

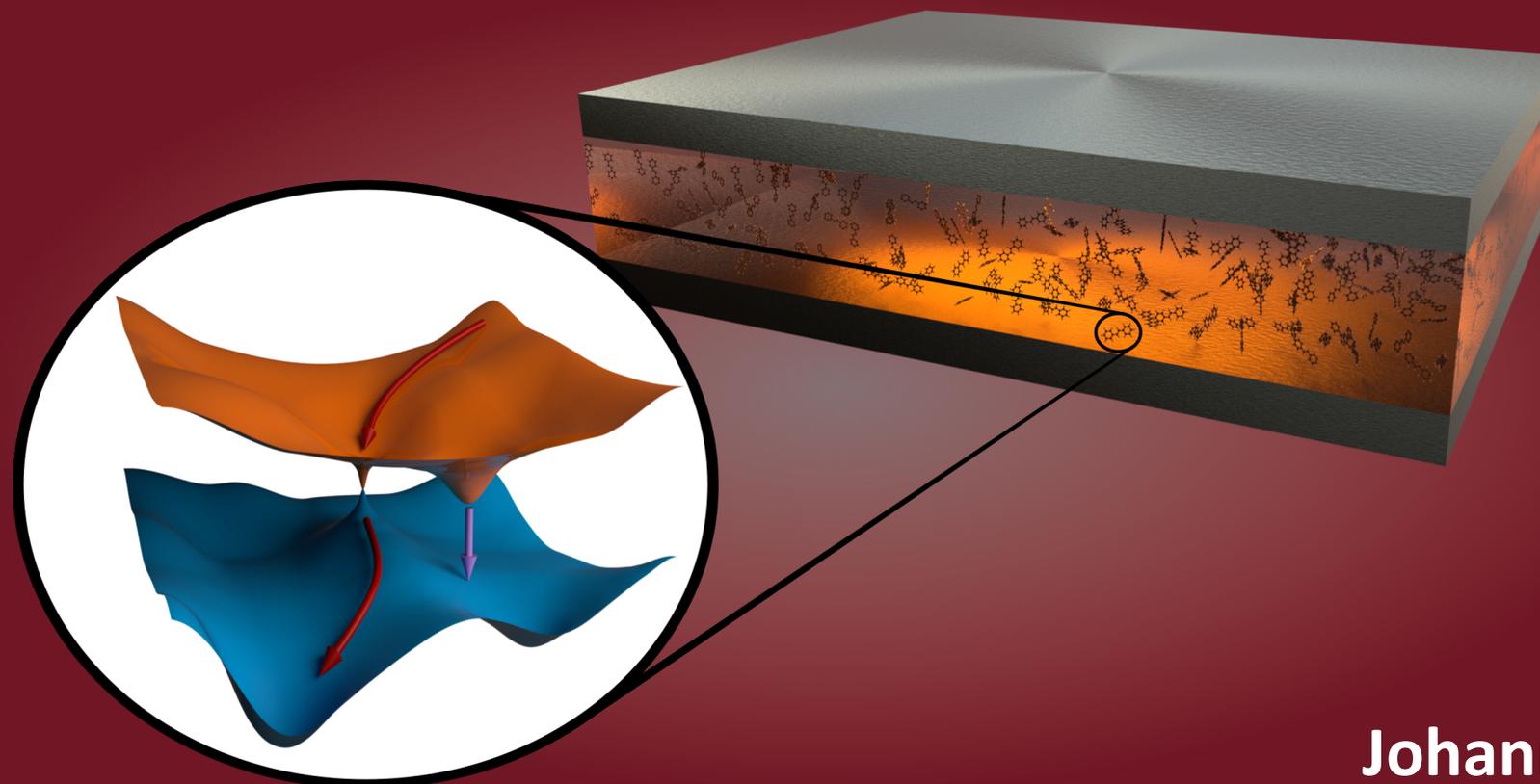
# Molecular polaritonics: Cavity-induced modifications of molecular structure and dynamics

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# Cavity-modified material properties

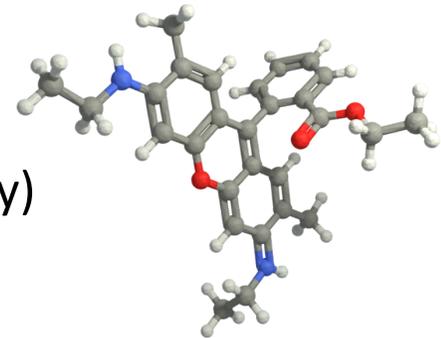
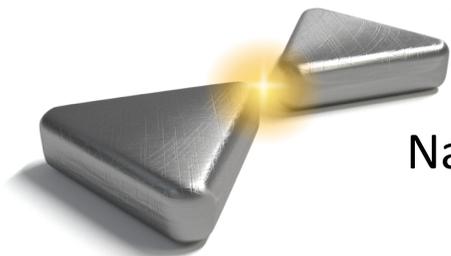
**Traditional nanophotonics:** tailor material properties to control the flow of light  
**New twist:** can we use **light (vacuum field)** to **modify material properties**?



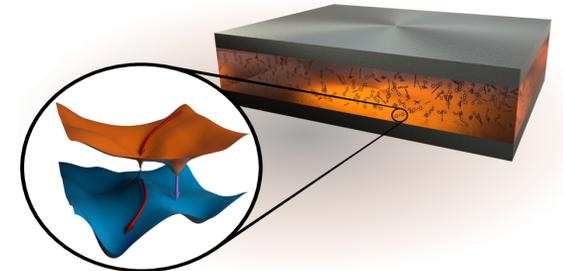
Enter the **QUANTUM** world and take advantage of the QED phenomenon of **strong coupling**, i.e., formation of hybrid light-matter states known as **polaritons**



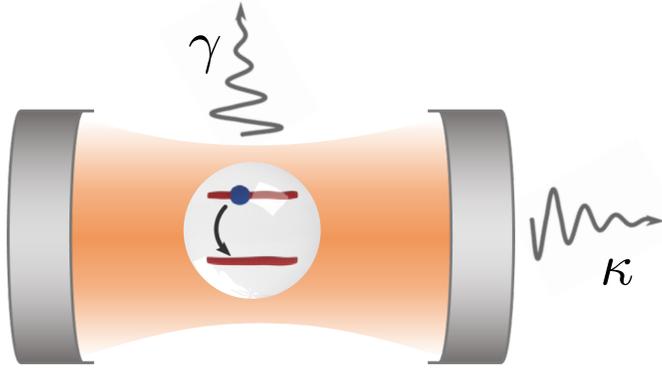
New field(s) of research have emerged that combine expertise from Nanophotonics, Materials Science, Quantum Optics, Chemistry (and Biology)



**Polaritonic Materials Science**  
**Molecular Polaritonics / Polaritonic Chemistry**



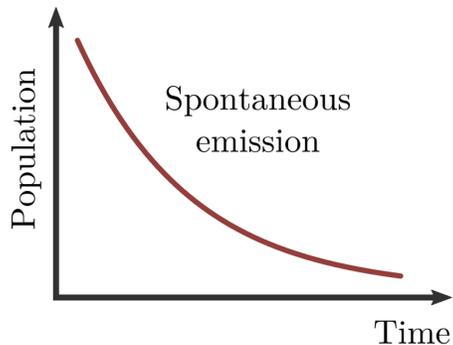
# Strong light-matter coupling



Cavity changes electromagnetic environment (density of states)

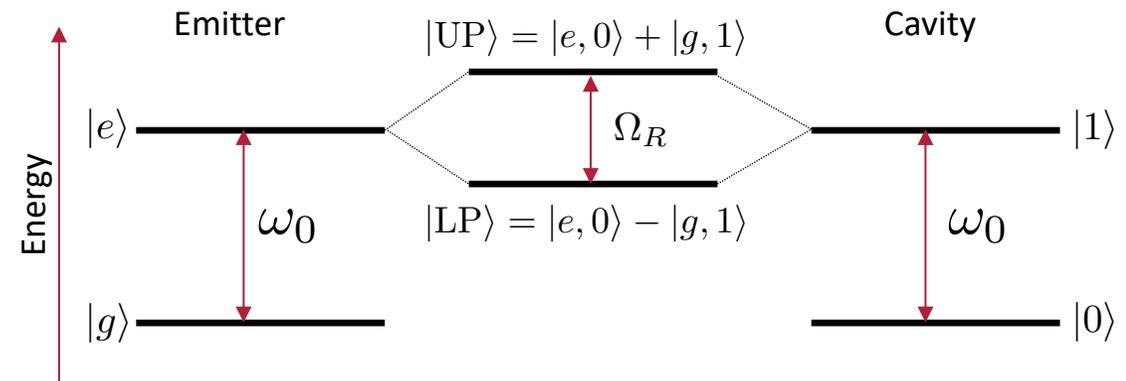
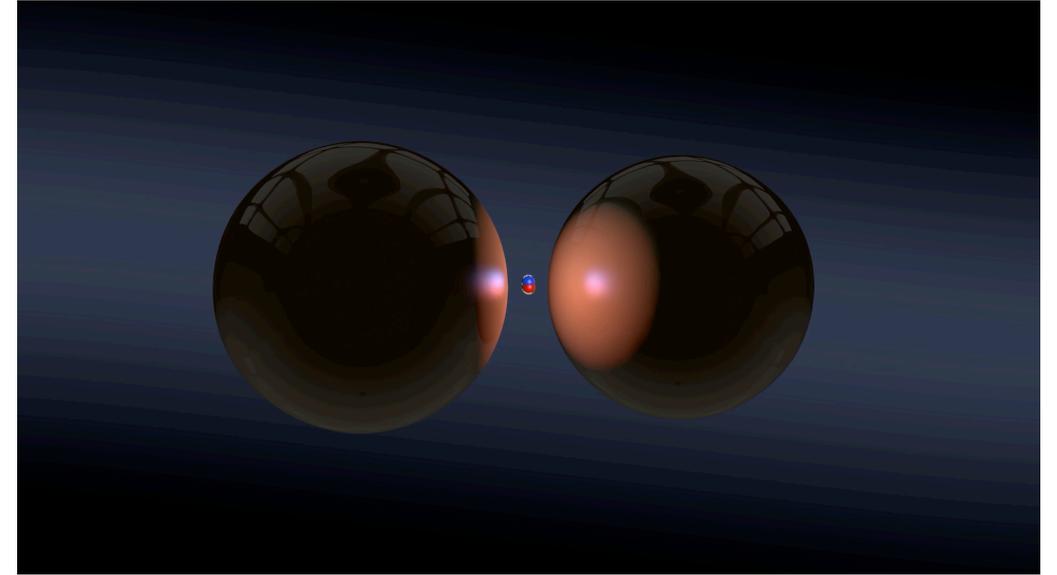
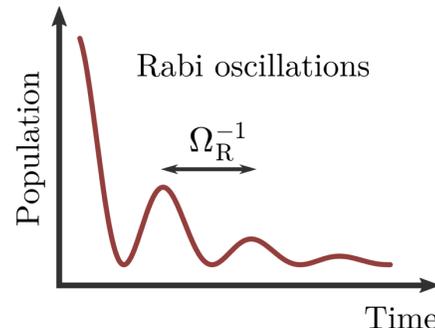
## Weak coupling ( $g \ll \gamma, \kappa$ )

- modify radiative decay (**Purcell effect**)



## Strong coupling ( $g \gtrsim \gamma, \kappa$ )

- **Vacuum Rabi oscillations** (coherent energy exchange)
- Hybrid light-matter states (**polaritons** / dressed states)



# Polaritonic chemistry

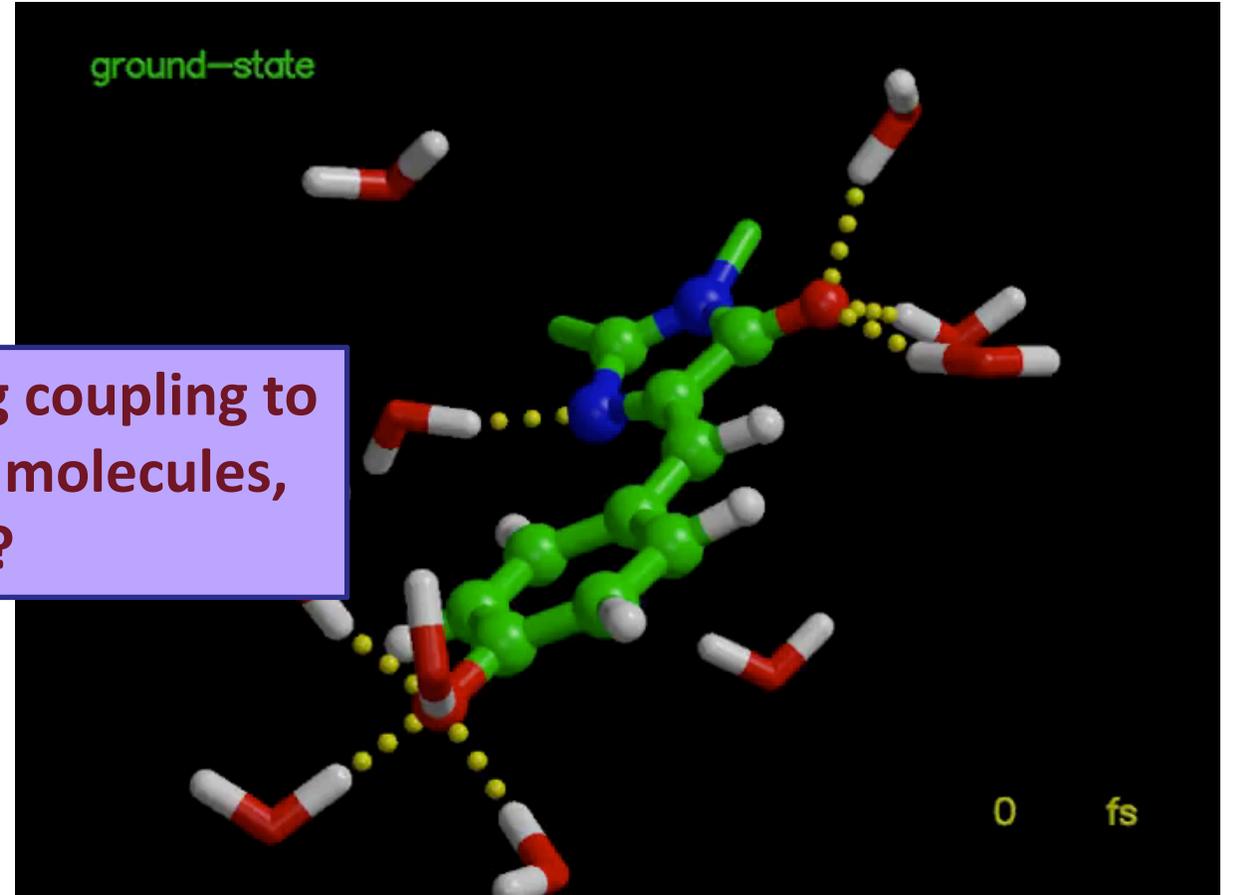


This is not a molecule!

Organic molecules are **co-emitters** with:

- Many nuclear (vibrational) DOFs
- Fast nuclear dynamics
- (Photo)chemical reactions

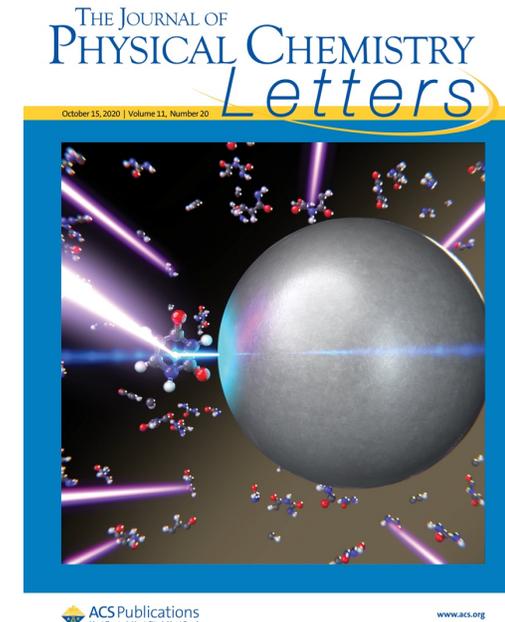
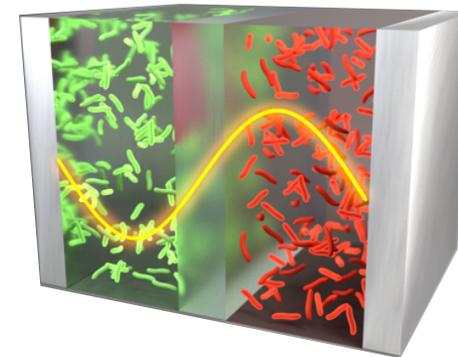
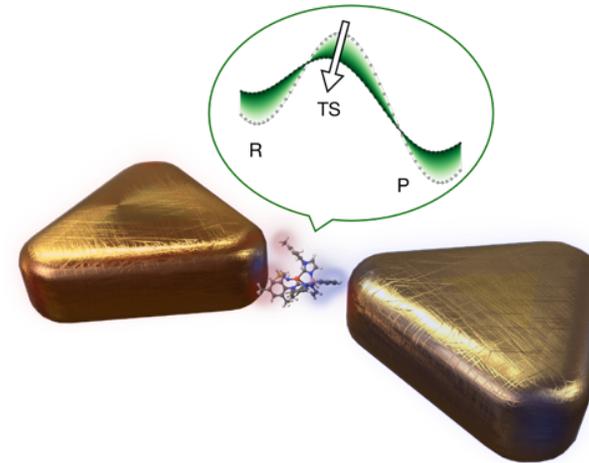
Can we use strong coupling to learn more about molecules, and control them?



(from G. Groenhof)

# Some research directions

- Modification of molecular structure, dynamics, and reactivity in plasmonic nanocavities
- Polariton-mediated energy transfer
- EM field quantization in nanophotonic structures
- Polaritonic quantum technologies



## Possible masters' thesis within CIVIS:

*“Nonadiabatic molecular dynamics in polaritonic chemistry”*

with **Markus Kowalewski**, Department of Physics, Stockholm University

# Team & Acknowledgements

## Local collaborators



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