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Topological nonsymmorphic metals from band inversion

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We expand the phase diagram of two-dimensional, nonsymmorphic crystals at integer fillings that do not guarantee gaplessness. In addition to the trivial, gapped phase that is expected, we find that band inversion leads to an unexplored class of topological, gapless phases. These topological phases are exemplified by the monolayers of MTe2 (M = W, Mo) if spin-orbit coupling is neglected as model systems. We characterize the Dirac band touching of these topological metals by the Wilson loop of the non-Abelian Berry gauge field. Furthermore, we develop a criterion for the proximity of these topological metals to 2D and 3D Z2 topological insulators when spin-orbit coupling is included; our criterion is based on nonsymmorphic symmetry eigenvalues, and may be used to identify topological materials without inversion symmetry. An additional feature of the Dirac cone in monolayer MTe2 is that it tilts over in a Lifshitz transition to produce electron and hole pockets – a type-II Dirac cone. These pockets, together with the pseudospin structure of the Dirac electrons, suggest a unified, topological explanation for the recently-reported, non-saturating magnetoresistance in WTe2, as well as its circular dichroism in photoemission.