Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Paired Composite Fermions

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The physics of electrons in half-filled Landau-levels is intimately related to that of free electrons via the composite fermion transformation. Analyzing different experimental systems where half filled Landau-levels occur, we find that a pairing instability is ubiquitous. For our analysis, we construct a general family of BCS paired composite fermion wavefunctions, which can be expressed for various pairing channels, and show that these are applicable in the context of both single-layer and bilayer quantum Hall systems. In the single layer, these states generalize, but remain in the same topological phase as, the Moore-Read Pfaffian state for the half-filled Landau level. It is shown that for a wide range of experimentally relevant inter-electron interactions in the second Landau-level, the groundstate can be very accurately represented in this form [1]. Going towards the lowest-Landau-level, the composite fermion Fermi-liquid is naturally obtained as a limiting case of the same wavefunctions. In the double layer, we show that the ground-state at $\nu = 1/2 + 1/2$ is a paired composite Fermion state at intermediate to large layer separation [2], and review how this paired phase connects to the exciton condensate at small layer separation [3].

[1] G. Möller, S. H. Simon, Phys. Rev. B **77**, 075319 (2008).
[2] G. Möller, S. H. Simon, E. H. Rezayi, Phys. Rev. Lett. **101**, 176803 (2008).
[3] G. Möller, S. H. Simon, E. H. Rezayi, Phys. Rev. B **79**, 125106 (2009).