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Hourglass semimetals LUYANG WANG, SHAO-KAI JIAN, HONG YAO, Tsinghua University — It was recently found that nonsymmorphic space group symmetries can protect surface states with hourglass-like dispersion. Here, we show that such dispersion can also appear in the bulk of systems which have nonsymmorphic symmetries. We construct lattice models with hourglass-like band structures in the bulk of systems in one, two, and three dimensions, which are protected by nonsymmorphic symmetries and time reversal symmetry. We name such materials as hourglass semimetals, since they all have point or line node degeneracies due to the hourglass-like dispersion. In three dimensions, the hourglass nodal lines in high symmetry planes are protected by glide reflection symmetry, while the hourglass Weyl points at high symmetry axes are protected by screw rotation symmetry. In the latter case, the hourglass Weyl semimetals host four Weyl points at each screw invariant axis, which can collectively disappear and reemerge when tuning spin-orbit couplings. These Weyl points are stable even if perturbations that break all the symmetries are turned on, but their locations shift away from the high symmetry axes. This scenario also provides a systematic way to find new nodal line and Weyl semimetals.

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