Electrical Generation and Detection of Spin Waves in a Quantum Hall Ferromagnet

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Spin waves are essential to understanding the intrinsic ordering and thermodynamic properties of magnetic systems. An attractive candidate for studying long-lived spin-wave physics is the quantum Hall (QH) ferromagnet, which forms spontaneously in clean two-dimensional electron systems at low temperature and in a perpendicular magnetic field. However, the charge-neutral nature of these elementary spin excitations has made them challenging to detect and study. Here we use out-of-equilibrium occupation of QH edge channels in graphene to excite and detect spin waves in magnetically ordered QH states. Our experiments provide direct evidence for long distance spin wave propagation through different ferromagnetic phases in the N=0 Landau level (LL), as well as across the insulating canted antiferromagnetic (CAF) phase. Our results open a new arena of experimental investigation into the fundamental magnetic properties of these exotic two-dimensional electron systems.