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Quantum spin Hall effect in the graphene zero energy Landau level - Part I ANDREA F. YOUNG, JAVIER D. SANCHEZ-YAMAGISHI, BEN HUNT, PABLO JARILLO-HERRERO, RAY C. ASHOORI, MIT, TAKASHI TANIGUCHI, KENJI WATANABE, NIMS — Shortly after the experimental discovery of graphene, it was predicted that Zeeman splitting of the graphene zero energy Landau level results in a quantum spin Hall phase, characterized by counterpropagating spin-filtered edge states. However, experimental realization of this state has been obscured by the existence of competing Coulomb interaction-driven insulating phases. We address this problem by fabricating monolayer graphene devices in which the Coulomb interaction is heavily screened by a proximal graphite gate. Despite the reduction in the strength of intralayer interactions, the resulting high mobility samples show all the usual signatures of Coulomb-driven symmetry breaking in high magnetic fields, with a strong insulating state developing at charge neutrality at fields of $\sim$1 Tesla. Unlike in conventional samples, however, we observe a continuous transition from this insulating state to a conducting state of order e^2/h as a function of in-plane field. Simultaneous high-sensitivity capacitance measurements reveal that the sample bulk remains gapped throughout the transition. The observation of finite conduction in the presence of a bulk insulator strongly implies that transport occurs via the edge states characteristic of the quantum spin Hall state.

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