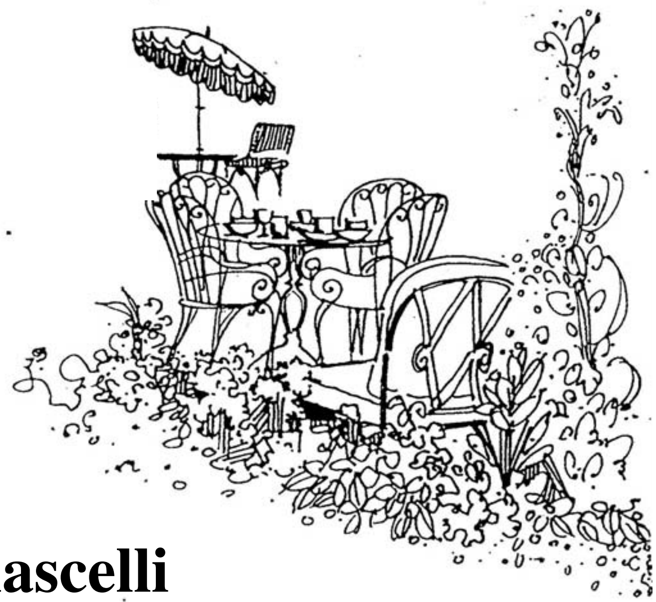
Chez Pierre

Presents ...

Monday, November 23, 2009

12:00pm

MIT Room 4-331



Andrea Damascelli

University of British Columbia

"In situ doping control of the surface of high-temperature superconductors"

Central to the understanding of high-temperature superconductivity is the evolution of the electronic structure as doping alters the density of charge carriers in the CuO_2 planes. Superconductivity emerges along the path from a normal metal on the overdoped side to an antiferromagnetic insulator on the underdoped side. This path also exhibits a severe disruption of the overdoped normal metal's Fermi surface [1,2]. Angle-resolved photoemission spectroscopy (ARPES) on the surfaces of easily cleaved materials such as $Bi_2Sr_2CaCu_2O_{8+\delta}$ shows that in zero magnetic field the Fermi surface breaks up into disconnected arcs [3]. However, in high magnetic field, quantum oscillations at low temperatures in $YBa_2Cu_3O_{6.5}$ indicate the existence of small Fermi surface pockets [4]. Reconciling these two phenomena through ARPES studies of $YBa_2Cu_3O_{7-\delta}$ (YBCO) has been hampered by the surface sensitivity of the technique. Here, we show that this difficulty stems from the polarity and resulting self-doping of the YBCO surface. Through in situ deposition of potassium atoms on cleaved YBCO, we can continuously control the surface doping and follow the evolution of the Fermi surface from the overdoped to the underdoped regime; the results differ markedly from the interpretation of the high-field measurements in terms of electron and hole pockets on the same material [5]. The present approach opens the door to systematic studies of high-temperature superconductors, such as creating new electron-doped superconductors from insulating parent compounds.

[1] N.E. Hussey et al., Nature 425, 814 (2003).
[2] M. Platé et al., Phys. Rev. Lett. 95, 077001 (2005).
[3] M.R. Norman et al., Nature 392, 157 (1998).
[4] N. Doiron-Leyraud et al., Nature 447, 565 (2007).
[5] M.A. Hossain et al., Nature Physics 4, 527 (2008).