Relativistic oxide materials

Jeroen van den Brink
IFW Dresden, Germany
E-mail: j.van.den.brink@ifw-dresden.de

The observed richness of topological states on the single-electron level prompts the question what kind of topological phases can develop in more strongly correlated, many-body electron systems. Correlation effects, in particular intra- and inter-orbital electron-electron interactions, are very substantial in 3d transition-metal compounds such as the copper oxides, but the spin-orbit coupling (SOC) is weak. In 4d and 5d transition-metal compounds such as iridates, the interesting situation arises that the SOC and Coulomb interactions meet on the same energy scale. The electronic structure of iridates thus depends on a strong competition between the electronic hopping amplitudes, local energy-level splittings, electron-electron interaction strengths, and the SOC of the Ir 5d electrons. The interplay of these ingredients offers the potential to stabilise relatively well-understood states such as a 2D Heisenberg-like antiferromagnet in Sr2IrO4, but in principle also far more exotic ones, such a topological Kitaev quantum spin liquid, in (hyper)honeycomb iridates and RuCl3. I will discuss the microscopic electronic structures of these materials, their proximity to idealized Heisenberg and Kitaev models and our contributions to establishing the physical factors that appear to have preempted the realization of quantum spin liquid phases so far.