Exploring the phase diagram of cuprates via Inelastic Light Scattering

Y. Gallais[1], A. Sacuto[1] and D. Colson[2]
[1]*Laboratoire de Physique du Solide, ESPCI, 75231 Paris, France*
[2]*Service de Physique de l'Etat Condensée, CEA-Saclay, 91191 Gif-sur-Yvette, France*

We report electronic Raman scattering studies on high-T_c cuprates. Inelastic light scattering has proven itself to be a powerful tool for exploring the phase diagram and the symmetry of the order parameter of the cuprates. Indeed by choosing different incoming and outgoing light polarisations Raman scattering allows to study electronic excitations in the the normal and superconducting state in different symmetries (known as B_{1g}, B_{2g} and A_{1g}) corresponding to different directions in k-space: the B_{1g} and B_{2g} symmetries probe respectively the $(\pi, 0)$ (hot spot) and (π, π) (cold spot) directions while the A_{1g} symmetry is fully symmetric and thus probe the entire Fermi surface. Here we explore the cuprates phase diagram in both bilayer Y-123 and single-layered Hg-1201 fucusing on the energy scales revealed by Raman scattering in the superconducting state. Using Ni impurity in the Y-123 system we show that the superconductivity-induced peak observed in the fully symmetrical A_{1g} channel tracks the energy of the resonance peak observed by inelastic neutron scattering. Our data indicates the presence of two distinct energy scales in the optimally doped regime of the cuprates, one is seen in B_{1g} symmetry and corresponds to the maximum of the $d_{x^2-y^2}$ gap while the other one (seen in A_{1g} symmetry) intriguingly tracks that of the neutron resonance. In the underdoped regime the Raman scattering intensity shows an abrupt decrease of intensity in the B_{1g} and A_{1g} channel in Y-123 and Hg-1201. In both compounds superconductivity-induced peaks disappear immediatly below optimal doping in both channels while intensity in the B_{2g} channel seems unaffected. The similar behavior towards underdoping of orthorombic bilayer Y-123 and tetragonal single-layered Hg-1201 points out the existence of an generic transition occuring in the superconducting state of the cuprate near optimal doping at the hot spots of the Fermi surface.

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