Origin of the Anomalous Mass Renormalization in Metallic Quantum Well States of Correlated Oxide $SrVO_3$

Masaki Kobayashi[1], **Kohei Yoshimatsu**[1,2], **Enju Sakai**[1], **Miho Kitamura**[1], **Koji Horiba**[1], **Atsushi Fujimori**[2], **and Hiroshi Kumigashira**[1]

[1]*Photon Factory, High Energy Accelerator Research Organization (KEK), Tsukuba, Japan*
[2]*Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo, Japan*
Adresse email de l'orateur : masakik@post.kek.jp

Quantum confinement of strongly correlated electrons in oxide heterostructure has attracted considerable interests for understandings of the fundamental low-dimensional physics in correlated electron systems [1]. Lowering dimensionality changes the complex interactions among spin, orbital, and charge degrees of freedom of the correlated electrons, resulting in the emergence of unusual quantum phenomena. Thus, the quantum well (QW) structures based of strongly correlated electrons provide a foundation for studying the quantum confinement effects of correlated electrons and for artificially controlling their extraordinary physical properties.

Recently, metallic QW states have been discovered in $SrVO_3$ ultrathin films [2]. The observed QW states exhibit characteristic behavior such as an "anomalous mass enhancement": The subband dispersion becomes considerably narrower as its bottom energy approaches the Fermi level (E_F). Such anomalous subband-dependent mass enhancement has not been observed in conventional QW structures, suggesting the importance of underlying correlated electronic states in the $SrVO_3$ QW. However, despite of intense theoretical [3] and experimental studies [2], the physical origin remains uncovered.

To address this issue, we have performed in situ angle-resolved photoemission spectroscopy (ARPES) measurements on $SrVO_3$ ultrathin films and analyzed line-shape of ARPES spectra in detail. In APRES images, the width of coherent peak reflects the self-energy of conduction electrons [4]. The line-shape analyses for QW subbands reveal that the strength of the electron correlation increases as the bottom energy approaches E_F. These results indicate that the anomalous subband-dependent mass enhancement primarily arises from the quasi-one-dimensional nature of the QW states as a result of their orbital-selective quantization.

[1] M. Imada, A. Fujimori, and Y. Tokura, *Metal-insulator transitions*, Rev. Mod. Phys. **70**, 1039 (1998).
[2] K. Yoshimatsu *et al*., *Metallic Quantum Well States in Artificial Structure of Strongly Correlated Oxide*, Science **333**, 319 (2011).
[3] S. Okamoto, *Anomalous mass enhancement in strongly correlated quantum wells*, Phys. Rev. B **84**, 201305 (2011).
[4] T. Valla *et al*., *Evidence for Quantum Critical Behavior in the Optimally Doped Cuprate* $Bi_2Sr_2CaCu_2O_{8+\delta}$, Science **285**, 2110 (1999).