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Quantum liquid state of J_{eff}=1/2 isospins in complex Ir oxides

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In 5d Iridium oxides, the relativistic spin-orbit coupling for 5d electrons is as large as ~0.5 eV and not small as compared with other relevant electronic parameters, including Coulomb U, transfer t and crystal field splitting D. The large spin-orbit coupling and its interplay with the other parameters gives rise to a variety of exotic magnetic ground states. In the layered perovskite Sr_2IrO_4, spin-orbital Mott state with J_{eff}=1/2 is realized due to the novel interplay of those energy scales [1]. Despite the strong entanglement of spin and orbital degrees of freedom, J_{eff}=1/2 iso-spins in Sr_2IrO_4 was found to be surprisingly isotropic, very likely due to a super-exchange coupling through almost 180° Ir-O-Ir bonds [2]. The temperature dependence of in-plane magnetic correlation length of J_{eff}=1/2 iso-spins, obtained from inelastic x-ray resonant magnetic scattering, was indeed well described by that expected for two-dimensional S=1/2 Heisenberg antiferromagnet [3].

When J_{eff}=1/2 iso-spins interact with each other through 90° Ir-O_2-Ir bonds, an Ising ferromagnetic coupling with an easy axis perpendicular to the bond plane is expected, due to an interference of the two Ir-O-Ir superexchange paths [2]. In α, β,γ-Li_2IrO_3 with honeycomb based structure, J_{eff}=1/2 iso-spin are connected by the three competeting 90° Ir-O_2-Ir bonds, which could be a materialization of Kiatev model [4] with quantum spin liquid state. A long range magnetic ordering, however, was observed at low temperatures in α, β,γ-Li_2IrO_3, which is very likely due to the presence of additional magnetic couplings not included in the original Kitaev model [4]. The exploration of Kitaev state was recently extended to related compounds and pressure effect. We found that a quantum spin liquid state is realized in hydorogenated Ir α-type 2D honeycomb $H_3LiIr_2O_6$ (see Figure) and β-Li_2IrO_3 under high pressure [5]. In $H_3LiIr_2O_6$, unusual fermionic excitations with a magnetic field induced gap are identified in the NMR relaxation and the specific heat.

References

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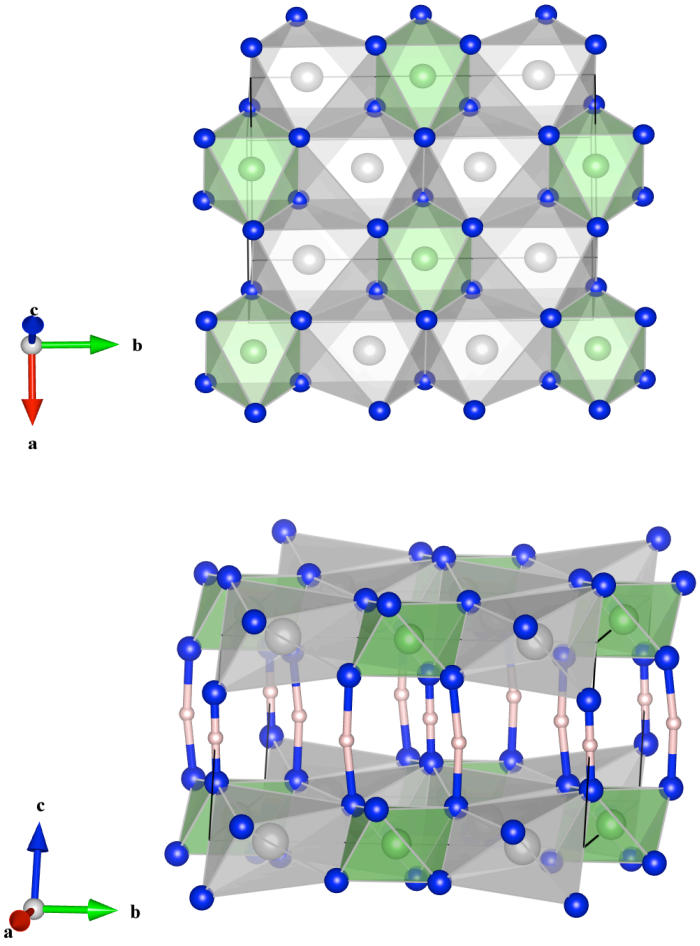

Fig. 1: Crystal structure of $H_3LiIr_2O_6$; gray:Ir, blue:O, pink: H.