Low energy charge dynamics of $SrRuO_3$ thin film

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$SrRuO_3$ is a well-known member of ruthenates with a ferromagnetic phase below Curie temperature at 165 K. Unlike other ferromagnetic materials, conductivity of bulk $SrRuO_3$ is high enough to be used as an oxide electrode with a stable perovskite structure. At the same time, it is one of the rare itinerant ferromagnetic oxides, which has attracted significant interest in its own right. Interestingly, it is also known that the metallic phase of bulk $SrRuO_3$ is close to the boundary between Fermi-liquid and non-Fermi-liquid states. Another interesting point is that $SrRuO_3$ thin films undergoes a metal-to-insulator phase transition as decreasing thickness. Thus, $SrRuO_3$ thin films can be a fertile ground for exploring some of fundamental physics.

In addition, LDA+U band calculations found that the Ru orbitals of $SrRuO_3$ thin film may exhibit rather unusual quantum confinement effects (QCE) as reducing the thickness. As the thickness of film gets thinner, the enhanced QCE may induce the distinctive charge dynamics for each t_{2g} orbital with regard to its geometry and each Ru orbital should be hybridized with different type of O orbitals in different position.

In order to investigate the charge dynamics of the metal-insulator transition, we measured the RIXS signals as a function of thickness across the metal-insulator transition. We also examined the proposed QCE by measuring the charge dynamics. Our RIXS studies at O K-edge found that there is a gradual suppression of the quasi-elastic peak across the metal-insulator transition. This quasi-particle excitations only disappear for our 1 u.c. sample. We also found the experimental evidence of the orbital quantum confinement effects in our RIXS data.