Abstract for an Invited Paper
for the MAR06 Meeting of
The American Physical Society

**Transition between Composite-Bosons and Composite-Fermions in $\nu = \frac{1}{2} + \frac{1}{2}$ Quantum Hall Bilayers**[1]

STEVEN H. SIMON, Lucent Technologies, Bell Labs

There has been considerable recent interest in bilayer quantum Hall systems at filling fraction $\nu = 1/2 + 1/2$. At large spacing between the layers, the system is described as two independent $\nu = 1/2$ composite fermion fermi seas, with each electron being bound to two vortices of the wavefunction within the same layer. At small spacing between the two layers the system can be described as a composite boson condensate (also known as "111 state" or exciton condensate) where each electron is bound to one vortex of the wavefunction within the same layer and to one vortex of the wavefunction in the opposite layer. As the spacing between the layers is continuously decreased, intra-layer correlations must be replaced by inter-layer correlations, and the composite fermion sea must be replaced by the composite boson condensate. In this talk we will focus on the nature of this transition. For intermediate distances between the two layers, we propose a scenario where composite bosons and composite fermions coexist in two interpenetrating fluids[1]. In other words, we allow some electrons to bind to vortices within the same layer, and some to bind to vortices in the opposite layer. Trial wavefunctions describing these mixed composite-boson-composite-fermion states compare favorably with exact diagonalization results. A Chern-Simons transport theory is constructed that is compatible with experiment. More recent work[2] has shown that pairing interactions between the composite fermions occur. Once this pairing is treated properly we obtain almost perfect numerical agreement with exact diagonalizations. Possible implications for experiments are discussed.

[1] S. H. Simon, E. H. Rezayi, and M. V. Milovanovic. Phys. Rev. Lett. 91, 046803 (2003)
[2] G. Moller , E. H. Rezayi, and S. H. Simon, to be published.

[1]Work done in Collaboration with E. H. Rezayi, M. V. Milovanovic, and G. Moller