When is the fractional quantum Hall effect stable

YANG LIU, JAVAD SHABANI, MANSOUR SHAYEGAN, Dept. of Electrical Engineering, Princeton University — The fractional quantum Hall (FQH) effect, signaled by the vanishing of the longitudinal resistance and the quantization of the Hall resistance, is the hallmark of interacting two-dimensional electrons in a large perpendicular magnetic field. The effect is most prominently observed at low Landau level (LL) filling factors (ν) and is conspicuously absent for ν > 4. We examine the stability of the FQH states at high fillings in a 2D electron system in a wide GaAs quantum well which we can tune the Fermi energy (E_F) to lie, at a given filling factor, in different LLs of two electric subbands. The data provide direct and definitive evidence that the stability of the FQH states is linked to the LL where E_F resides. We observe FQH states at high filling factors such as 13/3, 14/3, 16/3, and 17/3, but only when E_F lies in the ground state (N = 0) orbital LLs of either of the two electric subbands, regardless of the underlying, fully occupied levels.

1We acknowledge support through the NSF (DMR-0904117 and MRSEC DMR-0819860) for sample fabrication and characterization, and the DOE BES (DE-FG0200-ER45841) for measurements.

Yang Liu
Dept. of Electrical Engineering, Princeton University

Date submitted: 14 Dec 2010

Electronic form version 1.4