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Evidence of low-lying gapped excitations in the ν =5/2 quantum fluid[1]

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The competition between quantum phases that dictate the physics in the second Landau level (SLL) results in striking phenomena. A highly fascinating state is the even denominator fractional quantum Hall (FQHE) state at filling ν =5/2 that is widely believed to support non-Abelian quasi-particle excitations. Our work explores the low-lying neutral excitation modes in the SLL by resonant inelastic light scattering measurements. At 5/2 the spectra revealed a band of gapped modes with peak intensity at energy of 0.07meV. These modes are interpreted as a roton minimum in the wave vector dispersion of spin-conserving excitations. The intensity of the roton band significantly diminishes by increasing the temperature to 250mK and it fully collapses for T> 250mK. This temperature dependence is consistent with activated magneto-transport of the incompressible quantum fluid at 5/2. A long wavelength spin wave mode (SW) is seen at the bare Zeeman energy, indicating that there is non-zero spin-polarization. Both, roton and SW modes appear only in a very narrow filling factor range of less than ν< 5/2 $\pm$ 0.01. A gapless continuum of low-lying excitations emerges at filling factors slightly away from 5/2. This demonstrates a transition from an incompressible quantum Hall fluid at exactly ν =5/2 to compressible states at very close filling factors. This work is in collaboration with A. Pinczuk, A. Levy, K. West, L. Pfeiffer, S. Mondal, J. Watson and M. Manfra.

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