

IMPRS UFAST focus course

Light-matter interactions from first-principles

Michael Ruggenthaler

Abstract:

Light-matter interactions beyond the perturbative regime have become important in the control and modifications of material properties. This is possible either when driving a matter system out of equilibrium with many photons, for instance via a laser, or when reaching strong light-matter coupling in photonic environments, e.g., in an optical cavity. While a prescription for coupling light and matter is given via quantum electrodynamics, in practice various different ways are employed and many fundamental problems remain for a mathematically consistent theory of coupled light-matter problems beyond the perturbative regime.

In this focus lecture we will re-derive quantum electrodynamics from first principles, highlight some of the mathematical problems that arise in the resulting quantum field theory, discuss how some of these problems can be circumvented for non-relativistic particles and present the most common approximation strategies and their ranges of applicability. If time permits, we will discuss different theoretical approaches to solve non-relativistic quantum electrodynamics non-perturbatively.

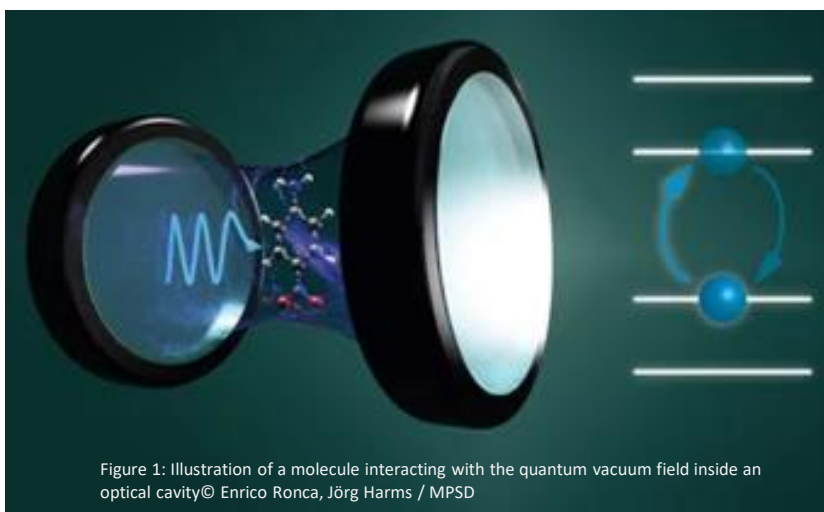


Figure 1: Illustration of a molecule interacting with the quantum vacuum field inside an optical cavity © Enrico Ronca, Jörg Harms / MPSD

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16th – 20th February 2026

09:30 h – 12:30 h

Register on Geventis: I-UF FC2

Registration deadline: 10th February