Even-denominator ν = ½ Fractional Quantum Hall Effect in GaAs 2D Hole Systems

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When electrons at sufficiently high density are confined to a high-quality *wide* GaAs quantum-well, they occupy two electric subbands and possess a bilayer-like charge distribution. Under appropriate conditions, the additional layer and/or subband degree of freedom stabilizes a special fractional quantum Hall state (FQHS) at the *even-denominator* Landau level filling factor ν = ½ [1,2]. This state is generally believed to be the two-component Halperin (331) state, a FQHS with strong inter-layer and intra-layer correlations. Although the ν = ½ state was discovered over 20 only years ago, its observation has been only reported in high quality GaAs electron systems [1-5].

Here we report the first observation of the ν = ½ FQHS in GaAs *hole* systems. Figure 1 shows the longitudinal and Hall resistances measured in a symmetric 35-nm-wide GaAs quantum well at density p = 1.44 x 10^{11} cm^{-2}. At filling factor ν = 1/2, we observe a strong minimum in R_{xx} and a clear plateau in R_{xy} quantized at $2h/e^2$. As a function of density, we observe an evolution of the ν = ½ FQHS which is qualitatively similar to that of the electron systems: the FQHS is only observed at intermediate densities; the system becomes metallic at low densities, and insulating at very high densities [2,3]. However, we also observe an unexpectedly strong ν = ½ FQHS which is unique to 2D hole systems.

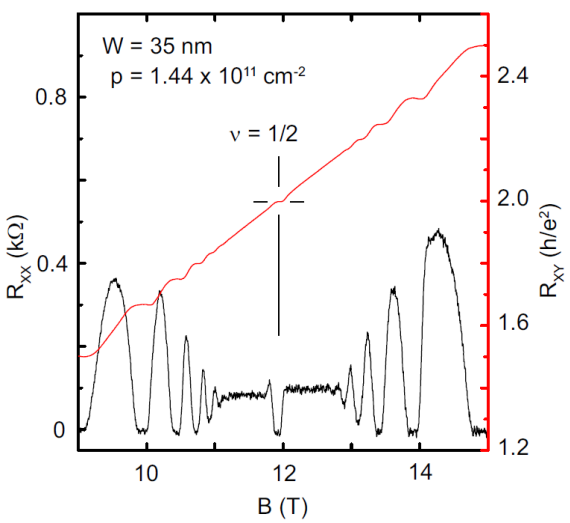

Fig. 1. Longitudinal (R_{xx}) and Hall (R_{xy}) resistances taken from a 2D hole system in a symmetric 35-nm-wide GaAs quantum well.

We discuss the results of our study, carried out as a function of both density and quantum well width, in light of the very complex and rich band structure of GaAs 2D holes.

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