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Optical probes of excitonic phases in quantum Hall bilayers at ν_T=1*

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In this talk we discuss our recent inelastic light scattering results that shed light on the interplay between incompressible and compressible quantum phases of electron bilayers at total filling factor $\nu_T = 1$. In the regime of finite values of tunneling gaps, we observe a quantum phase transformation between composite fermion (CF) metal and incompressible excitonic states as the tunneling gap is reduced. We show that the transition becomes discontinuous (first-order) by impacts of different terms of the electron-electron interactions that prevail on weak residual disorder [1]. The evidence is based on precise determinations of the excitonic order parameter and of measurements of CF spin excitations by resonant inelastic light scattering close to the phase boundary [2,3]. While there is marked softening of low-lying excitations, our experiments underpin the roles of competing order parameters linked to quasi-particle correlations in removing the divergence of quantum fluctuations [4]. In the regime of vanishingly small tunneling gaps we show that the abrupt disappearing of CF spin excitations below the spin-wave indicates the emergence of the inter-layer correlated quantum Hall state in the vicinity of $\nu_T = 1$ and when the temperature is lowered below a critical value [5]. Finally, the evolution of the spin-wave mode as a function of the Zeeman energy suggests the occurrence of a spin transition [5]. * Work done in collaboration with: B. Karmakar, A. Pinczuk, L.N. Pfeiffer, K.W. West.

[1] B. Karmakar, submitted; [2] S. Luin, et al. Phys. Rev. Lett. **94**, 146804 (2005); [3] B. Karmakar et al. Solid State Communications **143**, 499 (2007); [4] J. Schliemann, S. M. Girvin and A. H. MacDonald, Phys. Rev. Lett. **86**, 1849 (2001); [5] B. Karmakar et al. unpublished.