Nature of the magnetic correlations in photo-doped and chemically-doped spin-orbit Mott insulator

$\text{Sr}_2\text{IrO}_4$\textsuperscript{1}

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In the iridates, competition between spin-orbit coupling, crystal field, and electronic correlation has lead to the observation of several novel states. Particularly notable is the spin-orbit Mott insulating state in $\text{Sr}_2\text{IrO}_4$ which has close analogies to the high temperature superconducting cuprates. This talk will describe the nature of the magnetic correlations in $\text{Sr}_2\text{IrO}_4$ and how the magnetic correlations can be modified by two different doping schemes. I will first describe doping via photo-excitation in which we use femtosecond infrared pulses to excite carriers across the Mott gap. After excitation, we probe the resulting magnetic state as a function of time delay using the first implementation of magnetic resonant inelastic X-ray scattering at a free electron laser. We find that the non-equilibrium state 2 ps after the excitation has strongly suppressed long-range magnetic order, but hosts photo-carriers that induce strong, non-thermal magnetic correlations. The magnetism recovers its two-dimensional in-plane Néel correlations on a timescale of a few ps, while the three-dimensional long range magnetic order is restored over a far longer, fluence-dependent timescale of a few 100 ps. In the second part of the talk I will describe chemical doping via Ir-Ru substitution. In this situation, we find that with increased Ru concentration, the dispersive magnetic excitations in the parent compound become almost momentum-independent, opening a magnetic gap $>150$ meV. We attribute this gap to the combined effects of disorder and Ir-Ru interactions.

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