Ultra-thin topological insulator spin-current transistor

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Topological insulators are an existing class of band-gap insulators, whilst they do conduct through their edge (or the surface). These gapless metallic surface states are naturally generated with helically-polarized spin texture due to strong spin-orbit coupling with a peculiar energy band structure of materials. Moreover the states are protected by time-reversal symmetry simply due to prohibition of back scattering and realize almost dissipationless pure spin currents (no net charge current) at the edge (surface) of materials. Spin-current devices based on the topological insulators save energy because it requires small current that flow at the edge (the surface) not in the bulk to access their surface properties.

In this project, we will fabricate a spin-current field effect transistor with an ultra-thin topological insulator Bi_2Se_3 [1] or BI_2Te_3 [2] film grown by molecular beam epitaxy. Existence of gapless states in topological insulators are one of peculiar characteristics but we will open a gap in the surface state by employing ultra-thin films where the top and bottom surface states get unstable due to an interference between two. The gapped surface state with a gating technique will provide us a capability of fabricating a spin-current filed effect transistor that can switch on/off the spin current. We will also keep our eye on other topological insulator materials suitable for this device project.

This is a project in an exciting and very active research area which allows us to closely interact and collaborate with other research teams in the University of Leeds including a theoretical group. We are looking for a motivated student with a background in physics, physical chemistry, or material science.

[References]

1 Taskin *et al.*, Phys. Rev. Lett. **109**, 066803 (2012).
2 Yang *et al.*, Appl. Phys. Lett. **104**, 161614 (2014).