Seminar announcement

Tuesday, May 24, 2022
1:30 pm

WSI, Seminar room S 101
also ONLINE via ZOOM

https://tum-conf.zoom.us/j/67034732034

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"Ultrastrongly coupled single THz meta-atom and breakdown of topological protection by cavity vacuum fields in the integer quantum Hall effect"

Sub-wavelength electromagnetic field localization is a central theme in photonic research, as it allows sensing capabilities as well as increasing the light-matter coupling strength. Recently, the strong and ultrastrong light-matter coupling regime [1] in the THz range with split-ring resonators coupled to magnetoplasmons [2] has been widely investigated, achieving successive world-records for the largest light-matter coupling ever achieved. Ever-shrinking resonators have allowed to approach the regime of few electrons strong coupling, in which single-dipole properties can be modified by the vacuum field [3].

We will discuss, theoretically and experimentally, the existence of a limit to the possibility of arbitrarily increasing electromagnetic confinement in polaritonic systems. Strongly sub-wavelength fields can excite a continuum of high-momenta propagative magnetoplasmons [4]. This leads to peculiar nonlocal polaritonic effects, as certain polaritonic features disappear and the system enters in the regime of discrete-to-continuum strong coupling.

We will as well discuss experiments reporting spectroscopy of a single, ultrastrongly coupled, highly subwavelength resonator operating at 300 GHz. By using a combination of immersion lenses we unravel the linewidth dependence of planar metamaterials as a function of the meta-atom number indicating quenching of the superradiance. On these grounds, we investigate ultrastrongly coupled Landau polaritons at the single resonator level [5], measuring a normalized coupling ratio $\Omega\omega$=0.6.

Lastly, we will present magnetotransport measurements, showing that enhanced vacuum field fluctuations in subwavelength split-ring resonators dramatically affect the quantum Hall electron transport in high-mobility 2D electron gases. The observed breakdown of the topological protection of the integer quantum Hall effect is interpreted in terms of a long-range cavity-mediated electron hopping where the anti-resonant terms of the light-matter coupling finally result into a finite resistivity induced by the vacuum fluctuations [6].

[1] Forn-Diaz, P., et al., Rev. Mod. Phys.91, 025005 (2019)
[2] Scalari, G. et al., Science, 335, 1323–1326 (2012)
[3] R Chikkaraddy et al., Nature 535 (7610), 127-130 (2016)
[4] S. Rajabali, E. Cortese, M. Beck, S. De Liberato, J. Faist and G Scalari, Nat. Phot, (2021)
[5] S. Rajabali, S. Markmann, E. Jöchl, M.Beck, C. Lehner, W. Wegscheider, J. Faist and G. Scalari, Nat. Comm., in press (2022)
[6] F. Appugliese, J. Enkner, G. L. Paravicini-Bagliani, M. Beck, C. Reichl, W.Wegscheider, G. Scalari, C. Ciuti, and J. Faist, Science, 357, 1030 (2022)

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