Atomically Resolved Images of Spin Chirality.

Spin, like angular momentum and torque, is known as a pseudovector, in contrast with an axial or polar vector such as velocity. The interesting property of a pseudovector is that its mirror image is equal in magnitude but flipped in direction because it has chirality (Fig. 1a). Therefore, an ordered array of spins breaks the mirror symmetry of the lattice. This symmetry breaking can be seen in electrons when relativistic effects are important (spin-orbit coupling). In low Z materials, the coupling of spin to electron or to lattice is so weak, making the broken symmetry hard to be observed especially with techniques capable of seeing atoms.

An LSU team, first authored by graduate student Guorong Li, has found a way to see such a broken symmetry. They reported in late August (Phys. Rev. B 86, 060512(R) (2012)) that, in one of the parent compounds of new Fe-based superconductors $BaFe_2As_2$, the surface dramatically enhances the spin-lattice coupling so that dynamic antiphase spin domains in the bulk are frozen out at the surface. This leads to the coexistence of structural and spin antiphase domain walls. Due to the large spin-electron-lattice coupling at the surface, these domain walls have the broken mirror-plane symmetry associated with spin, resulting in a left- and right-handed chirality, which can be described as a spin toroidal moment chirality (Fig. 1b).

Guorong Li comments: "It is amazing to see that an STM image of charge has the fingerprint of spin ordering." Dr. Igor Mazin, a leading theorist at Naval Research Laboratory at Washington DC, said that "I think this is a seminal paper ...".