Electronic Excitations by Inelastic X-ray Scattering: Recent Results Obtained at the Taiwan IXS Beamline, SPring-8

Yong Cai,
National Synchrotron Radiation Research Center, Taiwan

Inelastic X-ray Scattering (IXS) is a powerful experimental technique that provides energy and momentum-resolved information on lattice and charge dynamics of a variety of condensed matters, and offers in particular unique strengths in the study of the low-energy charge excitations of correlated electron systems and the electronic properties of materials under extreme thermal dynamical conditions such as high pressure and extreme temperature. The technique has been widely implemented in third-generation synchrotron radiation sources around the world that produce the tuneable and highly intense and bright hard X-rays necessary for the practical application of the technique. The Taiwan IXS Beamline (BL12XU) at SPring-8 is designed for high-resolution experiments on electronic excitations and offers a range of IXS spectroscopic techniques, including X-ray Raman scattering (XRS), resonant and non-resonant IXS (NIXS/RIXS), X-ray absorption spectroscopy by partial fluorescent yield (PFY-XAS), and X-ray emission spectroscopy (XES), for the proposed research. It has been utilized to study a wide range of scientific problems, including pressure-induced phase transitions of low-Z materials of planetary and geophysical significance, low-energy charge excitations of correlated materials, and systems showing charge and magnetic instabilities induced by pressure and temperature. A selection of these results will be presented and discussed.

References:

[1] Y.Q. Cai, H.-K. Mao, P.C. Chow, J.S. Tse, Y. Ma, S. Patchkovskii, J.F. Shu, V. Struzhkin, R.J. Hemley, H. Ishii, C.C. Chen, I. Jarrige, C.T. Chen, S.R. Shieh, E.P. Huang, and C.C. Kao, "*Ordering of hydrogen bonds in high-pressure low-temperature H_2O*", Phys. Rev. Lett. **94**, 025502 (2005).

[2] W.L. Mao, H.-K. Mao, Y. Meng, P. Eng, M.Y. Hu, P. Chow, Y.Q. Cai, J.F. Shu, and R.J. Hemley, "X-ray-induced *dissociation of H_2O and formation of an O_2-H_2 alloy at high pressure*", SCIENCE (*accepted*).

[3] N. Hiraoka, H. Ishii, I. Jarrige, and Y.Q. Cai, "*Inelastic X-Ray Scattering Studies of Low-Energy Charge Excitations in Graphite*", Phys. Rev. B **72**, 075103 (2005).

[4] Y.Q. Cai, P.C. Chow, O.D. Restrepo, Y. Takano, K. Togano, H. Kito, H. Ishii, C.C. Chen, K.S. Liang, C.T. Chen, S. Tsuda, S. Shin, C.C. Kao, W. Ku, and A.G. Eguiluz, "*Low-Energy Charge Density Excitations in MgB_2: Striking Interplay between Single-Particle and Collective Behavior for Large Momenta*", Phys. Rev. Lett. (*accepted*), see also Cond-Mat 0605320.

[5] N. Hiraoka, H. Ishii, I. Jarrige, Y.Q. Cai, and C.C. Kao, "*Non-Resonant Inelastic X-Ray Scattering Studies of Charge Excitations in NiO*", to be published.

[6] E. Collart, A. Shukla, J.-P. Rueff, P. Leininger, H. Ishii, I. Jarrige, Y.Q. Cai, S.-W. Cheong, and G. Dhalenne, "*Localized and Delocalized Excitons: Resonant Inelastic X-Ray Scattering in $La_{2-x}NiO_4$ and $La_{2-x}Sr_xCuO_4$*", Phys. Rev. Lett. **96**, 157004 (2006).

[7] J.W. Seo, K. Yang, D.W. Lee, Y.S. Roh, J.H. Kim, H. Eisaki, H. Ishii, I. Jarrige, Y.Q. Cai, D.L. Feng, and C. Kim, "*Anomalous Resonant Inelastic X-Ray Scattering Dispersion of Sr_2CuO_3 Measured at the Cu 1s-3d Edge*", Phys. Rev. B **73**, 161104(R) (2006).

[8] I. Jarrige, J.-P. Rueff, S.R. Shieh, M. Taguchi, Y. Ohishi, T. Matsumura, C.-P. Wang, H. Ishii, N. Hiraoka, and Y.Q. Cai, "*Mixed-valence state of TmTe at high pressure*", to be published.