Quantum Hall resistance anomalies observed at $\nu = 1/3$ and $1 < \nu < 2$ in two-dimensional hole system

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We have grown p-channel GaAs/AlGaAs heterostructure with Be dopant on (100) GaAs substrate, and obtained two-dimensional hole system (2DHS) with decent mobility (30 $m^2V^{-1}s^{-1}$ at 20 mK) at relatively low carrier density (1.1×10^{15} m^{-2}). Our sample differs from most of today's high mobility 2DHS that are grown on (311)A GaAs substrate with silicon dopant. We have observed anomalous behavior at low temperatures in two specific regions of fractional quantum Hall (FQH) regime. A series of FQH states develop normally as temperature is lowered down to $\sim$ 100 mK showing well-developed Hall plateaus and zero resistance states. Aroung filling $\nu = 1/3$, however, the zero resistance state becomes unstable as temperature is further lowered. The magnetoresistance exhibits reproducible aperiodic fluctuations, whose amplitude becomes larger with decreasing temperature. The fluctuations in Hall resistance are not as conspicuous. By contrast, the $\nu = 2/3$ and other FQH states seem to be intact down to the lowest temperature (20 mK). The anomalous behavior around $\nu = 1/3$ disappears either by slightly raising the temperature ($T \geq 100$ mK) or by passing a modest probe current ($I \geq 10$ nA). Another anomalous behavior is found in the range $1 < \nu < 2$, where resistance fluctuations develop below $\sim$ 400 mK, which overwhelm the FQH features at $\nu = 5/3$ or $4/3$. Experimental checks have been made to eliminate conceivable experimental artifacts. The physical origin of these anomalies is yet to be identified.

Sorting category: Db Conducting electrons in condensed matter

Keywords: GaAs/AlGaAs, 2D hole gas, fractional quantum Hall effect

LT1903