Turning a topological insulator into a superconductor.

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Three-dimensional topological insulators are bulk insulators with charged surface states that are distinct from the bulk. The surface states are gapless (metallic) with linear excitation energy that in three dimensions traces out a cone, as does the Dirac energy spectrum for massless fermions. Robust against perturbations and scattering, such surface states are 'topologically protected' — the surface contains an odd number of 'Dirac cones' as a result of the topological index (Chern number) that characterizes the electronic band structure. Besides being mathematical curiosities, these states are also under consideration for fault-tolerant quantum computation and low-power spintronic devices.
(Our thanks to Mai Chao of Nature Physics for this nice text).

Surface electron band structure of bismuth telluride. (Image courtesy of Yulin Chen and Z. X. Shen.)

The Quantum Electron Matter group of the Van der Waals-Zeeman Institute for Experimental Physics is looking for a student to take on a project aimed at investigating the electronic structure of $Cu_xBi_2Se_3$, a doped topological insulator that is also a superconductor. We've just grown beautiful single crystals of this material and now want to get started investigating their surface electronic structure in k- and r-space as well as investigating their surface crystal structure and topography. Experimental techniques involved include angle-resolved photoemission (using the unique FAMoS facility), low temperature scanning tunneling spectroscopy and low energy electron diffraction. Depending on the time available (e.g. whether it's a BSc or MSc project), differing quantities and mixtures of these experimental techniques will be able to be used by the student.

The theory group of Kareljan Schoutens (ITFA) are expert in topological phases and a 'connected' project between experiment and theory (or a collaboration between two BSc students, one working in theory and one in experimental physics) would also be discussable.

Seeing as this would be the very first experimental work on topological insulator phases in Amsterdam, this is a somewhat 'high risk', non-trivial project, and calls for a bright and highly motivated student.

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See the following URLs for some relevant information.
http://www.nature.com/nphys/journal/v5/n6/full/nphys1294.html
http://physics.aps.org/articles/v3/11
http://www.sciencemag.org/cgi/reprint/325/5937/178.pdf (the paper from which the ARPES data shown above came from)