Exotic electronic states and quantum magnetism in complex iridium oxides

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The properties of transition metal oxides are dominated by localised, spatially constrained and strongly interacting *d*-electrons, which display charge, spin and orbital degree of freedom [1]. 3*d* transition metal oxides, where Coulomb repulsion *U* is strong, show a rich plethora of electronic phases, such as high-T_c superconductivity in cuprates, colossal magnetoresistance in manganites, or quantum spin liquid state in herbertsmithite [2]. In contrast, 5*d* compounds show reduced *U* due to spatially extended 5*d* orbital and greater spin-orbit coupling λ_{SO} due to larger mass. As a result, *U*, λ_{SO}, crystal field splitting Δ and hopping *t* fall into the same energy scale, giving rise to a new rich variety of correlated spin-orbit coupled phases [3]. Iridates have been receiving attention due to unique electronic state of Ir^{4+} ion $j_{eff} = ½$, where experiments and calculations render intriguing phenomena depending on the type of lattice where the iridium resides. Layered perovskite Sr_2IrO_4 is an unexpected spin-orbit coupled Mott insulator [4] and hyperkagome $Na_4Ir_3O_8$ is a candidate for a quantum spin liquid [5]. Honeycomb and hyperhoneycomb iridates are predicted to be Kitaev spin liquids [6, 7] and it is proposed that one can find a topological Mott insulator in pyrochlore iridates [8]. In this talk, I will discuss my project where I search for new quantum materials in such strongly spin-orbit coupled systems.

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