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Charge and spin correlations in high temperature superconductors[1]

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The cuprate high temperatures superconductors are characterised by numerous competing, and in some cases, co-existing broken symmetries. A important question is to what extent such additional ordered states exist for compositions with high superconducting transition temperatures. I will discuss high-energy X-ray diffraction measurements which show that a charge density wave state (CDW) develops at zero field in the normal state of superconducting $YBa_2Cu_3O_{6.67}$ (T_c = 67 K). This material has a hole doping of 0.12 per copper and a well-ordered oxygen chain superstructure. Below T_c, the application of a magnetic field suppresses superconductivity and enhances the CDW. We find that the CDW and superconductivity are competing orders with similar energy scales, and the high-T_c superconductivity forms from a pre-existing CDW environment. Our results provide a mechanism for the formation of small Fermi surface pockets which can explain the negative Hall and Seebeck effects and the T_c plateau in this material.

[1]Work performed in collaboration with J. Chang, E. Blackburn, A. T. Holmes, N. B. Christensen, J. Larsen, J. Mesot, Ruixing Liang, D. A. Bonn, W. N. Hardy, A. Watenphul, M. v. Zimmermann and E. M. Forgan.