Dirac Light

Eros Mariani, C.-R. Mann, W.L. Barnes, S.A.R. Horsley, T. Sturges and G. Weick
Department of Physics and Astronomy, University of Exeter, Stocker Rd EX4 4QL Exeter, UK
E.Mariani@exeter.ac.uk

Abstract

Pseudorelativistic Dirac quasiparticles have emerged in a plethora of artificial graphene systems that mimic the honeycomb symmetry of graphene. However, in these metamaterials it is notoriously difficult to manipulate the properties of Dirac quasiparticles without modifying the lattice structure.

Here we theoretically investigate Dirac polaritons (called "Dirac light") supported by honeycomb metasurfaces embedded in photonic cavities and unveil rich Dirac physics stemming from the competition between short-range Coulomb interactions and long-range photon-mediated interactions. By modifying only the photonic environment via the enclosing cavity we show that we can induce qualitatively different polariton phases and alter the fundamental properties of Dirac light [1-3].

Among several effects we discuss in particular the creation and manipulation of type I and type II Dirac points, the inversion of chirality of Dirac light [1], as well as the tunable fictitious magnetic fields for Dirac light in strained lattices. The latter is accompanied by a tunable Lorentz-like force that can be switched on/off and by a collapse and revival of polariton Landau levels [2].

We stress that the crossover between the different phases of Dirac light can be achieved by varying only the photonic cavity width while preserving the lattice structure—a unique scenario that has no analog in real or artificial graphene systems. Exploiting the photonic environment thus gives rise to unexplored Dirac physics beyond the conventional paradigms of metamaterials science.

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References

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