

Non-Abelian $2/5$ quantum Hall state in the lowest Landau level

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The ground state at $2/5$ fractional quantum Hall filling factor was portrayed by the so-called Gaffnian wave function which produces a high overlap with the exact Coulomb ground state. The quasi-particles of this Gaffnian wave function follow non-Abelian braiding statistics. However, due to the non-unitary conformal field theory of this Gaffnian state, it fails to produce a gapped quantum Hall state and thus suggested to be a quantum critical state. We interpret this non-Abelian Gaffnian wave function as the inter-flavor pairing of the composite fermions and propose a modified Gaffnian wave function by taking a minimally modified flux correlation of the Gaffnian wave function. The suitable linear combination of these two wave functions has excellent overlap with the exact Coulomb ground state and their entanglement spectra match up to reasonably higher levels. Also, in contrary to the Gaffnian wave function, our hybrid wave function provides increasing overlap value with the ground state of a mixed three-body and two-body model Hamiltonian when the weightage of the two-body Hamiltonian increases suggesting a possible parent Hamiltonian of our hybrid wave function near Coulomb point. Due to the pairing, our proposed wave function suggests non-Abelian quasi-particle statistics of this $2/5$ state in the lowest Landau level.



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