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Artificial gravity field, astrophysical analogues, and topological phase transitions in strained topological semimetals ZHIMING YU, Singapore University of Technology and Design, SHAN GUAN, YUGUI YAO, Beijing Institute of Technology, SHENGYUAN YANG, Singapore University of Technology and Design — Effective gravity and gauge fields are emergent properties intrinsic for low-energy quasiparticles in topological semimetals. Here, taking two Dirac semimetals as examples, we demonstrate that applied lattice strain can generate warped spacetime, with fascinating analogues in astrophysics. Particularly, we study the possibility of simulating black-hole/white-hole event horizons and gravitational lensing effect. Furthermore, we discover strain-induced topological phase transitions, both in the bulk materials and in their thin films. Especially in thin films, the transition between the quantum spin Hall and the trivial insulating phases can be achieved by a small strain, naturally leading to the proposition of a novel piezo-topological transistor device. Our result not only bridges multiple disciplines, revealing topological semimetals as a unique table-top platform for exploring interesting phenomena in astrophysics and general relativity; it also suggests realistic materials and methods to achieve controlled topological phase transitions with great potential for device applications.

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