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Theory of a quantum critical phenomenon in a topological insulator: (3+1)-dimensional quantum electrodynamics in solids HIROKI ISOBE, NAOTO NAGAOSA, Department of Applied Physics, University of Tokyo — We study theoretically the quantum critical phenomenon of the phase transition between the trivial insulator and the topological insulator in (3+1) dimensions, which is described by a Dirac fermion coupled to the electromagnetic field. The intriguing result is the recovery of the Lorentz invariance in the infrared limit, and the electrons in solids obey the conventional QED. In detail, the renormalization group (RG) equations for the running coupling constant α, the speed of light c, and electron v are derived by using perturbative RG method to one-loop level. The almost exact analytic solutions to these RG equations are obtained to reveal that (i) c and v approach to the common value with combination c^2v being almost unrenormalized, (ii) the RG flow of α is the same as that of usual QED with c^3 being replaced by c^2v, and (iii) there are two crossover momentum/energy scales separating three regions of different scaling behaviors. The dielectric and magnetic susceptibilities, angle-resolved photoemission spectroscopy (ARPES), and the behavior of the gap are discussed from this viewpoint. Reference: H. Isobe and N. Nagaosa, Phys. Rev. B **86**, 165127 (2012).

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