Contribution ID: **62** Type: **Invited Talk**

Electronic Raman Scattering in Cuprate Superconductors: The Pseudogap Story

Wednesday, 16 September 2015 08:30 (40 minutes)

The pseudogap phase in cuprates remains hitherto a mysterious state of matter out of which the high-temperature superconductivity emerges. Discovered more than twenty five years ago [1], its indentification is still challenging although extensively studies have been carried out to elucidate its true nature [2,3]. In addition recent investigations in the underdoped side of the cuprate phase diagram have shown inside the pseudogap phase the existence of charge density wave order [4-6] which could be at the origin of the Fermi surface reconstruction in electron and hole pockets detected at high magnetic field by quantum oscillations [7,8] and transport measurements [9]. Instead of clarifying our understanding of the cuprate phase diagram, these recent investigations have revealed its unexpected complexity. In this context our purpose is to reveal by electronic Raman scattering, the signature of the normal state pseudogap and track its doping evolution through the cuprate phase diagram. We will demonstrate there exists a direct connection between Raman and transport measurements on the pseudogap. Although intensively studied in the underdoped regime, relatively less is known about the normal state pseudogap on the overdoped side, where it weakens and eventually disappears at a critical doping pc. Here, combining Raman spectroscopy on Bi-2212 over a large range of finely tuned doping with theoretical calculations, we determine pc=0.22 and we show that it coincides with a Lifshitz transition where the underlying hole-like active Fermi surface becomes electron-like [10]. Interestingly, the superconducting critical temperature Tc is unaffected by this transition. This demonstrates that the microscopic origins of the normal state pseudogap and the superconductivity are distinct. Only the former is tied to the change in the Fermi surface topology.

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Session Classification: Excitations of strongly correlated electron systems

Track Classification: DyProSo2015 Main track