Fermi Surface of Superconducting LaFePO Determined from Quantum Oscillations

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LaFePO is a newly discovered bulk Fe-based superconductor with a transition temperature of *Tc*~ 6 K [1]. This compound is isostructural with LaFeAsO, which is non-superconducting and has a spin-density wave (SDW) ground state at low temperatures; when electron doped it becomes a relatively high-*Tc* superconductor (*Tc*~25 K) [2]. Understanding the superconductivity in Fe-based superconductors is intimately related to the details of the Fermi surface topology, its tendency towards instabilities as well as the strength of the coupling of the quasiparticles to excitations. Among pairing mechanisms mediating the superconductivity magnetic fluctuations are a possible candidate due to the proximity of the superconducting state to magnetic antiferromagnetic phase, as in cuprates but in fero-oxypcnities the nesting of the Fermi surface could be responsible for stabilizing the magnetic state. LaFePO is an ideal test material to investigate the Fermi surface topology as it has a much lower *Tc* among the other structurally related pcnitites, is non-magnetic and does not suffer any structural transitions at low temperatures. Moreover, its normal state can be easily access in moderate magnetic fields and high quality single crystalline materials can be grown.

We have recently observed quantum oscillations in LaFePO using the hybrid magnet in Tallahassee up to 45 T and at low temperatures 0.5 K [3]. By using both a thermodynamic (torque using piezoresistive microcantilevers (sample A)) and transport (sample C) techniques down to 0.3 K we have been able to map up the angular dependence of the Fermi surface extremal areas and also the elect of electronic correlations in LaFePO (Fig.1a). While four main frequencies (α_1 and α_2 closely split frequencies at *F*~1kT) and the two higher frequencies (β_1 and β_2) are observed clearly up to 18 T, only extending the field range to 45T in Tallahassee we were able to identify the orbits with smaller amplitudes (γ, δ, ε) (Fig.1b). Our results are in broad agreement with the band-structure calculations with the quasiparticle mass enhanced by a factor 2. Our observation suggests that the quasi-two dimensional Fermi surfaces of LaFePO consist of nearly-nested electron and hole pockets, suggesting proximity to a spin/charge density wave instability [3].

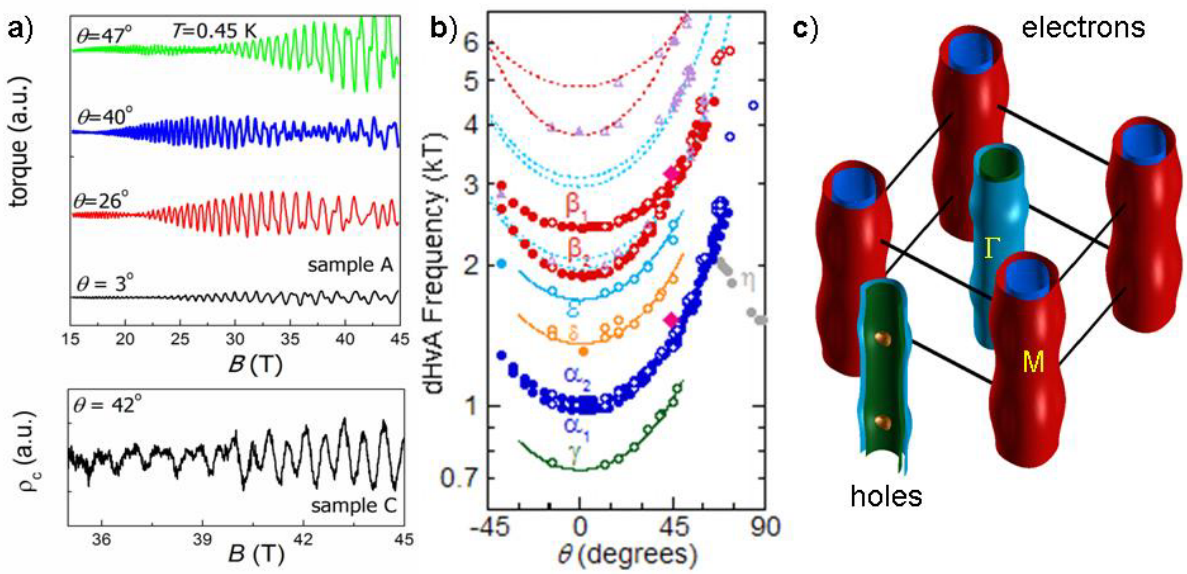

Figure 1. Quantum oscillations in the superconducting LaFePO. a) The oscillatory part of torque and interplane transport as function of magnetic field for different orientations between magnetic field and the *c* axis. b) The angular dependence of the fundamental frequencies (related to the extremal areas of the Fermi surface). The resulting Fermi surface of LaFePO.

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