Master *Matière Condensée et Nanophysique*

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Title: Hybrid light – matter states and material properties

Summary: Just as atoms exchange electrons to form molecular orbitals, an electromagnetic field can interact with a quantum system by the exchange of photons. When this interaction is strong enough to overcome decoherence effects, new hybrid light-matter states can form, separated by what is known as the Rabi-splitting energy. This strong coupling regime is typically achieved by placing the material in an optical cavity, such as that formed by two parallel mirrors, which is tuned to be resonant with a transition to an excited state. Theory shows that even in the absence of light, a residual splitting always exists due to coupling to vacuum (electromagnetic) fluctuations in the cavity. The cavity strong coupling and the associated hybrid states have been extensively studied due to the potential they offer in optics and quantum physics such as room temperature Bose-Einstein condensates and thresholdless lasers. The implications for material properties are just beginning to be explored. For instance, strong coupling with organic materials lead to exceptionally large vacuum Rabi-splittings (hundreds of meV) as compared to inorganic materials due to their large transition dipole moments which can affect the chemical properties, the work-function and electronic transport of organic semiconductors [1-5]. The traineeship will be focused on this theme and will involve nanofabrication of samples, their characterization by optical techniques both static and time-resolved (femtosecond), together with the measurements of other properties.

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[4] E. Orgiu et al, Nature Materials 14, 1123-1129 (2015)
[5] J. George et al, Phys. Rev. Lett. 117, 153601 (2016)