Resonant Inelastic X-ray Scattering Study of Spin-Orbit Entangled Electronic States in 5*d* Transition-Metal Compounds

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Resonant inelastic x-ray scattering (RIXS) using brilliant synchrotron radiation x-rays is developing as a tool to observe momentum-resolved and element-selective electronic excitations in materials [1,2]. In the field of condensed matter physics, transition-metal compounds have been intensively studied by means of RIXS. While RIXS in the soft x-ray regime is used for 3*d* transition-metal compounds such as cuprate superconductors, 5*d* transition-metal compounds are the central target of recent RIXS works using hard x-rays.

One of the main issues in the 5*d* transition-metal compounds is spin-orbit entangled electronic states induced by the strong spin-orbit interaction. In the archetypal Mott insulating iridate Sr_2IrO_4, IrO_6 octahedra are connected by sharing their corner and a spin-orbit entangled $J_{\mathrm{eff}} = 1/2$ state is realized under the fairly large Ir-Ir distance. By contrast, iridium oxides with edge-shared IrO_6 network has shorter Ir-Ir distance and they encounter competition between the spin-orbit entangle state and another quantum electronic state, orbital molecule [3]. In fact, formation of orbital molecule sometimes occurs in transition-metal oxides but the competition is unique in the 5*d* transition-metal. RIXS is an effective tool for studying such 5*d* electronic states through the observation of *dd* excitations (excitations between the *d* orbital). I will show a semi-metallic state in $Na_3Ir_3O_8$ produced by the competition [4] and pressure-induced phase transition between the competed states in β-Li_2IrO_3 [5] together with brief introduction of other capability of RIXS.

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