FERMIOLOGY OF THE UNDOPED CUPRATE SUPERCONDUCTOR Pr$_2$CuO$_4$

Ross D. McDonald$^1$, Nicholas P. Breznay$^{2,3}$, Yoshiharu Krockenberger$^4$, Kimberly A. Modic$^{1,5}$, Zengwei Zhu$^1$, Ian Hayes$^{2,3}$, Nityan Nair$^{2,3}$, Toni Helm$^{1,3}$, Hiroshi Irie$^4$, Hideki Yamamoto$^4$ and James G. Analytis$^{2,3}$.

$^1$National High Magnetic Field Laboratory, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA
$^2$Materials Science Division, Lawrence Berkeley National Laboratory, Berkeley CA 94720, USA
$^3$Department of Physics, University of California, Berkeley, Berkeley CA 94720, USA
$^4$NTT Basic Research Laboratories, NTT Corporation, 3-1 Morinosato-Wakamiya, Atsugi, Kanagawa 243-0198, Japan
$^5$Department of Physics, University of Texas, Austin TX 78712, USA

Unconventional, high temperature superconductivity consistently appears in the vicinity of suppressed phase transitions leading to the suggestion that quantum criticality is vital to the physics of these systems. A confounding factor in identifying the role of quantum criticality in the electron-doped cuprates is the competing influence of chemical doping and oxygen stoichiometry. Recent advances in molecular beam epitaxy and preparation of cuprate thin films indicate that annealing can be employed to optimize $T_c$ via the control of apical oxygen occupancy. For Pr$_2$CuO$_4$, the resulting square planar coordinated structure exhibits a 25 K superconducting transition in the absence of Cerium doping. Using these films and ultra high magnetic fields (>90 T) enables measurements of magnetic quantum oscillations – the first observation of their kind for a cuprate thin film. The oscillation frequency is consistent with the reconstructed Fermi surface of the bulk electron-doped cuprate Nd$_{2-x}$Ce$_x$CuO$_4$. Furthermore, we observe a mass enhancement, suggesting that tuning these materials via oxygen stoichiometry enables exploration of underlying quantum criticality, providing a new axis with which to explore the physics underlying the electron doped side of the cuprate phase diagram.

Figure 1. magneto quantum oscillations in the high field restivity of thin film Pr$_2$CuO$_4$