Gauge theory, geometry and the theory of quantum stripe liquids.

J. Zaanen, Z. Nussinov and H.V. Kruis
Instituut Lorentz for Theoretical Physics, Leiden University, Leiden, The Netherlands

A consensus has emerged that stripes are a generic phenomenon associated with the doped Mott-insulating state. The cuprate high Tc superconductors are special in the sense that the superconductivity goes hand in hand with the quantum-destruction of the static stripe phase. The question is, can this competition give rise to new states of quantum matter which cannot be reached by adiabatic continuation starting from a BCS superconducting state? In our way of thinking, the key property making stripes more than just charge and spin order is the empirical fact that the charge stripes are *Ising* domain walls in the spin system. Based on both emperical information and theoretical arguments, we claim that this 'antiphaseboundariness' acquires a life of its own as independent dynamical degree of freedom in the long wavelength realms. We demonstrate that this antiphaseboundariness is controlling the spin-charge separation of the one dimensional electron-Luttinger liquids; it is rooted in the 'squeezed space' *geometrical* structure discovered by Ogata and Shiba in the Bethe-ansatz solutions which can be linked to Z_2 gauge degrees of freedom. We promote this 1+1D vacuum structure to physical principle, to ask what happens when it is applied to 2+1 dimensions. When charge order takes over static stripes result. However, the charge disordered/superconducting phases are far more interesting. The rich physics of 2+1D Ising gauge theory switches on, and we predict a variety of novel phases like the quantum spin-nematic. Phases of this kind might be realized in the cuprates at intermediate dopings. Although it is impossible to measure the order parameters associated with these phases directly with existing experiments, we will present some indirect consequences which can be experimentally verified.