The Gordon and Betty Moore Foundation awards ICFO?s research on hybrid states of matter

Advances in hybrid states of matter are primarily science-driven, but can lead to a variety of technologies relevant for novel sensing, quantum computing devices, low-power consumption optical AI, etc.

October 26, 2023

Co-founder of Intel Corporation in the 1960s, Gordon Moore sought to go beyond the limits of science to achieve the unachievable. Moore's law, which predicted exponential miniaturization of the transistor size over time, earned him a prominent place as an inspirational figure in the history of semiconductors and in the recent digital revolution.
In constant pursuit of pioneering ideas, Gordon and Betty Moore established a foundation with a science program that seeks to advance basic science by funding research in high-risk, emerging fields, to develop new disruptive technologies, support imaginative and i¿½out-of-the-boxi¿½ research scientists and help create new collaborations and synergie

to go beyond the frontiers of traditional scientific disciplines. With this principle as a basis, the **Gordon and Betty Moore Foundation** offers scientists highly prized freedom to explore and advance novel concepts.

Frank Koppens, ICREA Professor at ICFO, has recently been awarded a **$1.4 million grant** to expand his world-leading research which involves the confinement of light into nanocavities and using these to manipulate materials with light. **This grant will enable Koppens' team to explore new, previously uncharted hybrid states of light and matter**. These exotic states can facilitate the engineering and manipulation of completely new materials properties. While much is known about traditional states of matter like liquid and solid phases, there exist more exotic variations where light and matter interact so intensely that they merge to form a new hybrid state. There is growing optimism in the field that understanding these hybrid state could lead to groundbreaking discoveries that could profoundly impact a wide range o technologies, including quantum sensors, low-power photonic integrated circuits, an devices for advancing artificial intelligence systems. Furthermore, they could pave the wa for quantum technologies developed for quantum communications, quantum memories quantum simulations and quantum computing

Prof. Koppens is internationally recognized as a leader in his field. Since his arrival to IC O from Harvard University, he has secured an ERC Starting grant (2012), an ERC Consolidat r grant (2017), six ERC Proof-of-concept grants, and played a key leading role in the Europe n Graphene Flagship initiative. He is vice-chair of the graphene flagship executive boards a d leads the graphene flagship opto-electronics activities. He has achieved high-impact resul s and publishes in the top journals in his field such as Nature, Science, Nature Physics, Nature Materials, earning him a spot on the Clarivate list of highly cited scientist. In 2015, Koppen was the recipient of the Premi Nacional de Recerca de Catalunya (Catalonia Nationa Research Award) for advances in the area of opto-electronics with materials based o graphene. Support from the Cellex and Mir-Puig Foundations has been a decisive factor in al of these projects and achievements

Currently coordinating the ambitious and growing QTwist research program at ICFO in clos collaboration with the Massachusetts Institute of Technology (US) and the Max Planc Society (DE), Koppens is working towards uncovering the fundamental properties o emerging synthetic materials, including a vast range of two-dimensional materials, and the r potential future applications in quantum nano-optoelectronics. The new project funded y the Gordon and Betty Moore Foundation, will be a major player running alongside the QTwi t program and helping unveil groundbreaking discoveries in the fiel

. i¿½We are already in the middle of the second quantum revolution, however new hybrid states of light and matter are needed to fuel progress.i¿½, comments Prof. Koppens. i¿½ his kind of grant supporting fundamental, curiosity driven and risky projects allows us to exp ore directions that were so far mostly explored only theoretically. By pursuing our ideas in the laboratory, we expect to discover new material properties or potentially even new classe

of materials that may lead to quantum technologies relevant for a wide range of applications such as novel computing schemes, low-power consumption AI, optical computing, and sensors.i¿½

What are hybrid light-matter states?

Light-matter interactions refer to how electromagnetic waves (like light) influence and are influenced by charged particles, typically electrons in atoms or molecules. When this interaction is "strong", the system cannot simply be described as a mere sum of its light and matter components. Instead, light and matter become intricately correlated, giving rise to new hybrid states of light and matter. Such states can be dominated by quantum effects, which in turn dictate the behavior of the materials. Through this new project, Koppens aims to manipulate materials in a completely different way, by making them interact with light at the nanoscale, confined within optical nanocavities. His goal is to miniaturize the size of the optical cavities, employing them for the first time to alter the properties of such hybrid materials.

Moore Foundation Funding Schemes

The Moore Foundation has awarded many research grants over the years to foster scientific discovery, environmental conservation, patient care improvements and preservation of the special character of the San Francisco Bay Area. The majority of these awards have gone to US-based institutions and include a notable large donation to Caltech, Gordon Moore's alma mater, to support basic research and discovery science in the life and physical sciences. That being said, their mission to i¿½foster path-breaking scientific discoveryi¿½ extends be ond the US borders and fosters international collaboration that is conducive to m jor breakthroughs. Likewise, it is highly flexible and complementary to any other nationa or international funding that the scientist may receive. ICREA Prof at ICFO Hugue de Riedmatten was the first ICFOnian to receive such funding in 2019 to link quantum nodes for the quantum interne

. ICFO Director Lluis Torner emphasizes, i¿½We are extremely proud to receive this grant from the Gordon and Betty Moore Foundation to advance the field of hybrid light-matter states, which are of paramount interest worldwide due to their potential to fundamental scientific discoveries and technological breakthroughs.i¿½

Dr. Dusan Pejakovic, Program Director in the Moore Foundation's Science Program, remarked: i¿½ICFO is a world-leading site for research on interactions of light with matter. As such, it is a perfect place to launch this risky project that explores novel concepts of solid-light hybrids. Given Prof Koppens' track record in conducting ground-breaking research, I expect exciting results from this grant.i¿½