ESRF	Experiment title: The determination of orbital fluxes in the pseudogap phase of high-Tc superconductors	**Experiment number**: HE-1501
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Report:

Understanding high-temperature superconductivity (high-T_C) in copper oxide compounds remains a major challenge of condensed matter physics. One of its most intriguing features is a pseudogap in the electronic excitations, resembling the superconducting gap in size and symmetry. The pseudogap occurs in underdoped compounds below a characteristic temperature T^* much higher than T_C, where superconductivity and phase coherence set in (see phase diagram, Fig 1a). Because many properties show a continuous behaviour through T^*, it was argued that the pseudogap state is a manifestation of fluctuations of the superconducting order parameter over a wide temperature range, and not a distinct phase with different (broken) symmetry. In this interpretation, T^* would coincide with T_C for overdoped samples. There were however indications that the pseudogap state actually continues into the superconducting state and that T^* goes to zero at a critical doping

level slightly above optimal doping, but still within the superconducting regime. Subsequent theories [1-4] proposed that the pseudogap state does indeed represent a different phase exhibiting some hidden order, which is not easily manifested in observable quantities such as for example the magnetization or other thermodynamic properties. These theories are based on the existence of orbital currents around portions of the unit cell, which become ordered at *T**. While such ordered currents would produce antiferromagnetic moments, there is yet no consensus on their existence as several investigations using neutron scattering [5-7] and sr [8] produced conflicting results. A state with ordered currents however also breaks time-reversal symmetry as was recently observed in angle resolved photoemission experiments using circularly polarized light [9]. This symmetry breaking is a clear indication that there is a true phase transition at T*.

Resonant X-ray scattering is a powerful tool to study hidden order phenomena as it couples directly to the orbitals of the resonant ions and can therefore lead to information otherwise not accessible. For the sample we chosen $Tl_2Ba_2CuO_6$, a single layer high-T_c underdoped cuprate with a simple crystallographic structure (tetragonal) and a clear effect of showing the pseudo gap temperature $T^* \approx 200K$.

We have tried to investigate 0 0 l type of reflections as a funciton of energy at the Cu K-edge, with l odd and integer, to test the occurrence of these orbital fluxes. We have not been able to detect a signal in the rotated light at any temperatures. The absence of the signal indicates either the effect is not there (the theory incorrect) or that signal expected is weaker than predicted.

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