Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Ultrastrong coupling cavity QED of the magnetic cyclotron transition in a 2D electron gas: massive versus Dirac fermions DAVID HAGENMÜLLER, SIMONE DE LIBERATO, CRISTIANO CIUTI, Laboratoire Matériaux et Phénomènes Quantiques, Université Paris Diderot-Paris 7 and CNRS, 75205 Paris Cedex 13, France — We show that the cyclotron transition of a two-dimensional electron gas can be ultrastrongly coupled to a cavity photon mode. The ratio between the vacuum Rabi frequency Ω_0 and the cyclotron frequency ω_0 can be much larger than 1 for large filling factor ν of the Landau levels (the normalized coupling Ω_0/ω_0 scales as $\sqrt{\alpha\, n_{QW}\nu}$, where α is the fine structure constant and n_{QW} is the number of quantum wells). We present a comprehensive cavity QED theory both for semiconductors with massive electrons[**?**, **?**] and graphene with Dirac fermions[**?**]. We show the dramatic impact on the quantum ground state and excitation properties, drawing the comparison between the two different types of 2D electron gas.

[1] D. Hagenmüller, S. De Liberato, and C. Ciuti, Phys. Rev. B 81, 235303 (2010) and references therein.
[2] Experiments demonstrating ultrastrong coupling of the cyclotron transition in a GaAs-system in the THz regime have been reported, see G. Scalari *et al.*, submitted.
[3] D. Hagenmüller and C. Ciuti, submitted.

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Date submitted: 27 Oct 2011 Electronic form version 1.4