50 & 100 YEARS AGO

50 YEARS AGO

Very few microbiologists would dispute that bacterial taxonomy is in a very confused state ... As if this were not enough, there has been added to it a cavalier indifference to the internationally accepted conventions for nomenclature on the part of bacteriologists themselves and an almost complete absence of type cultures ... For historical reasons the taxonomy of bacteria especially has been carried on as isolated fragments of other disciplines such as medicine or dairying, with the result that the same micro-organism has been known by a different name in each field, and not infrequently their identity has never been realized. Many taxonomic schemes have been devised but have been only cherished by their authors, while others such as Bergey's scheme have been tolerated with much vexation and disappointment for want of something better.
From *Nature* 16 July 1960.

100 YEARS AGO

Mr. H. O. Barnard states, as the result of personal observation, that the alleged partiality of cobras for music is a myth. "The sole effect, so far as I could see, was to arouse their curiosity, as they would project their heads out of their holes equally well for any kind of noise, from the shrill piping affected by snake-charmers down to the tinkling noise made by dragging a chain past their dwelling, or even that made by light and repeated tappings with a switch close to their holes. It would appear, however, that the tone must be high, as grave sounds, such as tom-tom beating or deep notes from a flute, had no effect upon them." Mr. Barnard likewise confirms the observations, made in the London Zoological Gardens, as to the absence of a "fascinating" influence of serpents on birds.
From *Nature* 14 July 1910.

Although electrons in helical metals cannot backscatter, nothing prevents them from scattering in all other directions if the defects are point-like (Fig. 1a). However, the probability of near U-turns is much reduced compared with ordinary metals, and this turns out to have major consequences for 'electron localization' properties[1–3]. But when electrons are scattered by a crystal step, as in the experiment performed by Yazdani and colleagues[4], the situation is very different. Because of conservation of energy and of the component of the momentum in the direction along the step, electrons can ultimately do only two things (Fig. 1b): they can either pass right through the step or reflect specularly from it, just as light rays would (in specular reflection, the incidence and reflection angles of a light ray are the same). Crucially, if electrons travel at a right angle to the wall of a crystal step in a helical metal, they will certainly pass through — they won't be reflected because backscattering is not allowed in helical metals. Electrons approaching the step at a small incidence angle will have a high probability of making their way through[5]. Remarkably, this is true whatever the size of the step.

The above considerations form the physical basis for the prediction that crystal steps should affect electrons in a helical metal much more weakly than those in ordinary metals. This prediction is indeed borne out in Yazdani and colleagues' experiment. By combining state-of-the-art scanning tunnelling spectroscopy with a simple physical model for the helical metal on the surface of an antimony crystal, the authors deduce a probability for electron transmission through a crystal step of about 35%, a significant enhancement compared with the surface states in ordinary metals such as copper or gold. Previous studies[6] showed that steps in ordinary metals completely absorb or reflect the electrons, with almost no transmission observed.

The antimony crystals used in this study[4] are bulk metals, rather than insulators, and this causes some 'leakage' of the surface electrons into the bulk during the collision with a step (about 23%). Also, antimony's surface energy-band structure is more complicated than the ideal helical metal shown in Figure 2b, and thus allows for more near-U-turns than can be explained by the arguments presented above. These factors suggest that the electron-transmission probability through the steps can be further increased by using a material such as Bi_xSb_{1-x} (bismuth–antimony alloy), which for a range of x is a bulk topological insulator, or Bi_2Te_3 (bismuth telluride), which can be tuned to become an insulator in the bulk and has a surface energy-band structure that is much closer to that depicted in Figure 2b. Indeed, recent experiments using Bi_2Te_3 surfaces[7] show some of these features.

The metallic surface states of topological insulators hold promise for investigating various exotic physical phenomena as well as potential practical applications[8,9], such as

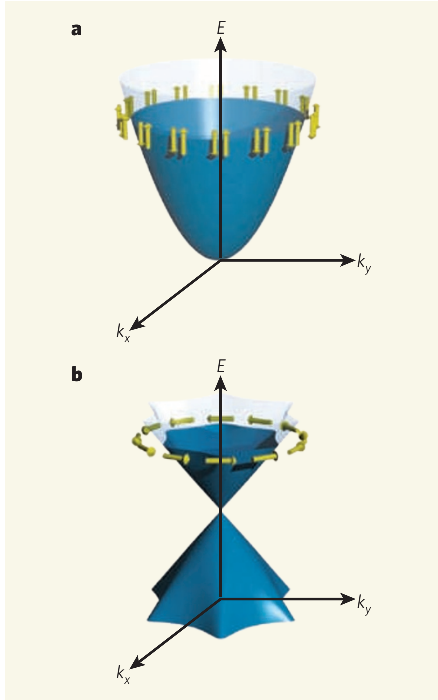

Figure 2 | Energy-band structure and spin orientation in normal and helical metals. a, In a normal metal, electrons occupy energy (E) levels up to a maximum level, the Fermi level, and for a given momentum **k** = (k_x,k_y) they have two possible spin orientations (spin-up and spin-down). **b,** In a helical metal, the energy levels form two cone-shaped bands that meet at their tips, and for a given **k** there is only one spin orientation.

dissipationless switching of magnetic moments, which could be of use in the data-recording industry. The underlying theoretical ideas are based on idealized, clean, perfectly flat surfaces and a somewhat vague notion of 'topological protection', according to which small changes to the ideal conditions that allow time-reversal symmetry will not alter the outcomes. It is encouraging to see that experiments such as that of Yazdani and colleagues are beginning to test these notions in real materials, and that their findings seem to support theoretical predictions. ■

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