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Report:

In this proposal we wanted to study and eventually determine the magnetic structure in the low temperature phase of magnetite. Diffraction profiles as a function of photon energy around the Fe $K-$edge would be recorded with right and left circularly polarized X-rays and with a horizontal magnetic field parallel to the easy axis of the magnetization.

Charge and orbital correlations at and above the Verwey phase transition in magnetite

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The subtle interplay among electronic degrees of freedom (charge and orbital orderings), spin and lattice distortion that conspire at the Verwey transition in magnetite (Fe_3O_4) is still a matter of controversy. Here we provide strong evidence that these electronic orderings set in a continuous phase transition at the temperature where a spin reorientation takes place at around 130K, i.e., well above $T_V \approx 120$K. The orbital orderings remains unaffected by the onset of the Verwey transition whereas the charge ordering appears to be quenched, in what we call the collapse of the charge ordering. Finally we show that the orbital ordering does not reach true long range (disorder), as the correlation length along the $c-$direction is limited to $\approx$100Å.

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Unfortunately we encountered severe problems with the quarter phase plate that maked the foreseen experiment impossible. After expending some days trying to optimize the circularly polarized device we therefore decided to turn to plan B. This plan B resulted from the experience in proposal HE2286 where the positions $(00\frac{1}{2})$ and (001) were clearly identified as *purely* orbital and charge reflections, respectively. In the remainder of the allocated beamtime we measured the temperature dependence of these two reflections at the resonance and of the (003) off-resonance. The results have been submitted to Phys. Rev. Lett. (see abstract above).

The most interesting feature is that the temperature dependence of the intensities, and hence of the *different* order parameters, follow different trends, as it is shown in the figure below. At the Verwey phase transition temperature, T_V=120.5K, there is a first order phase transition signaled by the occurrence of a abrupt jump on the intensity of the lattice distortions. Contrary to current wisdom, both the orbital and charge orderings reflections do not exhibit such jump and they progressively disappear in a continuous way at T^*=129K. Modification in the width of peaks have been observed at each one of the *critical* temperatures.