The Strange Metal

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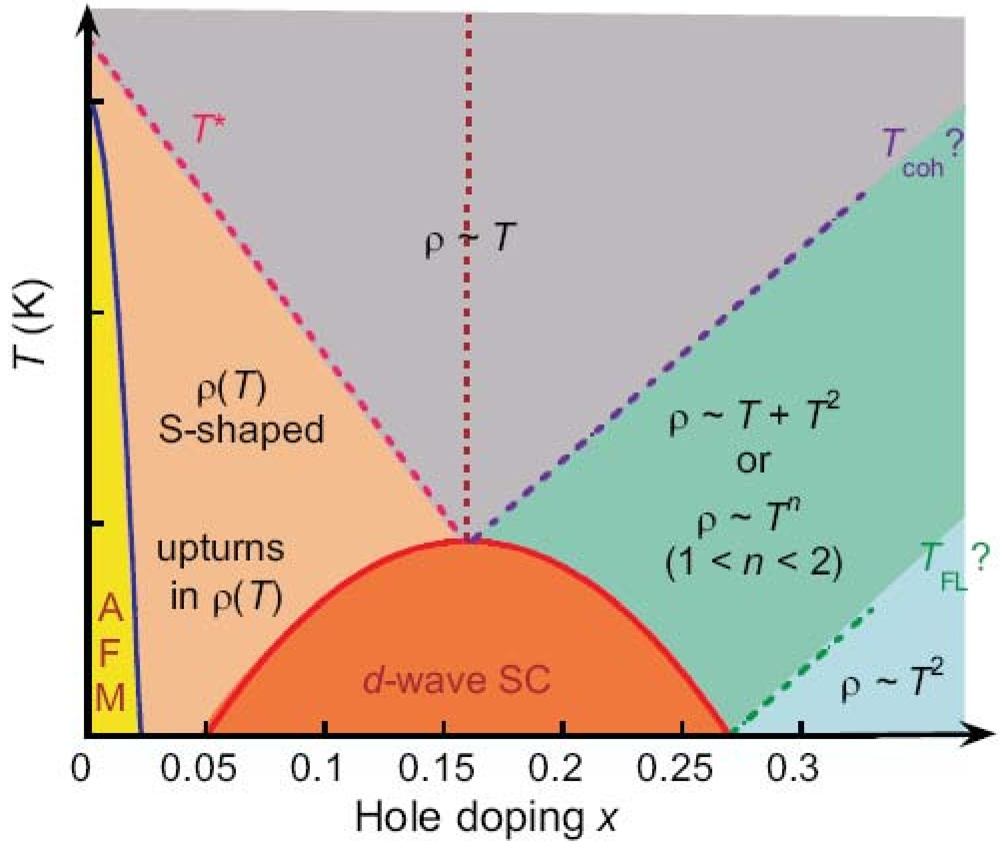

Figure 2. Phase diagram of (hole-doped) cuprates mapped out in terms of the temperature and doping evolution of the in-plane resistivity $\rho_{ab}(T)$. The solid lines are the phase boundaries between the normal state and the superconducting or antiferromagnetic ground state. The dashed lines indicate (ill-defined) crossovers in $\rho_{ab}(T)$ behavior. The meanings of the labels T^*, T_{coh} and T_{FL} are explained in the text.

From Hussey J. Phys: Condens. Matter 20 (2008) 123201

What are the facts in need of explanation?

- There is a Fermi surface but without (Fermi liquid scaling) of quasiparticles
  - Anisotropic lifetimes (different powers?)
- Power laws in transport
  - Different ranges for longitudinal and Hall
- Nothing dramatic in low frequency susceptibilities that correlates with transport scaling and T
  - But various instabilities at 400K and below
- Thermodynamics featureless

Top down explanation

cf FL theory

- Consider the Hubbard model (or something like it). Start at bandwidth and carry out exact RG towards the FS where low energy objects live. Arrive near unstable fixed point by 1000K.
- Unstable fixed point
  - Must be building up singular and/or retarded couplings – else get FL behavior
  - Contain multiple growing susceptibilities

Top down, continued

  - Exist in other materials
  - Allow doping dependent termination of strange metal regime to be understood in a natural way
- DMFT is producing growing retardation
  - Strange metal already in k independent self energy?
  - Can one import RG into DMFT?
- Stable phase too much? (D-wave bose liquid)

Bottom up explanation

- Quantum critical point between T=0 phases leads to a quantum critical funnel
- Needed
  - Criticality over most of Fermi surface – else hot spots shorted by cold spots
  - Explanation for why a single power in transport lifetime
  - Doubled critical fermi surface if transition between Fermi surfaces

Bottom up explanation

- Fluctuations at small q
  - Spin chirality, nematic, phase fluctuations
- Explanation of modest susceptibilities and small corrections to scaling, including in the scaling variable choice.