Emergent magnetism and superconductivity in strongly spin-orbit coupled oxides

B. J. Kim

Max Planck Institute for Solid State Research

Strong relativistic spin-orbit coupling present in 4d and 5d transition-metal oxides allows description of their magnetic properties in terms of pseudospins, which represent the entangled spin and orbital degrees of freedom. In this talk, I will discuss selected examples of how pseudospins can lead to novel emergent phenomena, studied using resonant x-ray scattering, inelastic neutron scattering, and angle-resolve photoemission.

i) Sr_2IrO_4 with pseudospins-1/2 on a square lattice realizes a low-energy effective Hamiltonian very similar to that of the high temperature superconducting cuprates. Indeed, the unique Fermiology of cuprates in the pseudogap phase—known as Fermi arcs—has been largely reproduced in electron doped Sr_2IrO_4. I will discuss on our recent experimental progress in the search of d-wave superconducting phase in electron-doped Sr_2IrO_4.

ii) Pseudospins-1/2 on a certain lattice and bonding geometry are predicted to have strong, bond-directional interactions, which lead to a potential realization of the long-sought Kitaev model with a quantum spin liquid ground state. I will discuss experimental evidence for the dominant bond-directional interactions in a honeycomb lattice iridate Na_2IrO_3.

iii) Spin wave dispersion in an archetypal 4d Mott insulator Ca_2RuO_4 grossly deviates from that known for Heisenberg antiferromagnets, indicating a sizable unquenched orbital moment and a prominent effect of spin-orbit coupling in determining the form of magnetic interactions. I will discuss an effective model for Ca_2RuO_4 in terms of pseudospins derived from the microscopic Hamiltonian.