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Low frequency spin dynamics in a quantum Hall canted antiferromagnet

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In quantum Hall (QH) systems, Coulomb interactions combined with the macroscopic degeneracy of Landau levels (LLs) drive the electron system into strongly correlated phases as illustrated by the series of fractional QH effects and may also lead to various forms of broken symmetry dictated by the LL filing factor ν. When two layers of such electron systems are closely separated by a thin tunnel barrier, the addition of interlayer interactions and the layer degree of freedom brings about even richer electronic phases, opening up possibilities for different classes of symmetry breaking. In particular, at total filling factor $\nu_T = 2$, where the two of the four lowest LLs split by the Zeeman and interlayer tunnel couplings are occupied, the competing degrees of freedom due to the layer and spin are predicted to lead to rich magnetic phases. Here we present results of resistively detected nuclear spin relaxation measurements in closely separated electron systems that reveal strong low-frequency spin fluctuations in the QH regime at $\nu_T = 2$ [1]. As the temperature is decreased, the spin fluctuations, manifested by a sharp enhancement of the nuclear spin-lattice relaxation rate $1/T_1$, continue to grow down to the lowest temperature of 66 mK. The observed divergent behavior of $1/T_1$ signals a gapless spin excitation mode (i.e., a Goldstone mode) and is a hallmark of the theoretically predicted canted antiferromagnetic order. Our data demonstrate the realization of a two-dimensional system with broken planar spin rotational symmetry, in which fluctuations do not freeze out when approaching the zero temperature limit. [1] N. Kumada, K. Muraki, and Y. Hirayama, Science **313**, 329 (2006).