Characterization and analysis of a symmetry-breaking THz chiral metamaterial

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Ultra-strong coupling (USC) between the cyclotron resonance of a 2D electron gas in a static perpendicular magnetic field and a cavity able to sustain chiral electromagnetic modes provides a way to break time-reversal symmetry, that is polaritonic states with opposite circular polarizations arise.
To investigate polaritons dressed by the electromagnetic vacuum in the cavity, highly subwavelength interacting volumes along with strongly polarizable materials must be employed, and to this purpose an antenna-based metamaterial coupled to electrons confined in quantum wells (QWs) in a GaAs / AlGaAs heterostructure is engineered and characterized by means of THz time-domain spectroscopy.
Classical circuit theory provides an understanding of the coupling mechanism and its limitations by cavity and material losses in an intuitive way, and may give insights on how to adapt the exact Hamiltonian approach to planar cavities.

References

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Figures

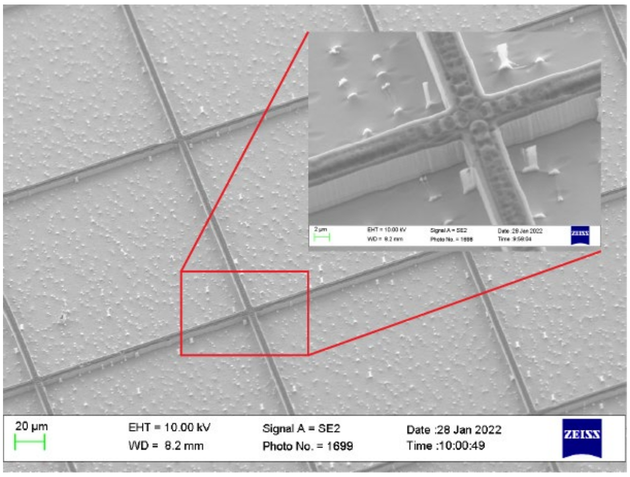

Figure 1: SEM image of the chiral metamaterial. Inset: zoom in to the antenna gap, where the field interacts with the 2DEG.

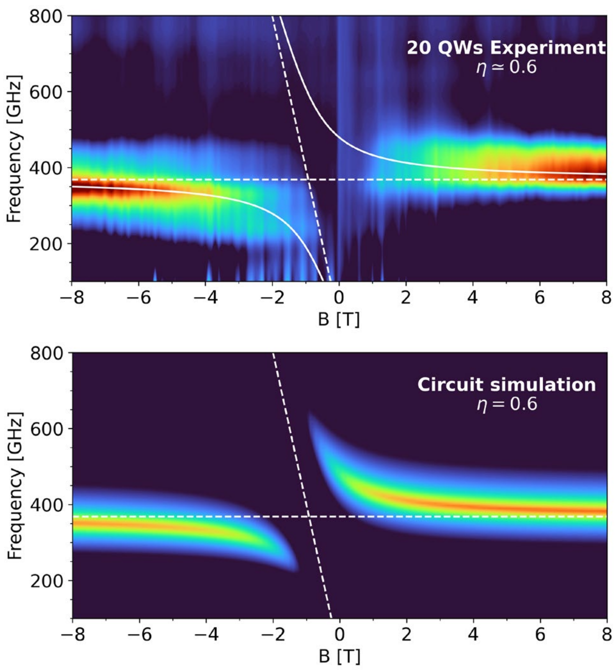

Figure 2: (top) Logarithm of transmission from metamaterial sample with 20 quantum wells, as a function of magnetic field and frequency of the excitation. (bottom) Simulation via circuital approach. The dashed lines are the cavity frequency (horizontal) and cyclotron resonance (diagonal). The estimated normalized coupling is 0.6.