Spin transition in a correlated liquid of composite fermions

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Fractional quantum Hall (FQH) effect occurs when 2D electrons fill a (specific) fraction ν of the lowest Landau level (LL) in a high magnetic field. This macroscopic phenomenon involves a new state of matter − incompressible electron liquid with fractionally charged quasiparticles (QPs), the most prominent example being the Laughlin $\nu = 1/3$ state. An elegant model of the FQH effect is the composite fermion (CF) picture, employing a concept of electrons capturing some of the external magnetic field and thus transforming themselves into nearly noninteracting CFs moving in a reduced (mean) field. New FQH states were found recently at LL fillings ν corresponding to several simple partial fillings ν^* of the 2nd CF LL. The importance of these "second generation" liquids relies on their incompressibility depending on the (distinct) interaction and correlation of CFs.
In this work we study spin transition of the most prominent 2nd-generation FQH state at $\nu^* = 1/3$. The complexity of the spin dynamics of CFs is caused by the fact that the two spin states of a CF represent distinct many-electron excitations (with different creation energies and interaction pseudopotentials). Therefore, the spin transition occurs between a pair of CF liquids with distinct CF–CF correlations (and thus different microscopic mechanisms of incompressibility). We have used numerical exact-diagonalization of representative few-body hamiltonians in spherical geometry to compare single-particle and correlation energies of the competing CF spin phases. The main result is a phase diagram in experimental parameters and prediction of a transition in realistic conditions.

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