P07

Strong coupling of magnetoplasmons to Faby-Pérot cavity modes

D. Yavorskiy[1,2,3], M. Białek[1], J. Wróbel[2], V. Umansky[4], M. Potemski[3],

and W. Knap[1,3]

[1]*Institute of High Pressure Physics, PAS, Warszawa, Poland*

[2]*Institute of Physics, PAS, Warszawa, Poland*

[3]*CENTERA, CEZAMAT, Warsaw University of Technology, Warszawa, Poland*

[4] *Braun Center for Submicron Research, Department of Condensed Matter Physics, Weizmann Institute of Science, Rehovot, Israel*
Email: dmitriy.yavorskiy@fuw.edu.pl.

Strong light-matter coupling forms polariton states, which are hybridized modes of electromagnetic cavity fields and a dipolar-active matter transition. In the terahertz (THz) range of frequencies, strong coupling can be achieved with many solid-state quasiparticles, such as phonons, magnons [1], or plasmons in two-dimensional electron gases (2DEG) [2]. Here, we consider cyclotron resonance and magnetoplasmons excited in a high electron mobility 2DEG based on GaAs/AlGaAs heterostructures coupled with Fabry-Pérot cavity modes formed by the sample substrate itself. We show that a strong coupling of excitations of two-dimensional electron gas can be achieved with Fabry-Pérot cavities of hundreds of μm dimensions. Additionally, we demonstrate that the coupling strength can be tuned with electron concentration.

During the experiments, samples were cooled down to 10 K in an optical cryostat with quartz windows. We used a THz time-domain spectrometer to measure reflection from GaAs samples fixed on a copper holder. Pulses of THz radiation were guided from an emitter to the sample using two parabolic mirrors, and the reflected beam was collected to the detector using an identical set of mirrors. The incident beam angle was equal to 10 degrees. We measured time-domain reflection traces as a function of the magnetic field, up to 2.5 T.

We prepared a sample patterned with rectangular 2DEG mesas of 3.1 μm side length ordered in a rectangular lattice with a period of 7.6 μm. In a reference sample without patterning, we observed polariton modes, manifested as avoided crossings of the cyclotron resonance with a series of cavity modes. Cavity modes in these series are spectrally separated by about 0.12 THz, which is mostly related to the thickness of the substrate and its dielectric constant. In a sample with patterning, we observed, as a function of the magnetic field, magnetoplasmon and edge magnetoplasmon, both of which interact with the cavity modes. We also observed that the coupling of plasmons with cavities is quenched when the second harmonic of the cyclotron resonance has a similar frequency. This observation poses basic questions on the mechanism of light-plasmon coupling in two-dimensional electron gases under strong magnetic fields when Bernstein modes are excited [3].

[1] M. Bia lek, W. Knap, and J.-P. Ansermet, PRA 19, 064007 (2023).

[2] M. Geiser, F. Castellano, G. Scalari, M. Beck, L. Nevou, and J. Faist, PRL. 108, 106402 (2012).

[3] V. V. Zheleznyakov, E. Y. Zlotnik, Sol. Phys. 43, 431–451 (1975).