MAR14-2013-020627
Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Correlated Electrons in Two Dimensions: The Fractional Quantum Hall Effect and More

JAMES EISENSTEIN, California Institute of Technology

A collection of electrons confined to move on a plane surface is surely one of the simplest many-body systems imaginable. But in spite of this apparent simplicity, a strong magnetic field applied perpendicular to the plane opens a door to a complex and beautiful world filled with many-body exotica. The magnetic field quenches the kinetic energy, leaving Coulomb interactions in control of the physics. The result has been a revolution in many-body physics comparable to that created by the discovery of superconductivity. Incompressible liquid ground states with fractionally charged quasiparticle excitations exhibit the quantized Hall effect at numerous discrete partial fillings of the lowest and first excited Landau level. The first examples of topological condensed matter, these many-body bulk insulators possess complex families of both conducting and neutral edge states at their boundaries. Highly correlated compressible phases of composite fermions also exist and may be viewed as progenitors of the various families of incompressible states. Multi-component two-dimensional systems with active discrete internal degrees of freedom (spin, layer, valley, etc.) display a wide array of broken symmetry states including ferromagnetism and exciton condensation. Now thirty years old, the field generically dubbed "the fractional quantum Hall effect," remains extraordinarily vibrant. Once confined largely to GaAs/AlGaAs heterostructures, the fractional quantum Hall effect and its many relatives and offspring are now pursued in graphene, various oxide interfaces, and other materials. Some of the most fundamental aspects, including the exotic non-abelian quasiparticle statistics expected of some of the more subtle phases, have hardly been touched experimentally even as their potential for applications to quantum computation is alluring. In this talk, I will try to give a flavor of this enormous field, emphasizing current topics and possible future directions.