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Spectroscopy of Emergent Phases of Electron Bilayers in the Quantum Hall Regime[1]

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Electron bilayers in semiconductor heterostructures in the quantum Hall regime are contemporary realizations of highly correlated systems where bizarre quantum phases may appear. A mean field configuration occurs when a tunneling gap splits the single-particle levels in their symmetric and anti-symmetric combinations and the Landau level filling factor is 1. This configuration has full spin and pseudospin ferromagnetic order, where pseudospin is a quantum operator describing layer occupation. The presentation considers optics experiments that offer evidence of the breakdown of the pseudospin order of the mean-field paradigm based on measurements of low-lying spin excitations [1]. The suppression of the pseudospin order manifests a new quantum phase that can be interpreted as a highly correlated fluid of electron-hole excitonic pairs across the tunneling gap. Evidence of a phase transition to a non-quantum-Hall phase is found in measurements of elastically-scattered light (Rayleigh scattering) and of spectral lineshapes of spin-excitations [2]. The transition occurs when the pseudospin order fully collapses by application of an in-plane magnetic field component.

[1] S. Luin, et al. Phys. Rev. Lett. **94**, 146804 (2005).
[2] S. Luin, et al., to be submitted.

[1]Work done in collaboration with S. Luin, A. Pinczuk, B.S. Dennis, L.N. Pfeiffer, K.W. West.