UNIVERSIDAD POLITÉCNICA DE MADRID

Expression of Interest – UPM Supervisor

Marie Skłodowska Curie Action – Individual Fellowship 2023 (MSCA-IF-2023)

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Address	Avda. Puerta de Hierro, 2-4. 28040 Madrid
Province	Madrid
Research Area	☐ Social Sciences and Humanities (SOC) Economic Sciences (ECO) ☐ Information Science and Engineering (ENG) ☐ Environmental Sciences and Geology (ENV) ☐ Life Sciences (LIF) ☑ Mathematics (MAT) ☑ Physics (PHY) ☑ Chemistry (CHE)
Brief description of the Centre/Research Group	The Grupo de Sistemas Complejos (GSC) is an interdisciplinary research group in Complex Systems formed by experienced Professors, and young postdocs and Ph. D. students of several schools of the Universidad Politécnica de Madrid, which creates an exciting environment and an enthusiastic atmosphere, always open to new ideas. The GSC has a long experience in the study of (classical and quantum) chaos, Complex Systems and nonlinear Dynamics in several different fields ranging from fundamental Science (Mathematics, Physics and Chemistry), to Optics and Geology. More recently, a new research line on Complexity has been implemented in order to study Complex Networks and Big Data using the latest methodologies (Optimization Algorithms, Machine Learning, Deep Learning…). So far, the members of the group have published over 200 articles in journals indexed in the JCR, such as Sci. Reports, Phys. Rev. Lett., Phys. Rev. E, PCCP and Chaos, among others. Our research is financed by different public institutions (European Comission, The Spanish Ministry of Science, Innovation and Universities, UPM...) and private companies, and is developed in collaboration with different Spanish (Universidad Autónoma de Madrid, Instituto de Ciencias Matemáticas, ...) and foreing (Johns-Hopkins University, Loughborough University, Humboldt-Universität zu Berlin...) institutions. For further information, visit our webpage at: www.gsc.upm.es .

Project description	This project focusses on the study of highly nonlinear systems, from the classical and/or quantum points of view. For this porpouse, strong computational skills in numerical (Python, FORTRAN…) programming is required. Experience in parallel computing and symbolic programming (e.g. Mathematica) is also appreciated. On the one hand, we want to provide new insights into the classical dynamics of atomic and molecular systems by carefully analizing their phase space structures. For this purpose, techniques borrowed from Celestian Mechanics (such as normal forms or perturbation theory) will be applied to study more involved situations (higher dimension, heteroclinic connections, etc.), such as the Normally Hyperbolic Invariant Manifolds (NHIM) in isolated systems or the so called 'time-dependent Transition State Theory'. On the other hand, quantum effects cannot always be neglected at mesoscopic scales, and then it is interesting to know how do they affect to the classical phase space structures and classical motion. Thus, we want to use semiclassical methods to incorporate quantum effects, in order to provide more realistic descriptions of their dynamics. Several different systems can be used as benchmarks, such as anharmonic potentials, chaotic billiards or quantum maps. Special attention to the quantum diffusion, and its supression (dynamical localization), will also be devoted. New semiclassical methods and control techniques will be developed, and novel classes of universality will be studied. Finally, the localization of quantum wave functions ('scarring') will also be studied
Applications: documents to be submitted and deadlines	The applicant should submit (as soon as possible, and no later than April30th 2023) the following documents: - Letter of motivation, Curriculum vitae, Two reference letters - A brief summary of up to three of the most important articles or patents, stressing the main contributions of the candidate