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ERC Advanced Grant

ICREA Prof Javier Garcia de Abajo awarded Advanced Grant for project QUEFES

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The European Research Council (ERC) has announced the awarding of 255 Advanced Grants to outstanding research leaders across Europe, as part of the Horizon Europe programme. The grants - totalling nearly ?652 million - support cutting-edge research in a wide range of fields, from Life sciences and physical sciences to social sciences and humanities. ?

The ERC Advanced Grant funding is amongst the most prestigious and competitive E funding schemes, providing researchers with the opportunity to pursue ambitious curiosity-driven projects that could lead to major scientific breakthroughs. They are awarde to established, leading researchers with a proven track-record of significant researc achievements over the past decade. 1,829 research proposals were submitted for this cal , which were reviewed by panels of internationally renowned researchers. Nearly fourte n percent of proposals were selected for funding. Estimates show that the grants will crea e 2,480 jobs in teams of new grantee

ICREA Prof at ICFO Dr Javier Garcia de Abajo, recipient of an ERC Advanced Grant in 2018 for the project eNANO: Free Electrons as Ultrafast Nanoscale Probes, has been awarded his second Advanced Grant for established research leaders, for the project **QUEFES: QUantum-Enhanced Free-Electron Spectromicroscopy.** In this new project, which will run from 2024- 2029, Prof. Garcia de Abajo will introduce a conceptually disruptive approach to capitalize on the quantum nature of free electrons and their interactions with matter and radiation fields aiming to obtain previously inaccessible information on the atomic-scale dynamics of such materials, to reveal hidden properties of the quantum vacuum, and to control the many-body state of quantum matter.

Ultrafast electron microscopy relies on the spatial, spectral, and temporal manipulation of free electrons with nm/meV/fs precision to map the structural dynamics as well as the vibrational and electronic ground and excited states of nanomaterials. This project wil address five challenges of major scientific relevance: (i) the spatiotemporal control over th density matrix of free electrons by interaction with suitably designed optical fields t overcome the current limits of space/time/energy resolution in time-resolved electro spectromicroscopy; (ii) a disruptive approach to map the nanoscale quantum fluctuation and the out-of-equilibrium state associated with optical near fields in vacuum and polaritoni excitations in nanomaterials; (iii) a Fourier-transform-inspired method to image th

spatiotemporal evolution of atomic structures, charge carriers, and dynamical screening; (iv the use of free electrons to flexibly read and write the many- body quantum state of trappe Rydberg atoms and quantum gases; and (v) the realization of all- electron pump-prob spectroscopy combined with the formation of dynamically screened multiple free-electro bound states for lossless charge transport in a semiconductor

The strong interdisciplinary theoretical background of the members of Nanophotonics Theory Group led by Prof. Garcia de Abajo will allow them to pursue these research frontiers at the intersection between electron-light-matter interactions and nanophotonics. By introducing a change of paradigm in the use of free electrons to break the current limits of spectromicroscopy, the project has the potential to revolutionize our ability to image and manipulate the nanoworld.

i¿½**The project tackles a very vibrant area that combines electron beams and ultrafast lasers to reach the limits of resolution in space and time when imaging material structures on the atomic scale,i¿½** explains Prof. Garcia de Abajo**. i¿½As a theory group, we try to push the fie d beyond its current experimental frontiers by devising new methods to achieve such a goal. We will also explore exciting new physics that involves the interaction between free electrons and light in unprecedented ways. We believe that we can contribute to steer this field with the help of theory and will do our best to produce breakthroughs!i¿½**

In congratulating the new ERC grantees, Iliana Ivanova, Commissioner for Innovation, Research, Culture, Education and Youth, said: i¿½**These grants will not only support leading researchers in pushing the boundaries of knowledge, but also create some 2500 jobs for postdoctoral fellows, PhD students and other research staff across Europe. This investment nurtures the next generation of brilliant minds. I look forward to seeing the resulting breakthroughs and fresh advancements in the years ahead**.i¿½

Congratulations Javier. We are looking forward to seeing where this ambitious project will take you!

About the ERC:

The ERC, set up by the European Union in 2007, is the premier European funding organisation for excellent frontier research. It funds creative researchers of any nationality and age, to run projects based across Europe. The ERC offers four core grant schemes: Starting Grants, Consolidator Grants, Advanced Grants and Synergy Grants. With its additional Proof of Concept Grant scheme, the ERC helps grantees to bridge the gap between their pioneering research and early phases of its commercialisation. The ERC is led by an independent governing body, the Scientific Council. Since November 2021, Maria Leptin is the President of the ERC. The overall ERC budget from 2021 to 2027 is more than ?16 billion, as part of the Horizon Europe programme, under the responsibility of the European Commissioner for Innovation, Research, Culture, Education and Youth, Iliana Ivanova.