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Solid-state physics and quantum electrodynamics, with its relativistic (massless) particles, meet in steadily expanding class of materials. Those include, 1D carbon nanotubes, 2D graphene or topological-insulator surfaces, and most recently, the systems with 3D conical dispersion - with Weyl, Dirac or Kane fermions. In this talk, I will review how the linear dispersion impacts the (magneto-) optical properties of these systems.

We focus on two representative materials: a 2D graphene and bulk HgCdTe which displays the 3D conical dispersion when tuned to the point of the semiconductor-to-semimetal transition. We show that it is the number of dimensions, which defines the (joint) density of states, and in consequence, the simple physical quantities such as absorption of light - dispersionless in graphene but displaying a linear-in-photon-energy dependence in HgCdTe. In magnetic field, the optical response is determined by by electronic excitations between discrete or dispersion Landau levels (in 2D or 3D), both, however, with a typical for relativistic particles, square root dependence on the magnetic-field. Further relativistic effects may appear, depending on the strength of spin-orbit coupling. Spin-related effects are rather absent in the optical response of graphene which exhibits a weak spin-orbit coupling. Instead, we observe a pronounced spin splitting of levels in HgCdTe, which follows the square-root-magnetic-field dependence - a well-established signature of relativistic particles.

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