"Exotic Magnon-Mediated Superconductivity in Topological Insulator/Ferromagnet Heterostructures"

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Ferromagnetism and superconductivity are often thought of as two incompatible phenomena, although there exists evidence for their coexistence in rare cases. In this talk, I will discuss our recent theory, which proposes a class of material systems – namely, heterostructures involving ferromagnets and strongly spin-orbit coupled metals – where ferromagnetism not only co-exists with superconductivity, but is responsible for its appearance in the first place. The main idea is that in the presence of strong spin-orbit coupling (such as on a topological insulator's surface for example), electrons' coupling to magnetic fluctuations in the ferromagnetic phase gives rise to unscreened, long-range forces (similar to current-current magnetic interactions), which open new exotic superconducting channels. I will present both details of the theory [1], which involves non-Fermi liquid behavior and highly exotic Amperean pairing, and recent experiment [2] in Bismuth-Nickel heterostructures, where some aspects of the proposal are realized and where magnon-mediated pairing leads to superconductivity that spontaneously breaks time-reversal symmetry. It will be argued that the proposed setups can serve as a versatile new platform to realize spin fluctuation meditated superconductivity in a more controlled way than what likely happens in unusual superconductors, such as the cuprates and heavy-fermion compounds, where magnetism and superconductivity are hosted by the same electrons.