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Quantum transport of two-species Dirac fermions in dual-gated three-dimensional topological insulators[1] YANG XU, IRENEUSZ MIOTKOWSKI, YONG P. CHEN, Department of Physics and Astronomy, Purdue University — Topological insulators (TI) are a novel class of quantum matter with a gapped insulating bulk yet gapless spin helical Dirac fermion conducting surface states. Here, we report local and non-local electrical and magneto transport measurements in dual-gated $BiSbTeSe_2$ thin film TI devices, with conduction dominated by the spatially separated top and bottom surfaces, each hosting a single species of Dirac fermions with independent gate control over the carrier type and density. We observe many intriguing quantum transport phenomena in such a fully-tunable two-species topological Dirac gas, including a zero-magnetic-field minimum conductivity of $4e^2/h$ at the double Dirac point, a series of ambipolar two-component "half-integer" Dirac quantum Hall states and an electron-hole total filling factor ν=0 state (with a zero-Hall plateau), exhibiting dissipationless (chiral) and dissipative (non-chiral) edge conduction respectively. Such a system paves the way to explore rich physics ranging from topological magnetoelectric effects to exciton condensation.

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