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Broken SU(4) symmetry in quantum hall states in graphene: an exact diagonalization study FENGCHENG WU, INTI SODEMANN, YASUFUMI ARAKI, Department of Physics, University of Texas at Austin, THIERRY JOLICOEUR, Laboratoire de Physique Théorique et Modèles statistiques, Université Paris-Sud, ALLAN MACDONALD, Department of Physics, University of Texas at Austin — Electrons in graphene have four flavors due to low-energy spin and valley degrees of freedom. Long-range Coulomb interactions are SU(4) symmetric in spin and valley space, providing an experimental realization of the SU(4) fractional quantum hall effect. However, weak short-range electron-electron and electron-phonon interactions break the valley symmetry, and act as a source of isospin anisotropy. Using an exact diagonalization method that takes all four flavors into account, we study the SU(4) fractional quantum Hall effect, identifying singlet and broken symmetry ground states and low lying excitations at integer and fractional filling factors within the N=0 Landau level. We also account for the presence of valley-isospin anisotropy and Zeeman fields. For the quantum Hall states at neutrality we assess the impact of quantum fluctuations that are beyond the mean-field theory of quantum Hall ferromagnets. For the fractional quantum Hall states, we compute the energies of novel multi-component states and evaluate their prospects for experimental realization. A systematic symmetry analysis based on the SU(4) multiplet structure of the many body spectrum will be presented.

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