Observation of a Bubble Phase of Composite Fermions, A New Class of Highly Correlated Electronic Phase

V. Shingla [1], H. Huang[1], A. Kumar [2], L.N. Pfeiffer [3], K.W. West [3], K.W. Baldwin [3], and G.A. Csathy [1]

[1]*Department of Physics and Astronomy, Purdue University, West Lafayette, IN 47907, USA*
[2]*Department of Physics, Monmouth College, Monmouth, IL 61462, USA*
[3]*Department of Electrical Engineering, Princeton University, Princeton, NJ 08544 NJ, USA*

Flat electronic bands are known to enhance correlation effects. Such flat bands are well-known to form in the two-dimensional electron gas exposed to a perpendicular magnetic field. Most recently, it was realized that flat bands are also present in the band structure of certain materials even in the absence of an externally applied magnetic field. However, because of the extremely high quality of some two-dimensional electron gases confined to materials, these host materials are known to support novel correlated states in the fractional quantum Hall regime that were not yet measured in flat band systems in the absence of a magnetic field [1,2]. In this talk we focus on one such recently discovered highly correlated ground states that form at ultra-low temperatures in a high-quality GaAs/AlGaAs two-dimensional electron gas.

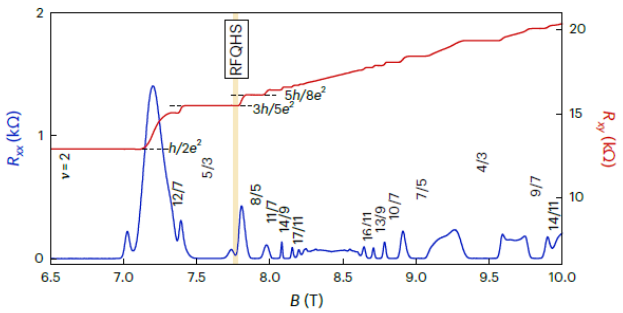

Fig.1. Transport data exhibiting the reentrant fractional quantum Hall state associated with the bubble phase of composite fermions.

In Ref.[1] we reported a new phenomenon we dubbed the reentrant fractional quantum Hall effect, see Fig.1. Such a reentrance clearly indicated the formation of a highly correlated phase built of fractionally charged quasiparticles. Furthermore, since this correlated phase occurs at a large quasiparticle density, we argued that the ground state associated with this effect is a highly correlated state with a bulk that can be described by clustering of the fractionally charged quasiparticles, then an ordering of these clusters on a lattice. We think this ground state can be described as a bubble phase of composite fermions. Our results demonstrate the existence of a new class of strongly correlated topological phases driven by clustering and charge ordering of emergent quasiparticles.

References

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[2] H. Huang, W. Hussain, S.A. Myers, L.N. Pfeiffer, K.W. West, K.W. Baldwin, and G.A. Csáthy, Nature Communications **15**, article number 1461 (2024)