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The Fractional Quantum Hall States at $\nu = 13/5$ and $12/5$ and their Non-Abelian Nature[1] W. ZHU, Cal State Univ - Northridge, S. S. GONG, National High Magnetic Field Lab, D. N. SHENG, Cal State Univ - Northridge — Topological quantum states with non-Abelian Fibonacci anyonic excitations are widely sought after for their exotic fundamental physics and potential applications in universal quantum computing. The fractional quantum Hall (FQH) state at filling factor $\nu = 12/5$ is such a promising candidate, however, its precise nature is still under debate and no consensus has been achieved so far. Here, we investigate the nature of the FQH $\nu = 13/5$ state and its particle-hole conjugate state at $12/5$ with the Coulomb interaction, and address the issue of possible competing states. Based on a large-scale density-matrix renormalization group (DMRG) calculation in spherical geometry, we present evidence that the essential physics of the Coulomb ground state (GS) at $\nu = 13/5$ and $12/5$ is captured by the $k = 3$ parafermion Read-Rezayi state (RR_3), including a robust excitation gap and the topological fingerprint from entanglement spectrum and topological entanglement entropy. Furthermore, by considering the infinite-cylinder geometry (topologically equivalent to torus geometry), we expose the non-Abelian GS sector corresponding to a Fibonacci anyonic quasiparticle, which serves as a signature of the RR_3 state at 13/5 and 12/5 filling numbers.

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