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# Light-Matter Coupling in Real and Artificial Two-Dimensional Lattices

The interaction of light and matter in solids sensibly depends on the nanoscopic properties of the materials. Consequently, controlling and engineering materials on the nanoscale is a crucial method to access and manipulate their most fundamental optical and electronic properties.

I will discuss two specific, extreme cases, to illustrate how controlling the coupling of light-and matter in semiconductor nanostructures yields the emergence of novel, fundamental phenomena :

The first material to be discussed are atomically thin transition metal dichalcogenide (TMDC) monolayers. I will show, that controlling the structural environment of such monolayers directly allows to study the emergence of manybody effects, as well as the fully deterministic localization of excitons. By integrating such materials in solid-state microcavities, I will show that laser-like radiation from a condensate of exciton-polaritons in a monolayer crystal can be established, whereas for the case of tightly localized excitons, the emission of single photons is observed.

I will further explain, how the strong spin-orbit coupling in TMDC materials can be potentially harnessed to observe and exploit spin-hall phenomena in the optical domain, and in perspective, to engineer topologically non-trivial, chiral exciton bands.

The second material class will be III-V semiconductor based microcavities with GaAs quantum wells. Here, I will specifically address the physics emergent from coupling individual microcavities to form photonic crystals lattices. In analogy to the case of layered semiconductors, the symmetries and topology of photonic bands in such lattices can be actively manipulated, which paves the way towards light-matter symbiotic topological insulators and topological lasers as novel, innovative light sources.

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