A study on ferromagnetism in fractional quantum Hall systems at filling factor $\frac{2}{3}$

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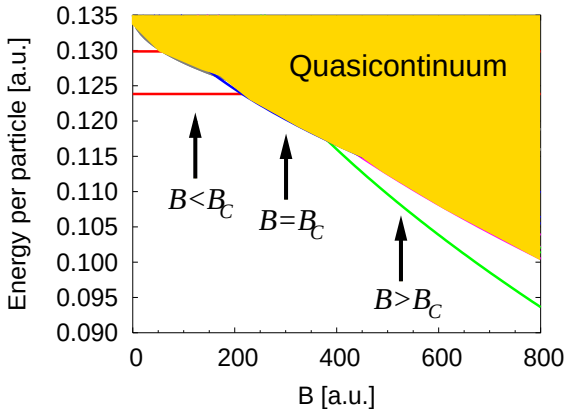
There are at least two possible incompressible ground states (GS) of a fractional quantum Hall system at filling factor $\nu = \frac{2}{3}$: the fully spin polarized one which occurs at high magnetic fields and the spin singlet one which is preferred for vanishing Zeeman energy. Under perspective of the composite fermion (CF) picture, the magnetic–field–induced transition between these GS's corresponds to a crossing of two CF Landau levels at total (CF) filling factor of $\nu^* = 2$. Several phenomena resembling ferromagnetism were observed experimentally in this system [1] and a question arises whether or not this system constitutes an example of Ising ferromagnet just as quantum Hall systems at integer filling factors do.
Applying exact diagonalization to electrons in a rectangle with periodic boundary conditions [2] we study the influence of magnetic inhomogeneities (MI) on the GS at the transition point. For finite Coulomb–interacting systems we observe a smooth transition between the two GS's (which are always separated from excited states by a gap) and no particular spin structures appear. On the other hand, the GS at the transition in short–range interacting systems (see Figure) is a gapless half–polarized state sensitive to MI. These half–polarized states show strong spin structures even in homogeneous systems. Varying aspect ratio of the rectangle we observe signs of a build–up of stripe–like domain wall states. The results indicate that the parallel between these systems and integer quantum Hall ferromagnets is not completely straightforward.



Spectrum of a homogeneous system with Zeeman term (8 electrons, short–range interaction). At the transition between the spin singlet ($B < B_C$) and fully polarized GS ($B > B_C$) a gapless half–polarized GS is observed.

References

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