Towards Unveiling the Topology of the 5/2 Fractional Quantum Hall State

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Ever since the discovery [1] of the enigmatic 5/2 fractional quantum Hall state, its true topological order has remained an open question. Several studies have shown the state to host non-Abelian quasiparticle excitations, thus making it a very promising state [2] for topological quantum computation. With the Coulomb interaction being the key interaction of the fractional quantum Hall effect, several theories [3, 4, 5, 6] have been proposed to describe the state over the years. However, for identifying the correct topological order, there remained an unsettled discrepancy between the theoretical predictions and experimental observations [7]. Unlike the lowest Landau level, the effect of Landau-level mixing [8] becomes very significant at the second Landau level, which occurs at a relatively weaker magnetic field. At a moderate range of Landau level mixing strength, in accordance with the GaAs-GaAlAs systems, we find [9] a re-entrant Anomalous phase (A-phase), which is quantized and well-gapped in the thermodynamic limit and topologically distinct from the phase near pure Coulomb interaction. We propose a ground state wave function for the 5/2 state in the second Landau level. This wave function has remarkably high overlap with the corresponding exact ground states in the A-phase and can support non-Abelian quasiparticle excitation. We believe our proposed wave functions for the 5/2 state in this A-phase should possibly corroborate with the experimentally observed state.

References

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