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Ajit Balram: ”Particle-hole symmetry for composite fermions: An emergent symmetry in the fractional quantum Hall effect”

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The particle-hole (PH) symmetry of electrons is an exact symmetry of the Coulomb Hamiltonian confined to a specific Landau level, and its interplay with the formation of composite fermions (CFs) has attracted much attention of late. In this talk, I will describe an emergent symmetry in the fractional quantum Hall effect, namely, the PH symmetry of composite fermions, which relates states of CFs confined to a specific CF-Landau level termed Λ-level. Detailed calculations using the microscopic theory of CFs demonstrate the following for low-lying Λ levels: (i) The two-body interaction between CF particles is very similar, apart from a constant additive term and an overall scale factor, to that between CF holes in the same Λ level; and (ii) the three-body interaction for CFs is an order of magnitude smaller than the two-body interaction. Taken together, these results imply an approximate PH symmetry for composite fermions in low Λ levels, which is also supported by exact-diagonalization studies and available experiments. This symmetry is not present in the original electronic Coulomb Hamiltonian and owes its existence entirely to the formation of CFs. With increasing Λ-level index, the two-body and three-body pseudopotentials become comparable, but at the same time they both diminish in magnitude, indicating that the interaction between CFs becomes weak as we approach the half-filled Landau level.

Reference:
Particle-hole symmetry for composite fermions: An emergent symmetry in the fractional quantum Hall effect, Ajit C. Balram and J. K. Jain, Phys. Rev. B 96, 245142 (2017)

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