Valley-controlled Even-denominator Fractional Quantum Hall Effect in Bernal-stacked Bilayer graphene

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The braiding statistics of non-abelian anyons is the foundation for topological quantum computation. The even-denominator fractional quantum Hall (FQH) effect in a two-dimensional electron system is expected to host such quasi-particles. In Bernal-stacked bilayer graphene (BLG), even-denominator FQH states at filling factors ν = -5/2, -1/2, 3/2 and 7/2 have been observed. In this presentation, I'll discuss our observation of a new even-denominator state at filling factor ν = 5/2 in samples of unprecedented quality and by manipulating the valley isospin degrees of freedom in BLG using a perpendicular electric field. We show that the 5/2 state is spontaneously polarized in the limit of zero valley Zeeman splitting. Theory proposes three possible topological orders for the even-denominator states, i.e. the Moore-Read Pfaffian, its particle-hole conjugate the anti-Pfaffian, and a particle-hole symmetry state. Both the Pfaffian and the anti-Pfaffian break the particle-hole symmetry. They are predicted to have different FQH daughter states. We observe the daughter states of the Pfaffian near ν = 3/2, 7/2 and of the anti-Pfaffian near ν = 5/2 and -1/2. These results provide new information on the rich physics of the FQH effect [1].

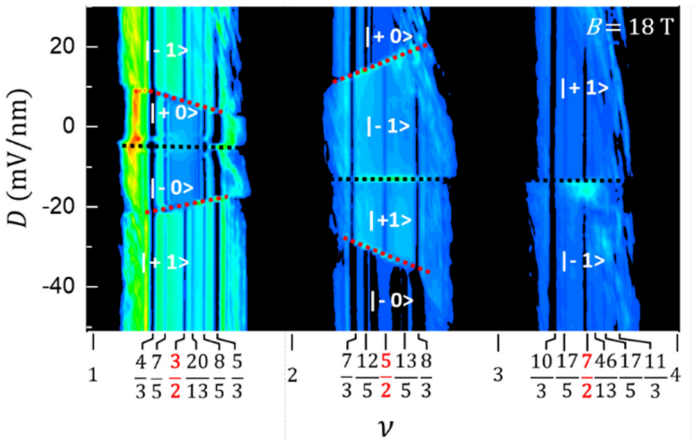

Figure 1. (a) A false color map of R_{xx} (ν, D) showing integer and fractional quantum Hall states in BLG. The 5/2 state is observed for the first time. Adapted from Ref. [1].

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