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EINLADUNG zum IFP-SEMINAR

Ultrastrong coupling of 2D electrons with terahertz cavity photons

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Nonperturbative coupling of light with condensed matter in an optical cavity is expected to reveal a host of coherent many-body phenomena and states that are inaccessible in equilibrium. In addition, strong coherent light-matter interaction in a solid-state environment is of great interest to emerging quantum-based technologies. However, creating a system that combines a long electronic coherence time, a large dipole moment, and a high cavity Q-factor has been a challenging goal. Here, we report collective ultrastrong light-matter coupling in an ultrahigh-mobility two-dimensional electron gas in a high-Q terahertz photonic-crystal cavity in a quantizing magnetic field, demonstrating a cooperativity of 360. The splitting of cyclotron resonance (CR) into the lower and upper polariton branches exhibited a $\sqrt{n_e}$-dependence on the electron density (n_e), a hallmark of collective vacuum Rabi splitting. Furthermore, a small but definite blue shift was observed for the polariton frequencies due to the normally negligible A^2 term in the light-matter interaction Hamiltonian. Finally, the high-Q cavity suppressed the superradiant decay of coherent CR, which resulted in an unprecedentedly narrow intrinsic CR linewidth of 5.6 GHz at 2 K.