Noncommutative geometry in fractional Chern insulators

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If electrons in a noninteracting band structure experience a nonvanishing Berry curvature, the components of their position and density operators do not commute when projected to a given band. In a Landau level, where the Berry curvature originates from an applied magnetic field and is uniform in momentum space, this leads to a closed algebra of projected density operators which was discovered by Girvin, MacDonald, and Platzmann. In my talk, I will discuss how this noncommutative geometry is altered in lattice systems hosting bands with nonzero Chern number as compared to the Landau level case. Upon partially filling a nearly dispersionless band with nonzero Chern number with repulsively interacting electrons, a fractional Chern insulator emerges. This state shares many universal and topological properties with fractional quantum Hall states in Landau levels. I will discuss some similarities and differences from the point of view of the noncommutative geometry. In particular, I will derive a general formula for the Hall conductance of many-body states in isolated bands.

[1] Adolfo G. Grushin, Titus Neupert, Claudio Chamon, Christopher Mudry, arxiv:1207.4097.
[2] Titus Neupert, Luiz Santos, Claudio Chamon, Christopher Mudry, arxiv:1207.3747.
[3] Titus Neupert, Luiz Santos, Shinsei Ryu, Claudio Chamon, Christopher Mudry, Phys. Rev. B **86**, 035125 (2012).