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The role of pseudospin in the optical and electronic properties of relativistic materials

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Graphene, a two-dimensional carbon material discovered in 2004, is the hallmark relativistic material. Its charge carriers, although moving at less than one percent the speed of light, are described by the massless Dirac equation (derived in 1928 for ultrarelativistic fermions). These Dirac fermionic quasiparticles carry not only the intrinsic spin-1/2 of the electron, but are imbued with an additional emergent spin-1/2, referred to as pseudospin. It is no stretch of the imagination then to consider the existence of relativistic condensed matter systems with particles of pseudospin higher than 1/2. This thesis details some of the optical and electronic properties of such systems, exhibiting individual characteristic signatures. These experimentally accessible signatures may then lend to the discovery of novel materials that are similar to graphene, but enjoy their own fascinating properties as well.

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