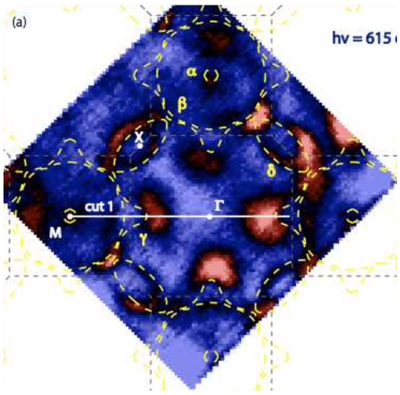

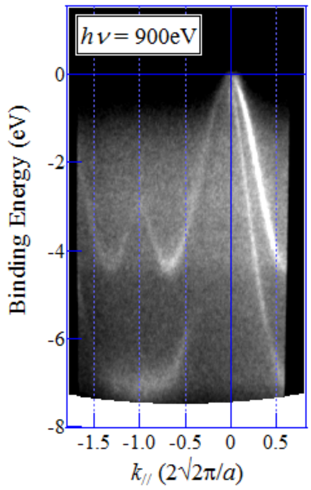

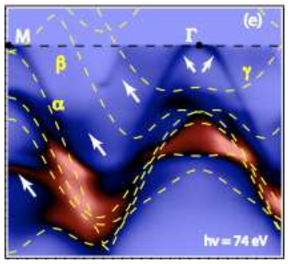

SLS Symposium on

Spectroscopy of Electronically Ordered Ground States

Tuesday, February 7, 2011

10:00 to 12:15, WBGB/019

10:00 Bulk electronic structure of LaRu2P2 probed by soft X-ray angle-resolved photoemission spectroscopy (SX-ARPES)
E. Razzoli

10:30 Dispersive high-energy spin excitations in iron pnictide superconductors investigated with resonant inelastic x-ray scattering
K. J. Zhou, Y. B. Huang, C. Monney, X. Dai,V. N. Strocov, N. L. Wang, P. C. Dai, L. Patthey, J. Van den Brink, H. Ding, and T. Schmitt

11:00 Coffee

11:15 Impurity-band state responsible for ferromagnetism in diluted magnetic semiconductor Ga1-xMnxAs revealed by soft x-ray ARPES
M. Kobayashi, V. N. Strocov, I. Muneta, J. Krempasky, T. Schmitt, Y. Takeda, A. Fujimori, M. Oshima, S. Ohya, M. Tanaka, L. Patthey

11:45 Imprinting magnetic information in manganites with X-rays
M. Garganourakis

Bulk electronic structure of $LaRu_2P_2$ probed by soft X-ray angle-resolved photoemission spectroscopy (SX-ARPES)

E. Razzoli[1]

[1]Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland

elia.razzoli@psi.ch

We present soft X-ray angle-resolved photoemission spectroscopy (SX-ARPES) study of the stoichiometric pnictide superconductor $LaRu_2P_2$. The observed electronic structure is in good agreement with density functional theory calculations. However, it is significantly different from its counterpart in high-temperature superconducting Fe-pnictides - i.e., the bandwidth renormalization of all Ru 4*d* bands is negligible and the Fermi surface is highly three-dimensional. Our results suggest that the appearance of superconductivity in $LaRu_2P_2$ is closely related to the covalency band formed by Ru 4*d* and 5*d* La orbitals. Finally we demonstrate that the increased probing depth of SX-ARPES, compared to the widely used ultraviolet ARPES, is essential in determining the bulk electronic structure in the experiment.

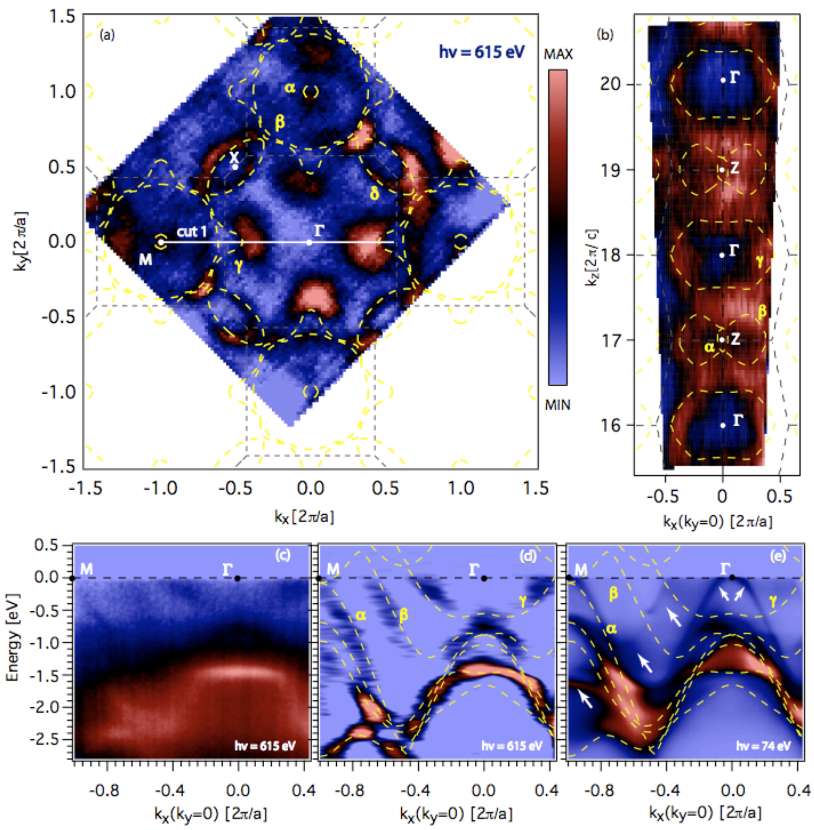

FIG. 2: ARPES spectra for $LaRu_2P_2$. (a) Fermi surface (FS) map in $(k_x,k_y,22\pi/c)$ plane, taken with $h\nu$ = 615 eV. (b) FS map in $(k_x,0,k_z)$ plane, taken with $h\nu = 300-550$ eV in steps of 5 eV. The maps in (a) and (b) are obtained by integrating ARPES spectral weight in an energy window of $E_F \pm 50$ meV. The superimposed dashed lines are the FS from DFT calculation. (c) ARPES spectrum along M-Γ direction (cut 1 in (a)) taken with $h\nu$ = 615 eV. (d) The second derivative of momentum distribution curves (MDCs) of the ARPES data in (c). (e) UV-ARPES spectrum along M-Γ direction taken with $h\nu$ = 74 eV. The superimposed dashed lines are the band structure from DFT calculation.

DISPERSIVE HIGH-ENERGY SPIN EXCITATIONS IN IRON PNICTIDE SUPERCONDUCTORS INVESTIGATED WITH RESONANT INELASTIC X-RAY SCATTERING

K. J. Zhou[1], Y. B. Huang[2,1], C. Monney[1], X. Dai[2],V. N. Strocov[1], N. L. Wang[2], P. C. Dai[3,2], L. Patthey[1], J. Van den Brink[4], H. Ding[2], and T. Schmitt[1]

[1]Paul Scherrer Institut, Swiss Light Source, CH-5232 Villigen PSI, Switzerland
[2]Beijing National Laboratory for Condensed Matter Physics, and Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China
[3]Department of Physics and Astronomy, The University of Tennessee, Knoxville, Tennessee 37996, USA
[4]Institute for Theoretical Solid State Physics, IFW Dresden, 01171 Dresden, Germany

The discovery of iron-based high temperature superconductivity has triggered tremendous research efforts in searching for novel high-Tc superconductors and in understanding the related fundamental physics. Unlike the cuprates whose parent compounds are long-range ordered antiferromagnetic Mott insulators, the iron-based parent compounds are ‘spin-density wave’ metals with delocalized electronic structure and more itinerant magnetism. Recent ARPES studies provides cumulative evidence that superconductivity in iron-based materials may be connected with interband pair scattering between the quasi-nested electron-hole Fermi surfaces. On the other hand, the observation of spin fluctuations by Inelastic Neutron Scattering (INS) in these materials, similar to those seen in cuprates, suggests that cuprate and iron-based high-Tc superconductors may share a common pairing mechanism.
Recent developments of the high-resolution resonant inelastic X-ray scattering (RIXS) technique [1] have enabled investigations of magnetic excitations in cuprates [2,3,4], which show excellent agreement with results from INS. In this presentation we demonstrate that RIXS can be used to measure collective magnetic excitations in iron-based superconductors despite their much stronger itinerancy compared to cuprates. The persistence of high-energy spin excitations even in optimally doped pnictide superconductors in a wide range of temperatures strongly suggests a spin-mediated Cooper pairing mechanism as proposed in cuprate superconductors.

[1] G. Ghiringhelli *et al.*, Rev. Sci. Instrum. **77**, 113108 (2006); V. N. Strocov *et al.*, J. Synch. Radiat. **17**, 631 (2010).
[2] J. Schlappa *et al.*, Phys. Rev. Lett. **103**, 047401 (2009).
[3] L. Braicovich *et al.*, Phys. Rev. Lett. **104**, 077002 (2010).
[4] M. Le Tacon *et al.*, Nature Phys. 7, 725 (2011).

Impurity-band state responsible for ferromagnetism in diluted magnetic semiconductor $Ga_{1-x}Mn_xAs$ revealed by soft x-ray ARPES

M. Kobayashi[1,2], V. N. Strocov[1], I. Muneta[3], J. Krempasky[1], T. Schmitt[1], Y. Takeda[4], A. Fujimori[5], M. Oshima[2], S. Ohya[3], M. Tanaka[3], L. Patthey[1]

[1] *Swiss Light Source, Paul Scherrer Institut, Villigen PSI CH-5232, Switzerland*
[2] *Department of Applied Chemistry, Graduate School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-5165, Japan*
[3] *Department of Electrical Engineering and Information Systems, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan*
[4] *Japan Atomic Energy Agency, Quantum Beam Science Directorate, Sayo, Hyogo 679-5148, Japan*
[5] *Department of Physics, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*

masaki.kobayashi@psi.ch

Diluted magnetic semiconductor (DMS) is a semiconductor doped with several percent of magnetic impurity. In ferromagnetic DMS, it is considered that the magnetic interaction between the magnetic ions is mediated by itinerant carriers of host semiconductor, and then the ferromagnetism is called "*carrier-induced ferromagnetism*". III-V-based DMS $Ga_{1-x}Mn_xAs$ is a typical and traditional ferromagnetic DMS [1] and has been studied intensively from fundamental points of view so far [2]. The knowledge of the valence-band electronic structure is most important to understand the carrier-induced ferromagnetism in $Ga_{1-x}Mn_xAs$ [3].

In this study, we have conducted soft X-ray angle-resolved photoemission spectroscopy (SX-ARPES) measurements on $Ga_{1-x}Mn_xAs$ thin films to obtain a fundamental understanding of the valence-band electronic structure. Surprisingly, even though the thin films were covered by amorphous As layer to protect the surface oxidation, the dispersible features have been clearly observed when incident photon energy is around 900 eV, implying the potential usefulness of SX-ARPES for electronic structure studies on thin films. The photon energy dependence of the dispersions confirms the observation of bulk three-dimensional electronic structure of $Ga_{1-x}Mn_xAs$. The resonant ARPES at the Mn L_3 edge have revealed the location of the Mn impurity-band in the valence band. These results will give an obvious picture of the valence-band electronic structure of $Ga_{1-x}Mn_xAs$.

References:

[1] H. Ohno *et al.*, Appl. Phys. Lett. **69**, 363 (1996).
[2] T. Jungwirth *et al.*, Rev. Mod. Phys. **78**, 809 (2006).
[3] S. Ohya *et al.*, Nat. Phys. **7**, 342 (2011).

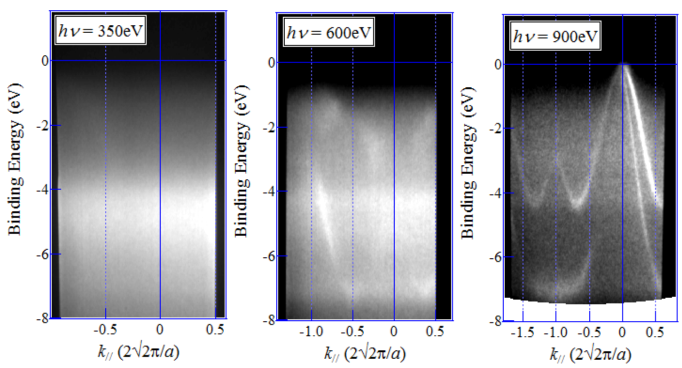

Figure1: SX-ARPES image of a $Ga_{1-x}Mn_xAs$ thin film capped by amorphous As layer as a function of incident photon energy. The spectral images have been taken at 350 eV, 600 eV, and 900 eV.

Imprinting magnetic information in manganites with X-rays

M. Garganourakis

Many interesting electronic and magnetic phenomena occur in transition metal oxides, such as colossal magnetoresistance, superconductivity and metal-insulator transitions. These phenomena result from the intimate interplay between charge, orbital and magnetic degrees of freedom, and their coupling to structural distortions. Such complex interactions lead to rich phase diagrams and the tuning of electronic properties close to phase boundaries. Here we report on a novel effect, the writing and in-situ observation of magnetic information in $Pr_{0.5}Ca_{0.5}MnO_3$ by X-rays. Normally, the (magnetic) structure is degraded or even lost when exposed to an ultra-bright X-ray beam, resulting in an absence of diffracted intensity. However for these materials quite the opposite is found, anti-ferromagnetic order is in fact found to improve upon exposure. Here we attribute this effect to the photodoping of the material with X-rays. As a result, the manganese magnetic moments tilt, improving the magnetic order and affecting the orbital order. This effect indicates a new interplay of X-rays with magnetic structure, appealing to the fields of both fundamental and applied physics and possibly providing a fundamentally new pathway to future magnetic storage devices.