Pressure and magnetic-field induced novel quantum phenomena in single-layered ruthenates

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To explore novel quantum phenomena such as unconventional superconductivity, related magnetism and Mott transition is one of the most attractive subjects in condensed matter physics. In particular, single-layered ruthenates (Ru^{4+}-$4d^4$) have gained more attention because they display versatile quantum phenomena. As well known, Sr_2RuO_4 (SRO) is a strong candidate for the spin-triplet superconductor. In contrast, Ca_2RuO_4 (CRO), which has a larger U/W than SRO, is a Mott insulator with an antiferromagnetic (AF) ground state. To bridge the gap between a Mott insulator and an unconventional superconductor, we have studied pressure and magnetic field effects on CRO and SRO because pressure and field are generally known as a unique technique to tune internal parameters without introducing disorder to super clean systems. For example, pressurisation to CRO transforms it from an AF insulator to a quasi-2D metal with a FM ground state (maximum T_C is ~25K at ~5GPa). Moreover, an unconventional superconductivity related to ferromagnetism can be fully expected at around 10GPa where the material shows a FM quantum criticality.

Here, we proposed two projects. First, we explore the pressure-induced superconductivity, and then compare the Q2D metallic state of pressurised CRO to that of SRO. Second, we perform ultrasonic measurement for superconductivity of SRO under magnetic field in order to explore a new phase induced by field as a crucial test of triplet superconductivity.