Non-equilibrium fractional quantum Hall states in bilayer electron systems

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The remarkable quantum Hall states of a 2D electron gas (2DEG) showcase the interesting non-equilibrium phenomena, where the bulk conductivity is low, leading to long relaxation times. In a bilayer electron system, non-equilibrium effects between the layers can occur, and in transport measurements, this results in hysteresis and spikes observed on the resistance dependence on the magnetic field, particularly when one of the layers is in the quantum Hall effect regime. In the present work, we study the non-equilibrium phenomena using longitudinal and transverse magnetoresistance measurements, particularly the 5/2 state in a bilayer system formed in a GaAs/AlGaAs-based double quantum well heterostructure. The 5/2 state observed in the combined filling factor (1/+3/2) of the bilayer system shows interest response to the applied top gate in that it appears only when both the 2DEGs are contributing to the current. The observed 5/2 is accompanied by spikes in the magnetoresistance measurements, an indication of the non-equilibrium phenomenon; the spikes are absent when both layers are in the Quantum Hall regime. We have performed temperature dependence of the 5/2 and other fractional states formed in the second Landau Level, as well as investigated the anisotropy in the behaviour of the 5/2 state, which will be presented and discussed along with other results [1,2].

[1] A. Shevyrin, et al, Phys Rev B, 107 (4), L041302 (2023).
[2] J. Shabani, Y. Liu, and M. Shayegan, Phys Rev Lett, 105, 246805 (2010).