Hinge states of second order topological insulator in nanowire geometry.

Maciej lis and Jakub Tworzydło

Faculty of Physics, University of Warsaw, ul. L. Pasteura 5, 02-093 Warszawa, Poland

In second order topological insulators the protected gapless modes may appear at the hinge connecting two surfaces, despite the presence of bulk gap in the band structure and gapped surface states. For those to happen the gaps in the spectrum of neighbouring edges must be opposite to each other. Those materials have become a field of increasingly active study in the last years [1].

The simplest realization of such a scenario is provided by a topological insulator crystal subject to the external magnetic field, which penetrates adjacent faces pointing inwards and outwards. We model such states starting from the continuum bulk Hamiltonian by extracting its surface part and the projector operators. We then calculate the hinge transition operator [2], which allows us to connect the states on the surface of crystal in order to analytically model the hinge states.

These universal technique allows us to obtain closed form conditions for the existence of hinge states as dependent on the crystal momentum along the edge, and also value and orientation of the applied magnetic field. We can also solve for the two hinge states interacting over a finite perimeter of the nanowire, and so provide contributions resulting from the finite size dependence. We argue, that this dependence can be experimentally tested by varying the orientation of the magnetic field.

[1] J. Langbehn, Y. Peng, L. Trifunovic, F. von Oppen, and P. W. Brouwer, *Phys. Rev. Lett.* **119**, 246401 (2017).
[2] Oindrila Deb, Abhiram Soori, and Diptiman Sen, *J. Phys. Condens. Matter* **26**, 315009 (2014).