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Towards a complete Fermi surface in underdoped high T_c superconductors[1]

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The discovery of magnetic quantum oscillations in underdoped high T_c superconductors raised many questions, and initiated a quest to understand the origin of the Fermi surface the like of which had not been seen since the very first discovery of quantum oscillations in elemental bismuth. While studies of the Fermi surface of materials are today mostly assisted by computer codes for calculating the electronic band structure, this was not the case in the underdoped high Tc materials. The Fermi surface was shown to reconstructed into small pockets, yet there was no hint of a viable order parameter. Crucial clues to understanding the origin of the Fermi surface were provided by the small value of the observed Fermi surface cross-section, the negative Hall coefficient and the small electronic heat capacity at high magnetic fields. We also know that the magnetic fields were likely to be too weak to destroy the pseudogap and that vortex pinning effects could be seen to persist to high magnetic fields at low temperatures. I will show that the Fermi surface that appears to fit best with the experimental observations is a small electron pocket formed by connecting the nodal 'Fermi arcs' seen in photoemission experiments, corresponding to a density-wave state with two different orthogonal ordering vectors. The existence of such order has subsequently been detected by x-ray scattering experiments, thereby strengthening the case for charge ordering being responsible for reconstructing the Fermi surface. I will discuss new efforts to understand the relationship between the charge ordering and the pseudogap state, discussing the fate of the quasiparticles in the antinodal region and the dimensionality of the Fermi surface. The author acknowledges contributions from Suchitra Sebastian, Brad Ramshaw, Mun Chan, Yu-Te Hsu, Mate Hartstein, Gil Lonzarich, Beng Tan, Arkady Shekhter, Fedor Balakirev, Ross McDonald, Jon Betts, Moaz Altarawneh, Zengwei Zhu, Chuck Mielke, James Day, Doug Bonn, Ruixing Liang, Walter Hardy.

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