ICFO Colloquium Series: Cavity materials engineering "How photons change the properties of matter"

ANGEL RUBIO

October 04, 2024

12:00 to 13:00

Auditorium

PROFILE:

Angel Rubio is the Director of the Theory Department of the Max Plank Institute for Structure and Dynamics of Matter at Hamburg where his research focuses on the modeling and theory of electronic and structural properties of condensed matter. His group works on developing novel theoretical tools, such as time-dependent functional theory for quantum electrodynamics and computational codes for the ab initio description and control of the dynamics of decoherence and dissipation in quantum many-body systems, and on characterizing new nonequilibrium states of matter. His work has been recognized by severa awards, including the 2018 Max Born medal and prize, 2016 Medal of the Spanish Roya Physical Society, the 2014 Premio Rey Jaime I for basic research, the 2006 DuPont Prize i nanotechnology, the 2005 Friedrich Wilhelm Bessel Research Award of the Humbold Foundation, and two European Research Council advanced grants (2011 and 2016). He is fellow of the American Physical Society, the European Physical Society, the Americ n Association for the Advancement of Science, the European Academy of Sciences, t e Academia Europaea, and a foreign associate member of the National Academy of Science

ABSTRACT:

One of the principal challenges in computational physics is to formulate an accurate yet computationally viable theory that can address non-equilibrium light-driven phenomena in molecules and quantum materials. Additionally, there is a need to simulate spatially and temporally resolved spectroscopies, ultrafast events, and newly emerging states of matter. In pursuit of this goal, TDDFT has emerged as the cutting-edge ab initio theoretical framework, enabling reliable and precise simulations of light-induced alterations in the physical and chemical characteristics of intricate systems. In this context, I will also introduce the recently developed framework of Quantum Electrodynamics Density-Functional Formalism (QEDFT). This framework offers a first-principles approach to predict, characterize, and manipulate the spontaneous emergence of ordered phases in strongly interacting light-matter hybrids, referred to as polaritons These phases manifest both as ground states, resulting in novel states of matter, as well as metastable states. Noteworthy examples include photon-mediated superconductivity, cavity fractional quantum Hall physics, and optically driven topological phenomena in low dimensions. This exploration brings to light a burgeoning field, which we term "Cavity Materials Engineering" or the science of strongly correlated electron-photon interactions. We will conclude with the great challenges ahead in this captivating field of research.

Hosted by Prof. Dr. Jens Biegert

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