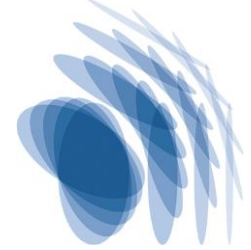


Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter



IMPRS UFAST Call for PhD applications 2025/2026

AR2 – Cavity quantum electrodynamical control of material phases



Title of PhD Project	Cavity quantum electrodynamical control of material phases
Type	Theoretical (Condensed Matter Physics)
Supervisor(s)	Prof. Angel Rubio Dr. Emil Viñas Boström Dr. Hannes Hübener
Affiliation(s):	Max Planck Institute for the Structure and Dynamics of Matter
Number of positions:	1
Abstract:	<p>Vacuum fluctuations of the electromagnetic field can have a non-trivial effect on its surroundings, as demonstrated by the Casimir effect. Coupling to these fluctuations also allow to modify material properties, such as electronic, magnetic and superconducting orders. The nascent field of cavity material engineering [1,2] stands in contrast to the well-studied regime of coupled collective excitations (so-called polaritonic physics and chemistry), in that it attempts to modify the materials' thermal equilibrium state.</p> <p>This project will focus on studying two-dimensional materials with unconventional electronic and magnetic orders, and how they can be modified through the interaction with confined electromagnetic fields. This will involve both standard Fabry-Perot like cavities, and cavities based on surface or hyperbolic polaritons. To describe hybrid light-matter systems with strong and quantum fluctuations correlations, we will use effective low-energy models derived from first principles simulations. To further increase the control over system, strong light-matter coupling may also be combined with finite temperatures and moiré twisting.</p> <p>[1] Hübener, H., Boström, E. V., et al. (2024). Quantum materials engineering by structured cavity vacuum fluctuations. <i>Materials for Quantum Technology</i>, 4 (2), 023002. https://doi.org/10.1088/2633-4356/ad4e8b</p> <p>[2] Hübener, H., de Giovannini, et al. (2021). Engineering quantum materials with chiral optical cavities. <i>Nature Materials</i>, 20 (4), 438–442. https://doi.org/10.1038/s41563-020-00801-7</p>
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