Comment on "Magnetoresistance Anomalies in Antiferromagnetic $YBa_2Cu_3O_{6+x}$: Fingerprints of Charged Stripes"

In a recent Letter [1] Ando *et al.* discovered an anomalous magnetoresistance (MR) in hole doped antiferromagnetic $YBa_2Cu_3O_{6+x}$, which they attributed to charged stripes, i.e., to segregation of holes into lines. In this Comment we show that the experiments, albeit being interesting, do not prove the existence of stripes. In our view the anomalous behavior is due to an (a, b) plane anisotropy of the resistivity in the bulk and to a magnetic field dependent antiferromagnetic (AF) domain structure. It is unlikely that domain walls are charged stripes.

The main experimental findings [1] were the following: the anomalous MR (i) appears only with magnetic field in the (a, b) plane, (ii) saturates at magnetic fields of a few Tesla, (iii) changes sign when the magnetic field turns from parallel to perpendicular to the current, (iv) disappears gradually as the temperature is raised to the Néel temperature (T_N), and (v) depends on magnetic field history below 20 K. To explain the observations it was proposed that holes order into an array of stripes which act as current paths. The array of holes was supposed to be charged, ferromagnetic, and to reorder in small magnetic fields.

The AF domain structure has been recently studied [2] in detail in insulating $YBa_2Cu_3O_{6+x}$ single crystals doped with 1% Gd. Substitution of Gd serves as an ESR probe, and physical properties are unaffected. Differently oriented AF domains appear as distinct series of lines in the ESR spectra of Gd^{3+} ions. In the study of Ando *et al.* [1] crystals had an oxygen concentration of $x \simeq 0.3$ while in the ESR study, $x < 0.15$. We assume, however, that the domain structures are similar in the two cases. According to the ESR study, the easy axis of the AF order is along [100] and in the zero magnetic field high quality crystals consist of equal amounts of AF domains oriented along the two possible easy axes. [110] is a hard axis in the (a, b) plane. Magnetic fields in the (a, b) plane reorient domains. At $T = 20$ K a field of 5 T applied along an (a, b) plane principle axis is enough to turn practically all domains perpendicular to the field. The component of the magnetic field along c does not affect the domain structure. The anisotropy of the magnetic susceptibility of the domains is the driving force of the reorientation. The ESR showed a temperature independent domain structure between 10 and 150 K.

Above T_N the crystal structure of lightly hole doped $YBa_2Cu_3O_{6+x}$ is tetragonal. In the AF ordered state it has a small orthorhombic distortion along [100] due to coupling of the crystal lattice with the ordered Cu(2) magnetic moments. We suggest that the lowering of the symmetry leads to an anisotropy of the (bulk) resistivity in the (a, b) plane. The resistivity is larger when current is parallel to the sublattice magnetization and smaller when it is perpendicular. In the absence of a magnetic field, the average resistivity is measured. Large magnetic fields wipe out unfavored domains and the anisotropy appears in the resistance. The anisotropy disappears gradually as T_N is approached. The symmetry of the in-plane MR reflects the symmetry of the orthorhombic distortion of the lattice.

Thus there is no need for ferromagnetically ordered charged arrays of holes to explain the MR. The question of the nature of the domain walls remains, however, unanswered. Neither ESR nor MR experiments distinguish between AF domain walls parallel or perpendicular to the c axis. As explained in Ref. [2], neutral domain walls perpendicular to c are more likely to be the cause of the observed magnetic field dependence of the domain structure.

The experiments do not rule out that walls consist of charged stripes of holes in the (a, b) plane but are no confirmation either. It is difficult to see why relatively small magnetic fields would change the array of charged lines since Coulomb repulsion would render such an arrangement extremely rigid.

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