Cavity-modified molecular dynamics

Supervisor: Johannes Feist (johannes.feist@uam.es)
Group web page: www.mmuscles.eu

It is nowadays routinely possible to reach the regime of strong light-matter coupling in experiments. In this regime, the interaction between confined light modes (such as optical cavity modes or plasmonic resonances in nanoparticles) and material excitations is faster than the decoherence of either component. The excitations of the system, called polaritons, then acquire hybrid light-matter character. While this general phenomenon has been realized in a wide range of platforms, a particularly interesting system is provided by the excitons of organic molecules due to their large coupling to light (large transition dipole moments) and their stability at room temperature. Consequently, the light-matter coupling strength, parameterized through the vacuum Rabi splitting (the energy splitting between the different polariton modes), can reach a significant fraction of the transition energy of the exciton. At the same time, organic molecules possess complex internal structure and dynamics, as for example demonstrated by the large difference between their light absorption and emission spectra, while the plasmonic modes used for strong single-molecule light-matter coupling are typically highly lossy and lead to femtosecond-scale emission dynamics. The interplay between these internal molecular dynamics and the hybrid character of the polaritons leads to complex light absorption and emission dynamics [1,2,3]. The goal of this master's thesis is to study ultrafast molecular dynamics in such settings. The work will combine concepts and techniques from electro-magnetism, molecular physics, and quantum optics, and will be performed within the supervisor's group at the Departamento de Física Teórica de la Materia Condensada.

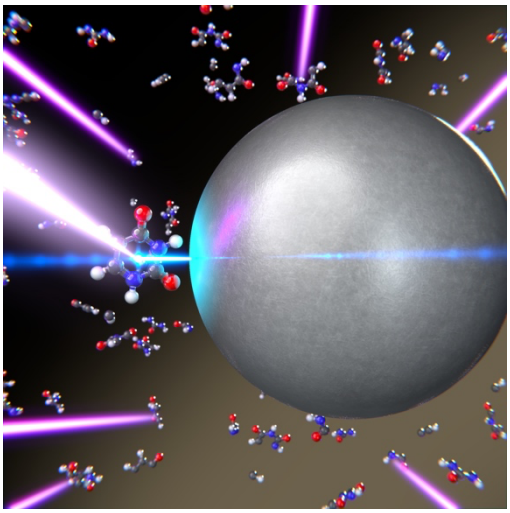

Illustration of photoprotection through strong light-matter coupling [3].

1. *Many-Molecule Reaction Triggered by a Single Photon in Polaritonic Chemistry*
   J. Galego, F. J. Garcia-Vidal, and J. Feist
   Phys. Rev. Lett. **119**, 136001 (2017)
2. *Tensor Network Simulation of Non-Markovian Dynamics in Organic Polaritons*
   J. del Pino, F. A. Y. N. Schröder, A. W. Chin, J. Feist, and F. J. Garcia-Vidal
   Phys. Rev. Lett. **121**, 227401 (2018)
3. *Photoprotecting uracil by coupling with lossy nanocavities*
   S. Felicetti, J. Fregoni, T. Schnappinger, S. Reiter, R. de Vivie-Riedle, and J. Feist
   J. Phys. Chem. Lett., in press (2020); arXiv:2007.07551