Fritz-Haber-Institut der Max-Planck-Gesellschaft

Physikalische Chemie — Direktor: Prof. Dr. Martin Wolf

MAX-PLANCK-GESELLSCHAFT

Department Seminar:

Thursday, October 17, 2019, at **11:00** a.m.;
— all are invited to meet at around 10:40 for a chat with coffee & cookies —

Dr. Mathieu Jeannin Département de Physique,
Ecole Normale Supérieure de Paris.

Ultrasmall Mode Volume THz LC circuits: from intersubband polaritons to photodetectors

PC Seminar Room G2.06, Building G, Faradayweg 4 A. Paarmann

Abstract:

Metamaterials, consisting of the periodic repetition of artificially designed meta-atoms with dimensions much smaller than the wavelength of interest λ_0, are often described as high frequency inductor-capacitor (LC) resonators sustaining a resonance at $\lambda_0=(LC)^{1/2}$. The LC circuit concentrates the electric field in an extremely small effective volume V_{eff} linked to its capacitive parts. Light-matter interaction occurring in the coupling between an absorber/emitter and the electric field inside the circuit capacitors scales as $1/ V_{eff}^{1/2}$, and can thus be strongly enhanced.

I will demonstrate a novel, three-dimensional metamaterial realizing a LC resonator which embeds a semiconductor active region in its capacitive elements. Unlike conventional metallic wafer bonding that requires a uniform metallic plane below the active region, this architecture relies on a newly developed processing technique to define structured metallic patterns co-aligned on both sides of the semiconductor layers. The active region hosts a two-dimensional electron gas sustaining an intersubband plasmon. The spectroscopic polaritonic features of the ultra-strong coupling regime achieved between the plasmon and the resonator mode allow to characterize the optical properties of the meta-atom, which has a highly subwavelength dimension ($\lambda_0/20$) and confines the electric field in a nanoscale volume $V_{eff} =10^{-6}\lambda_0^3$. I will discuss the potential application of this new kind of resonators for the study of ultra-strong light-matter coupling, as well as for the creation of a new generation of photoconductive THz detectors. Furthermore, I will discuss a new strategy to achieve a critical coupling with free-space radiation, enabling perfect absorption in the metamaterial-polariton system.