A cascade of phase transitions in an orbitally mixed half-filled Landau level

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In a two-dimensional electron system (2DES), the emergent Fermi-sea of the half-filled Landau level is known to display instabilities towards paired and nematic ground states as the nature and magnitude of many-body terms are modified. The Landau level index (*N*) plays a prominent role in influencing the ground state, with a correlated metal forming in *N*=0, a gapped phase in *N*=1 and a nematic stripe phase in *N*=2. In this presentation I will discuss the physics of high mobility ZnO-based 2DES at filling factor $\nu = 5/2$ as the orbital character of electrons is continuously tuned between *N*=1 and 0. In stark contrast to the naive expectation of a first-order transition between level-polarized states, a rich cascade of five phases with distinct transport features are resolved as charge is gradually transferred between the two levels. In addition to incompressible (in *N*=1) and compressible (in *N*=0) states, intermediate polarizations witness additional compressible, incompressible and anisotropic nematic phases. The emergence of these unexpected phases in an orbitally mixed regime when the levels are near degeneracy motivates speculation this is a promising system for realizing unanticipated flavors of inter-level coherent states at fractional filling factors.