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Atomic scale observation of C_4-plaquette antiferromagnetic order coexisting with superconductivity in iron-based superconductor Sr_2VO_3FeAs

SEOKHWAN CHOI, WON-JUN JANG, KAIST, JONG MOK OK, HYUN-JUNG LEE, POSTECH, SE-JONG KAHNG, Korea Univ., YOUNG KUK, Seoul Nat. Univ., JA-YONG KOO, KRISS, SUNGBIN LEE, KAIST, SANG-WOOK CHEONG, Rutgers Univ., YUNKYU BANG, Chonnam Nat. Univ., JUN SUNG KIM, POSTECH, JHINHWAN LEE, KAIST — The symmetry requirement and the origin of magnetic orders coexisting with superconductivity have been strongly debated issues of iron-based superconductors (FeSCs): it has been argued that the C_2-symmetric magnetism is a pre-requisite for the superconductivity in FeSCs. C_4-symmetric antiferromagnetism in superconducting ground state indeed has never been observed in real-space yet, likely due to the onset of C_2 structural orthorhombicity. The superconducting material Sr_2VO_3FeAs with its magnetism (T_N ~50 K) and superconductivity (T_c ~37 K) coexisting at parent state, has no reported structural orthorhombic distortion and thus makes a perfect system to look for some of the theoretically expected C_4 magnetisms. In this work, we studied the magnetic ground state and its phase transition using spin-polarized scanning tunneling microscopy. We observed C_4-symmetric plaquette antiferromagnetic order coexisting with superconductivity in tetragonal Fe spin lattice, and confirmed that the plaquette order can only be explained by Fe local moments picture. Furthermore, the inconsistency of its modulation Q vectors from the nesting condition implies that the nesting-based C_2-symmetric magnetism is not a unique pre-requisite of high-T_c FeSC.

Seokhwan Choi
KAIST

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