High temperature cuprate superconductors

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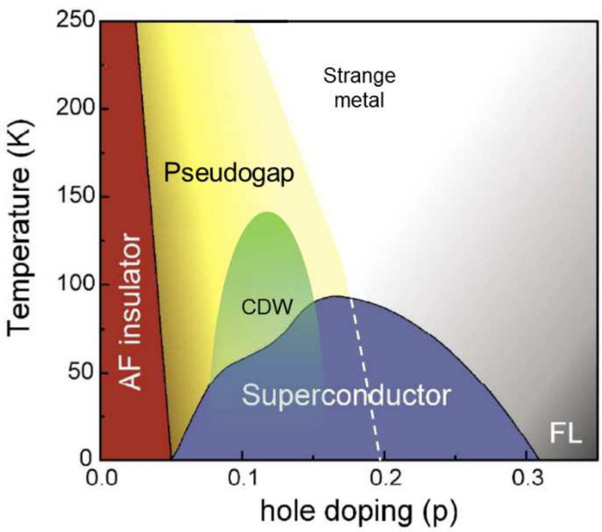

Figure 1: Generic temperature–doping phase diagram of high temperature superconductors. Various states are revealed: superconductivity, an antiferromagnetic Mott insulator at low doping, the pseudogap phase below a temperature T^* ending at a critical point p^*, a charge density wave (CDW) phase and a strange metal phase just above p^*. At high doping, a Fermi liquid (FL) behaviour is recovered.

After more than three decades, copper oxyde superconductors continue to fascinate physicists. Not only the unique properties of superconductors —from loss-free transmission of electrical power, through levitated trains to the ultimate sensitivity in MRI— could all be accessed using liquid nitrogen but also there is a growing conviction that these materials host novel quantum phenomena. The core mysteries of the cuprates —the origin of electron pairing, the normal state pseudogap, the strange metal and the prominence of various forms of collective fluctuations such as charge density wave— arise from electron interactions that are most likely responsible for the exceptionally strong superconductivity. These are cornerstones of modern condensed matter physics that have acted as a catalyst for the development of experimental and theoretical tools.

Here, we aim to give a brief overview of the state of the art of high temperature superconductors [1]. We will then focus on the ground state properties of these materials, once superconductivity is removed by the application of a magnetic field [2-5].

[1] B. Keimer *et al.* From quantum matter to high-temperature superconductivity in copper oxides. *Nature* **518**, 179 (2015).
[2] N. Doiron-Leyraud *et al.* Quantum oscillations and the Fermi surface in an underdoped high-T_c superconductor. *Nature* **447,** 565 (2007).
[3] W. Wu *et al.* Magnetic-field-induced charge-stripe order in the high-temperature superconductor $YBa_2Cu_3O_y$. *Nature* **477,** 191 (2011).
[4] S. Badoux *et al.* Change of carrier density at the pseudogap critical point of a cuprate superconductor. *Nature* **531**, 210 (2016).
[5] S.E. Sebastian and C. Proust. Quantum oscillations in hole-doped cuprates. *Annu. Rev. Condens. Matter Phys.* **6**, 411 (2015).