Formation of an incoherent metallic state in Rh-doped Sr_2IrO_4

A. Louat, V. Brouet, F. Bert, L. Serrier-Brinon, (LPS), F. Bertran, P. Le Fèvre, and J. Rault (Synchrotron SOLEIL)

Sr_2IrO_4 is considered as the archetype of a novel type of Mott insulator, the "Spin Orbit Mott Insulator. While it should be metallic, since Ir has 5 electrons in its 5d shell, it is an antiferromagnetic insulator. This canno't be understood in the standard Mott scenario because the electronic correlations, responsible for Mott insulating behavior, are relatively small for 5d transition metals. However, it was shown that the Spin-Orbit Coupling (SOC), which is very strong for heavy atoms like Ir, induces a reconstruction of the electronic structure (see figure 1a) with a narrow half-filled J_{eff}=1/2 band, where even small Coulomb repulsion may open a gap. This situation offers many similarities with cuprates and the evolution of this new type of insulator when doped is an active field of research.

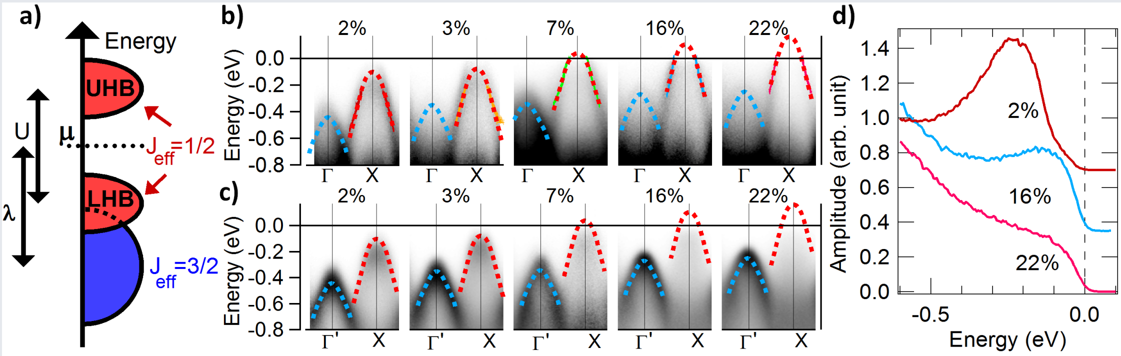

Figure: {a) Sketch of the energy positions of the bands expected in Sr_2IrO_4. The $J_{1/2}$ band is divided into a Lower Hubbard Band (LHB) and an Upper Hubbard Band (UHB). The chemical potential μ is represented by a dashed black line. U is the Columb repulsion and λ the SOC constant. b) Energy-momentum plot along ΓX for different Rh dopings. The $J_{1/2}$ and $J_{3/2}$ bands are emphasized by red and blue guides to the eye, respectively. c) Energy-momentum plots along Γ'X. d) Energy Distribution Curve (EDC) at k_F in the ΓX direction for the indicated doping.

We have synthesized and investigated with ARPES $Sr_2(Ir_{1-x}Rh_x)O_4$, where Rh is a 4d element isovalent to Ir. With ARPES, we observe a rigid band shift toward the Fermi level until at least 22% of Rh doping (figure 1b et 1c). This corresponds to an effective hole doping, which was unexpected due to the isovalency of Ir and Rh. For a doping of about 7%, the $J_{1/2}$ band just touches the Fermi level, which corresponds well to an Insulator-Metal transition also observed in transport. However, the metallic state does not present quasiparticle peaks, even at the optimal doping (around 15%), the bands are not renormalized compared to the band calculations, and a "`pseudogap'" of about 30meV (see figure 1d) is present on the entire Fermi surface. We attribute this to an incoherent behavior resulting from the interplay between correlation and disorder introduce by Rh. We suggest that the observed formation of charged defects around Rh holds clues to understand how doping proceeds in these compounds.

The effect of disorder in a strongly correlated compound is a rich theoretical and experimental subject. This study of the Insulator-metal transition in an exotic Mott insulator brings a novel point of view in this large field of research.

A. Louat, V. Brouet, F. Bert, L. Serrier-Brinon, F. Bertran, P. Le Fèvre and J. Rault, *Formation of an incoherent metallic state in Rh-doped Sr_2IrO_4*, in preparation

Résultats obtenus dans le cadre du projet SOC financé par le thème 1 du LabEx PALM et porté par Fabrice Bert (LPS), François Bertran (SOLEIL) et Dorothée Colson (SOLEIL).