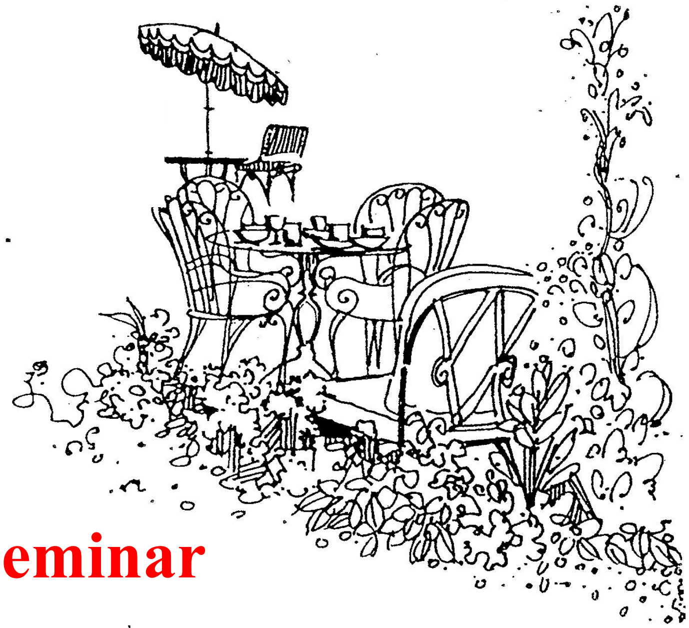
Chez Pierre



Presents ...

Monday, December 9, 2019

12:00pm Noon

MIT Room 4-331

Chez Pierre Seminar

Robert Willett – Nokia Bell Labs

"Interference measurements of non-Abelian e/4 & Abelian e/2 quasiparticle braiding and a path to a topological qubit."

The strongly correlated two-dimensional electron system in low disorder heterostructures can demonstrate different statistics depending upon the active particle composite of charge and applied magnetic flux. Within a B-field sweep exposing the fractional quantum Hall effect, quasiparticle excitations can demonstrate non-conventional particle statistics. A method to assess particle statistics is through interferometry in which particle paths can be made to encircle or braid other particles.

The quantum Hall states at filling factors (electron density/flux line density) $\nu = 5/2$ and 7/2 are expected to have Abelian charge $e/2$ quasiparticles and non-Abelian charge $e/4$ quasiparticles. We test this and examine the fermionic parity, a combined degree of freedom of two non-Abelian quasiparticles, by measuring resistance oscillations as a function of magnetic field in Fabry–Pérot interferometers using new high purity heterostructures. At $\nu = 5/2$, measured oscillations have four dominant frequencies, as expected for transport due to these two quasiparticle types. A different set of frequencies is expected at $\nu = 7/2$, and the measured oscillations match those. The phase of observed $e/4$ oscillations is reproducible and stable over long times (hours) near $\nu = 5/2$ and 7/2, indicating stability of the fermionic parity. When phase fluctuations are observed, they are predominantly π phase flips, consistent with fermionic parity change. These results constitute new evidence for the non-Abelian nature of $e/4$ quasiparticles; the observed life time of their combined fermionic parity further strengthens the case for their utility for topological quantum computation.

In this talk I will briefly review the composite particle picture of the fractional quantum Hall effect and focus on the anomalous state at 5/2 filling factor, including the models of non-Abelian charges and their fusion through multiple channels, manifesting as the fermionic parity degree of freedom. I will present in detail our interferometry method and results at 5/2 and 7/2 that show specific evidence for non-Abelian excitations and their striking stability in both number and fermionic parity. I will then show how these interferometers might be elaborated to produce topological qubits, both their construction and operation.