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Hourglass Fermions ZHIJUN WANG, A. ALEXANDRADINATA, ROBERT J. CAVA, B. ANDREI BERNEVIG, Princeton University — Spatial symmetries in crystals are distinguished by whether they preserve the spatial origin. We show how this basic geometric property gives rise to a new topology in band insulators. We study spatial symmetries that translate the origin by a fraction of the lattice period, and find that these nonsymmorphic symmetries protect a novel surface fermion whose dispersion is shaped like an hourglass; surface bands connect one hourglass to the next in an unbreakable zigzag pattern. These exotic fermions are materialized in the large-gap insulators: KHgX (X=As,Sb,Bi), which we propose as the first material class whose topology relies on nonsymmorphic symmetries. Beside the hourglass fermion, a different surface of KHgX manifests a 3D generalization of the quantum spin Hall effect. To describe the bulk topology of nonsymmorphic crystals, we propose a non-Abelian generalization of the geometric theory of polarization. Our nontrivial topology originates not from an inversion of the parity quantum numbers, but rather of the rotational quantum numbers, which we propose as a fruitful in the search for topological materials. Finally, KHgX uniquely exemplifies a cohomological insulator, a concept that we will introduce in a companion work.

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