcelona Supercomputing Center (Spain), a prestigious Severo Ochoa Centre of Excellence (since 2011, renewed in 2015). After my PhD in Applied Mathematics (UPC, 2009), I was encouraged by Prof. J. Peraire�s (MIT, USA), a world leader in aerospace computational design, to be a Postdoctoral Associate at the world top Massachusetts Institute of Technology (USA), starting in 2011. I conducted my PhD (UPC, 2009) research at Prof. A. Huerta�s group (UPC), a top researcher in computational methods.

My contributions are in the field of computational methods for simulation and specifically, in: mesh generation, unstructured high-order methods, and scientific computing. In my career, I have been fully committed to combine the analytical rigor with a genuine desire to apply my methods in real applications. This commitment is shown by my: 16 journal papers, 7 book chapters, 56 conference contributions (37 international), and an exceptional number of 12 technological transfer activities and 7 software packages. Specifically, my methods and software packages have been transferred to the in-house professional software of top-level institutions (MIT, US AF/OSR) and companies (The Boeing Co., Pratt & Whitney). I have more than 50 months of international experience, period where I have been involved in several research activities with top international centers and companies. These activities have led me to collaborate with exceptional international scholars on non-Spanish institutions (Prof. Peraire (MIT), Prof. Persson (UC Berkeley), Dr. Nguyen (MIT)), contribute to international conferences, and participate in international mobility programs.

Nowadays, I have the unique research opportunity to lead the first combination of a curved meshing method with a hybridizable discontinuous Galerkin solver to obtain a 3D high-fidelity flow simulation capability of industrial interest. This capability has low numerical dispersion and dissipation, and high physical and geometrical fidelity. Therefore, it is really well suited for noise and turbulence prediction on complex geometries. I proved my leadership in my field: leading a meshing research group, directing research works (1 PhD directed thesis, 2 directed Master Theses, 5 other supervision activities), being invited to present my research, obtaining awards and recognitions, being elected member of the steering committee of the International Meshing Roundtable (top meshing conference), organizing mini-symposia and conferences, chairing sessions, eliciting research and mobility funding from companies and institutions, and teaching in advanced graduate courses. Furthermore, I have supported the community of computational methods as a member of scientific societies, peer-reviewer of journals and conferences.

Resumen del Currículum Vitae:

Leading the mesh generation group at the Barcelona Supercomputing Center

Positions:
04/2015, Barcelona Supercomputing Center, Marie Sklodowska-Curie Fellow
06/2011, Massachusetts Institute of Technology (world top), USA, Postdoctoral Associate
06/1999, Universtitat Politècnica de Catalunya, Spain, Personal de soporte a la investigación

University education:
2009, PhD, Applied Maths, UPC, Spain
1998, Degree, Applied Maths, UPC, Spain

Teaching experience: 6 courses (1 Advanced Summer School, FP7-ITN, European Commission, 1 MIT post-graduate course); supervision of 4 theses (1 PhD thesis, 2 Master thesis, 1 Academy Senior thesis); and production of 12 educational publications (6 lecture notes).

Scientific and technological experience: member of 3 research groups (1 lead by Prof. Peraire, MIT, USA); 16 R&D projects through competitive calls (US/AFOSR, European Commission, …); 12 R&D non-competitive contracts (Boeing, Pratt & Whitney, …); 5 projects as Co-PI and 1 as PI; and 10 technological results (7 of them as software packages) for transfer activities.

Scientific production: 16 papers for JCR indexed journals, 7 book chapters for the IMR, 56 works for conferences (37 international conferences, 10 peer-reviewed conference papers); and 8 other dissemination activities (1 media interview for …La Razón…, 4 videos, 3 other scientific divulgation activities for university and high-school students).

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2015

Turno de acceso general

R&D management and participation in scientific committees: elected member of the steering committee of the International Meshing Roundtable (Sandia National Laboratories); organization of 8 R&D activities (2 conferences, 3 mini-symposia, 3 chaired sessions); evaluation and revision of papers for 10 institutions (9 scientific journals listed by JCR, 1 peer-reviewed conference).