Anomalous 5/2 quantum Hall phase due to Landau-level mixing

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The potential to host non-Abelian quasi-particles, whose existence has been strongly substantiated by a number of studies, has made research into the 5/2 fractional quantum Hall state absolutely fascinating. However, the correct topological order of the state is still a subject of debate among theorists and experimentalists. The plausibility of the Pfaffian and anti-Pfaffian topological orders, which were supported by the majority of theoretical research, has been ruled out by recent thermal Hall conductivity and short noise experiments, which have instead confirmed the validity of the particle-hole symmetric Pfaffian (PH-Pf) order of the 5/2 state. Our work finds a possible resolution to this debate between experimental observations and theoretical predictions. We found a reentrant anomalous quantized phase at an intermediate range of Landau level mixing strength whose physics is fundamentally different from the lower Landau level mixing strength regime, where the majority of theoretical studies are performed. An identical topological order has been found for this anomalous phase irrespective of all the three candidate flux shifts, which doesn't have analogy in the lower landau level mixing strength regime. We propose a wave function having the same flux shift of PH-Pf in the spherical geometry, that possesses a very high overlap and good matching of entanglement spectra with the exact ground state of this anomalous phase. This anomalous phase at higher Landau-level mixing strength should possibly correspond to the experimentally observed phase.

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