GP-Spin (Graduate Program in Spintronics) Seminar

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Topological Materials Doped with Magnetic Impurities

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Room A401
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Since magnetic impurities break time reversal symmetry, their presence was initially regarded as a source of back scattering that can destroy topological protection and preclude the observation of signatures of topological matter such as the quantum spin Hall effect. Surprisingly, however, topological insulators doped with transition metals show a number of remarkable properties, the striking example being the quantum anomalous Hall effect, predicted theoretically [1] and then observed in macroscopic samples by several groups. The development of materials in which charge transport occurs entirely *via* a single edge spin channel in the absence of an external magnetic field offers a number of novel spintronic capabilities.

In the talk, I will first explain while in semiconductors and, thus, in topological materials, effects of spin scattering are much less important than spin splitting brought about by polarization of magnetic-impurity spins. I will then present the recent progress in the understanding of the nature of spin-spin interactions between magnetic ions in semiconducting topological insulators, semimetals, and metals, *i.e.,* in bismuth/antimonite and lead/tin chalcogenides, mercury chalcogenides, and cadmium/zinc arsenide, respectively. In particular, I will discuss the physics and the relative importance of ferromagnetic Ruderman-Kittel-Kasuya-Yosida, Bloembergen-Rowland, and super-exchange interactions, and their competition with antiferromagnetic superexchange, depending on the carrier concentration as well as on the location of magnetic impurities in the lattice and their charge state [2]. Finally, the role of topological boundary states in mediating exchange interactions between localized spins will be presented.

[1] Rui Yu, Wei Zhang, Hai-Jun Zhang, Shou-Cheng Zhang, Xi Dai, and Zhong Fang, *Science* **329**, 61 (2010).

[2] see, e.g., T. Dietl and H. Ohno, *Rev. Mod. Phys.* **86**, 187 (2014); T. Dietl, K. Sato, T. Fukushima, A. Bonanni, M. Jamet, A. Barski, S. Kuroda, M. Tanaka, Phan Nam Hai, and H. Katayama-Yoshida, *Rev. Mod. Phys.* **87**, 1311 (2015).