Proposal for μSR- detection of spin- locking in the surface of topological insulators

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The surface conducting state in three dimensional topological insulators (TIs) is distinguished from ordinary metal by a helical spin structure, where the spin vector points parallel to the surface and perpendicular to the momentum. The nearly perfect spin polarization on TIs is brought by a Dirac-cone dispersion in the surface state.

So far, the surface band structure of BiSe has been investigated by angle-resolved photoemission spectroscopy [1], which has clearly shown the experimental evidence for the new phase, and quite recently further investigation by the low energy, spin- and angle-resolved photoemission spectroscopy (SR-ARPES)[2] has been carried out on the same material presenting the evidence for the existence of the out-of-plane spin component.

The existence of the out-of-plane component in the realistic sample poses an importance of the effects such as the anisotropy in the Fermi surface, electron-electron interaction or impurity scattering. In our presentation, we propose an idea to detect the spin structure in the surface state by μSR, which is expected to enable us to investigate the robustness of spin texture in the topological insulator surfaces.

Here we propose a new method utilizing slow muons to investigate the spin structure in the surface state. Due to the Kramers doublet in the spin state of TI, no hyperfine field is expected, and hence the state is not likely to be detected by muons. However, by applying a weak parallel field, the electron spins tend look away from the field direction rather than are aligned along, because the spin locking is suppressed by the break down of the time reversal symmetry. Thus induced perpendicular net moment is expected to readily detected by the ultra slow muon technique. In the presentation, we will discuss a detailed configuration for a proposed study as well as the effect of disorder on the spin locking.

References

[1] Y. Xia et al., Nature Physics **5**, 398 (2009)

[2] S. Souma et al., PRL **106**, 216803 (2011)

[3] K.-I. Imura et al., Phys. Rev. **B 84**, 195406 (2011)