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Competing Phases of 2D Electrons at $\nu = 5/2$ and $7/3$[1]

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The N=1 Landau level (LL) exhibits collective electronic phenomena characteristic of both fractional quantum Hall (FQHE) states seen in the lowest LL and anisotropic nematic states in the higher LLs. A modest in-plane magnetic field $B_{||}$ is sufficient to destroy the fractional quantized Hall states at $\nu = 5/2$ (and $7/2$) and replace them with anisotropic compressible nematic phases, revealing the close competition between the two. We find that at larger $B_{||}$ these anisotropic phases $\nu = 5/2$ can themselves be replaced by a new isotropic state, dubbed re-entrant isotropic compressible (RIC) phase. We present strong evidence that this transition is a consequence of the mixing of Landau levels from different electric subbands in the confinement potential. In addition, we find that with $B_{||}$, the normally isotropic $\nu = 7/3$ FQHE state can transform into an anisotropic phase with an accurately quantized Hall plateau but an anisotropic longitudinal resistivities. As temperature is lowered towards zero, ρ_{xx} diminishes while ρ_{yy} tends to diverge, reminiscent of the anisotropic nematic states, while surprisingly ρ_{xy} and ρ_{yx} remain quantized at $3h/7e^2$, indicating a completely new quantum phase.

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