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Abelian and non-Abelian states in $\nu = 2/3$ bilayer fractional quantum Hall systems[1] MICHAEL PETERSON, Cal State Univ- Long Beach, YANG-LE WU, Joint Quantum Institute, University of Maryland, MENG CHENG, MAISSAM BARKESHLI, Microsoft, ZHENGHAN WANG, Microsoft, University of California Santa Barbara — There are several possible theoretically allowed non-Abelian fractional quantum Hall (FQH) states that could potentially be realized in one- and two-component FQH systems at total filling fraction $\nu = n + 2/3$, for integer n. Some of these states even possess quasiparticles with non-Abelian statistics that are powerful enough for universal topological quantum computation, and are thus of particular interest. Here we initiate a systematic numerical study, using both exact diagonalization and variational Monte Carlo, to investigate the phase diagram of FQH systems at total filling fraction $\nu = n + 2/3$, including in particular the possibility of the non-Abelian Z_4 parafermion state. In $\nu = 2/3$ bilayers we determine the phase diagram as a function of interlayer tunneling and repulsion, finding only three competing Abelian states, without the Z_4 state. On the other hand, in single-component systems at $\nu = 8/3$, we find that the Z_4 parafermion state has significantly higher overlap with the exact ground state than the Laughlin state, together with a larger gap, suggesting that the experimentally observed $\nu = 8/3$ state may be non-Abelian. Our results from the two complementary numerical techniques agree well with each other qualitatively.

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