MAR13-2012-008281

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Spin-charge interplay on frustrated lattices

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Frustration has gained increasing interest in the study of itinerant electron systems. There, not only spin but also charge degree of freedom of electrons plays a crucial role in the structure of the energetically degenerate manifold, providing a new frontier of the frustration physics. A particular interest is in Kondo-type spin-charge coupled systems, in which itinerant electrons couple with localized moments on a frustrated lattice. In these systems, localized moments act as internal local magnetic fields for itinerant electrons, which significantly affect the electronic and transport properties. On the other hand, the kinetic motion of electrons induces effective magnetic interactions between localized moments, resulting in exotic magnetic correlations and orders. It is highly nontrivial what kind of electronic and magnetic state is realized as a consequence of the spin-charge interplay. In this contribution, we review our recent theoretical and numerical studies of the Kondo-type models on frustrated lattices. We have investigated several types of models, with Heisenberg and Ising spins for localized moments defined on 2D triangular and kagome lattices and 3D pyrochlore lattice. Complementary theoretical techniques have been adopted, such as perturbation, mean-field approximation, variational calculation, exact diagonalization, and Monte Carlo simulation. We found that these models exhibit emergent electronic and magnetic properties, such as a spontaneous spin scalar chiral order and topological Hall effect, non-Kondo resistivity upturn in spin-ice liquid, partial disorder accompanied by charge disproportionation, emergence of Dirac electrons under particular magnetic ordering, quantum anomalous Hall effect in spin scalar chiral liquid, and spin-Hall effect by spontaneous inversion symmetry breaking. These works have been done in collaboration with Y. Akagi, S. Hayami, H. Ishizuka, and M. Udagawa. For references, visit http://www.motome-lab.t.u-tokyo.ac.jp/index-e.html.