

MAR16-2015-020230

Abstract for an Invited Paper  
for the MAR16 Meeting of  
the American Physical Society

### **Fractionalized Fermi liquids and the pseudogap<sup>1</sup>**

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Fractionalized Fermi liquids (FL<sup>\*</sup>) are metals with Fermi surfaces of electron-like quasiparticles; however the volume enclosed by the Fermi surface is not equal to the Luttinger value determined by the density of all electrons. There are general non-perturbative arguments that any such state with a non-Luttinger volume must also have emergent gauge excitations which have vanishing energy on manifolds of non-trivial topology. In doped antiferromagnets with hole density  $p$ , the Luttinger volume of a closed Fermi surface of holes is  $1 + p$  in the state without antiferromagnetic order. Simple FL<sup>\*</sup> models of doped antiferromagnets will be described with ground states which preserve all symmetries, and have hole pockets of total volume  $p$ . Such models provide natural explanations for a number of recent observations on the pseudogap phase of the hole-doped cuprate superconductors. Confinement transitions of such FL<sup>\*</sup> phases to conventional phases will also be described.

<sup>1</sup>Supported by NSF Grant DMR-1360789