Highlights

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Mn-induced Fermi-surface reconstruction in the SmFeAsO parent compound

M. Meinero[1,2], P. Bonfà[3]. I. J. Onuorah[3], S. Sanna[4], R. De Renzi[3], I. Eremin[5,6], M. A. Müller[5], J.-C. Orain[7], A. Martinelli[2], A. Provino [2,8], P. Manfrinetti[2,9], M. Putti[1,2], T. Shiroka[7,10] G. Lamura[2]

[1]Dipartimento di Fisica, Università di Genova, via Dodecaneso 33, 16146 Genova, Italy.
[2]CNR-SPIN, Sede Genova, Area della Ricerca di Genova, C.so F. M. Perrone 24, 16152 Genova, Italy
[3]Dipartimento di Scienze Matematiche, Fisiche ed Informatiche, Università di Parma, Parco delle Scienze, 7a, 43124 Parma, Italy.
[4]Dipartimento di Fisica e Astronomia "A. Righi", Università di Bologna, Viale Berti Pichat 6/2, 40127 Bologna, Italy.
[5]Theoretische Physik III, Ruhr-Universität Bochum, 44801 Bochum, Germany.
[6]National University of Science and Technology MISiS, 119049 Moscow, Russian Federation.
[7]Laboratory for Muon-Spin Spectroscopy, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland.
[8]Department of Physics and Astronomy, Rutgers, The State University of New Jersey, Piscataway, USA.
[9]Dipartimento di Chimica e Chimica Industriale, Università di Genova, via Dodecaneso 31, 16146 Genova, Italy.
[10]Laboratorium für Festkörperphysik, ETH-Hönggerberg, 8093 Zürich, Switzerland.

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The electronic ground state of iron-based materials is unusually sensitive to electronic correlations. Among others, its delicate balance is profoundly affected by the insertion of magnetic impurities in the FeAs layers. Here, we address the effects of Fe -to-Mn substitution in the non-superconducting Sm-1111 pnictide parent compound via a comparative study of $SmFe_{1-x}Mn_xAsO$ samples with x(Mn)=0.05 and 0.10. Hall effect (Fig.1-a), dc magnetization (Fig.1-b) and muon-spin spectroscopy data provide a coherent picture (Fig.2) indicating a weakening of the commensurate Fe spin-density-wave (SDW) order, as shown by the lowering of the SDW transition temperature T_{SDW} with increasing Mn content and the unexpected appearance of another magnetic order, occurring at $T^* \approx 10$ and 20 K for x=0.05 and 0.10, respectively.

Despite a higher chemical pressure with respect to $LaFe_{1-x}Mn_xAsO$ system, expected to weaken the electronic correlations, in the $SmFe_{1-x}Mn_xAsO$ case, they are still sufficiently strong to sustain a Mn-Mn coupling via Ruderman–Kittel–Kasuya–Yosida (RKKY) interaction. Such magnetic coupling is able to pin the electronic charges locally, resulting in a full reorganization of the Fermi surface and the onset of an incommensurate antiferromagnetic (AF) order at T*, well inside the existing SDW phase (Fig. 1-2).

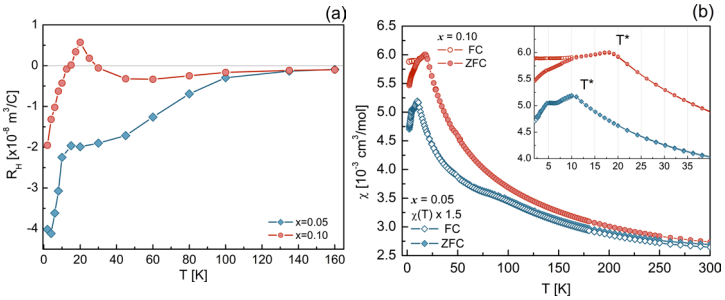

Fig. 1: (a) Hall coefficient R_H vs. T for the x=0.05 (blue) and 0.10 (red) cases. (b) DC magnetic susceptibility vs. temperature measured at 3 T in both zero-field-cooled (ZFC) and in field-cooled (FC) conditions. The full and open blue symbols refer to the x =0.05 case, while the red symbols to x = 0.10. To facilitate a comparison, the χ(T) data for x = 0.05 were multiplied by a factor of 1.5. The inset highlights the low-temperature features with the cusps at T* indicating the magnetic anomaly induced by the Mn substitution.

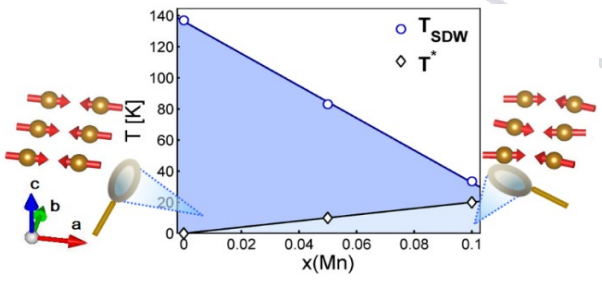

Fig. 2: Phase diagram of $SmFe_{1-x}Mn_xAsO$, showing the commensurate ordered phase (dark-blue area) and the Mn-induced incommensurate ordered phase (light-blue area). The collinear vs. tilted arrangement of Fe moments is also sketched.