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Quantum spin Hall effect in the graphene zero energy Landau level - Part II JAVIER D. SANCHEZ-YAMAGISHI, ANDREA F. YOUNG, BENJAMIN HUNT, Massachusetts Institute of Technology, KENJI WATANABE, TAKASHI TANIGUCHI, Advanced Materials Laboratory, National Institute for Materials Science, RAY C. ASHOORI, PABLO JARILLO-HERRERO, Massachusetts Institute of Technology — Zeeman splitting of graphene's zeroth Landau level has been predicted to lead to a quantum spin Hall effect, but a competing interaction-driven insulating state has hampered previous attempts to drive the graphene into this regime. By using a proximal graphite gate to screen Coulomb interactions in the graphene, we are able to reduce the strength of this competing insulating state and observe a continuous transition to a conductive state as a function of in-plane field. We study this transition simultaneously in capacitance and transport, and find that despite conduction increasing by many orders of magnitude with in-plane field the bulk remains gapped throughout the transition. These observations indicate the continuous closing of a transport gap along the edge of the sample, with resulting counter-propagating edge states that are characteristic of the quantum spin Hall effect. We discuss the behavior of this transition across multiple samples with various levels of Coulomb screening, and present nonlocal multiterminal transport measurements designed to probe the nature of backscattering within the edge states. We also comment on the implications of our work for the rest of the graphene phase diagram at high magnetic fields.

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