“Many-body ground states and collective excitations in a tunable 2D system”.

The Landau levels (LLs) of a two-dimensional electron system support a plethora of fascinating many-body ground states and collective low-energy excitations, thanks to enhanced electron-electron interactions and the characteristics of the LL wave functions. The n=1 LL is particularly fascinating as it hosts even-denominator fractional quantum Hall states and other exotic topological orders that are potentially useful in topological quantum computation. In this talk, I will describe a few recent experiments of ours in Bernal-stacked bilayer graphene, which is a remarkably tunable platform for exploring emergent phenomena. In particular, an electric displacement field-tuned valley degree of freedom acts as an SU(2) pseudospin. A new even-denominator fractional quantum Hall state is observed at low D-field and is found to be spontaneously valley polarization in the limit of vanishing valley Zeeman energy. Our measurements show that even-denominator fractional quantum Hall states in bilayer graphene are accompanied by the Levin-Halperin daughter states of either the Pfaffian or the anti-Pfaffian order. Further, at filling factor 7/5, a new fractional quantum Hall state develops at the coincidence of the N=1 and N=0 LLs. Its appearance points to an unusual type of two-component fractional quantum Hall state.


Levin and Halperin, PRB, 79, 205301 (2009)