PhLAM
Physique des Lasers Atomes et Molécules

Unité Mixte de Recherche 8523 CNRS- Université de Lille

PhLAM RESEARCH SEMINAR SERIES
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IRCICA Building

Synthetic polariton matter : assembling matter with light

by

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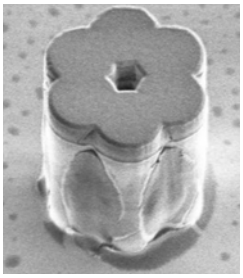
Materials are all composed of a periodic arrangement of atoms, in which electrons can move, interact within themselves or with vibrations of the lattice. The object of solid-state physics is to understand how macroscopic properties of solids emerge from their microscopic description.

Recently, new experimental techniques have been developed to explore the physics of crystalline matter. The idea is to assemble synthetic materials brick by brick, and to experimentally study their emerging macroscopic properties in the laboratory. For example, systems of neutral atoms or ions trapped in lattices, or even arrays of artificial atoms (quantum dots, superconducting circuits) have been realized to achieve this goal. Interesting questions are being raised when it comes to using light as a way to assemble synthetic materials: how can one provide photons with a mass? Is it possible to arrange light in ordered lattices? And can we make photons interact with each other?

In this talk I will discuss our efforts at C2N to realize synthetic materials made of light. Using nanotechnology techniques, we grow optical cavities made of semiconductor materials, and process them into micrometer-size traps. Once trapped into such cavities, the photons acquire a mass. Furthermore, by coupling light to electronic excitations of the semiconductor materials, we generate hybrid particles (polaritons) that are able to interact with each other. Finally, by fabricating lattices of coupled microcavities we realize synthetic molecules and materials with photons. I will describe in detail the examples of the photonic benzene molecule, and staggered honeycomb lattice. I will discuss the advantages of the photonic platform to implement useful devices such as microlasers, and to explore fundamental properties of lattices using advanced optical spectroscopy techniques



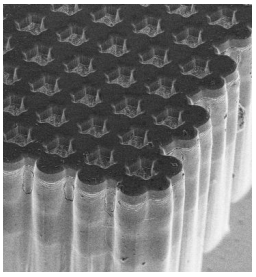


Figure : (Left) SEM image of an ensemble of six coupled microcavities forming a photonic benzene molecule. (Right) SEM image of an extended array of optical microcavities arranged into a synthetic crystal honeycomb lattice.