UNIVERSITÄT DUISBURG ESSEN

PHYSIK

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Magnetic skyrmions at topological insulator surfaces and in proximity to a superconductor

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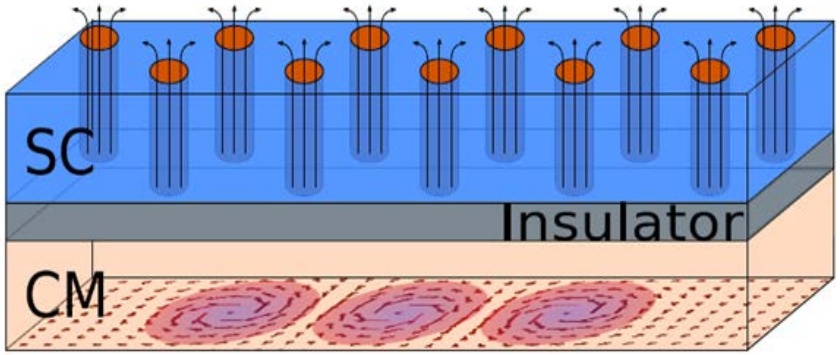

Ferromagnets in contact with a topological insulator have become appealing candidates for spintronics due to the Dirac surface states, which exhibit spinmomentum locking. Bilayer Bi2Se3-EuS structures, for instance, show a finite magnetization at the interface at temperatures well exceeding the Curie temperature of bulk EuS. Here we determine theoretically the effective magnetic interactions at a topological insulator ferromagnet interface above the magnetic ordering temperature. We show that by integrating out the Dirac fermion fluctuations an effective Dzyaloshinskii-Moriya interaction and magnetic charging interaction emerge. As a result individual magnetic skyrmions and extended skyrmion lattices can form at interfaces of ferromagnets and topological insulators, the first indications of which have been very recently observed experimentally. In the second part of my talk I will analyze a hybrid heterostructure with magnetic skyrmions (Sk) inside a chiral ferromagnet interfaced by a thin superconducting film via an insulating barrier. The barrier prevents the electronic transport between the superconductor and the chiral magnet, such that the coupling can only occur through the magnetic fields generated by these materials. We find that Pearl vortices (PV) are generated spontaneously in the superconductor within the skyrmion radius, while anti-Pearl vortices (PV) compensating the magnetic moment of the Pearl vortices are generated outside of the Sk radius, forming an energetically stable topological hybrid structure. Finally, we analyze the interplay of skyrmion and vortex lattices and their mutual feedback on each other. In particular, we argue that the size of the skyrmions will be greatly affected by the presence of the vortices offering another prospect of manipulating the skyrmionic size by the proximity to a superconductor.