But still, with a view to practical implementations, a device that works without any magnetic materials or magnetic fields would be attractive. Indeed there is, in addition to the obvious ways to manipulate the spin using magnetic fields, an indirect effect on the electron spin from externally applied electric fields, due to the so-called spin–orbit interaction. The spin–orbit interaction is a relativistic effect whereby an electric field in the crystal is experienced by a moving electron as a magnetic field in the rest frame of the electron, which can then lead to spin polarization or spin precession, among other magnetic effects. A manifestation of spin–orbit interactions is the spin Hall effect[5,6], in which a spin current flows transversally to a charge current in a non-magnetic material. The spin Hall effect, however, still requires a d.c. charge current to generate a d.c. spin current, and the spin current and charge current are transverse to each other.

Smirnov and colleagues propose that the spin–orbit interaction alone can be used to create a hybrid spin ratchet in which an alternating voltage drives spin-up carriers in one direction (on average) and spin-down carriers in the opposite direction. Their proposal consists of an electrostatically defined quasi-one-dimensional wire in which the strength and sign of the spin–orbit interaction can be controlled by gates. The transformation of the applied electric field from these gates into an effective magnetic field acting on the spins in the rest frame of the moving electrons (called the Rashba effect[7]) produces an energy dispersion relation for spin-up and spin-down carriers as shown in Fig. 1c. Even though the energies of the carriers are spin-dependent, time-reversal invariance is preserved for the dispersion in Fig. 1c, for the energy of a spin-up carrier is the same as that of the spin-down carrier of opposite wavevector. The spin ratchet, therefore, cannot be visualized exactly as shown in Fig. 1b; the difference in effective potential between spin-up and spin-down carriers only emerges once the carriers begin to move. But the orientation of easy and hard directions for spin flow in the spin ratchet is controlled by these gates, so it should be straightforward to reconfigure them (if desired) so that the spin current flows in the opposite direction. The requirements for the device are quite modest — spin–orbit interaction, an asymmetric potential for the ratchet, and dissipation. A hybrid device of this kind may therefore permit reconfigurable spin-current flow in a circuit without reconfiguring the oscillatory motion of the charges, opening a potential path to low-power spintronic circuits.

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58TH ANNUAL LINDAU MEETING OF NOBEL LAUREATES

Words of advice to young people

From 29 June to 4 July 2008, 24 Nobel Prize winners and 557 young scientists from 67 countries gathered in the Bavarian town of Lindau, on the bank of Lake Constance (pictured), to take part in the 58th Annual Lindau Meeting of Nobel Laureates. The meetings were initiated in 1951 by Lindau physicians Gustav Parade and Franz Karl Hein, with the aim for Nobel laureates to come together and address an international audience. Since then they have evolved under the patronage of Count Lennart Bernadotte of Wisborg and his wife, Countess Sonja Bernadotte, to become a unique a forum for laureattes to pass their experience, knowledge and enthusiasm for scientific discovery onto a new generation of scientists.

ED GERSTNER

The young scientists were chosen from 20,000 applicants, including undergraduates, postgraduates and postdoctoral researchers. The focus of the meeting alternates each year between physics, chemistry, and physiology and medicine, and every fourth year an interdisciplinary mix of all three. This year's focus on physics couldn't have been more timely. With the Large Hadron Collider at CERN due to be switched on in just over a month's time (announced during the meeting), the sense of anticipation of history in the making felt by laureates and young researchers alike made for an atmosphere that was electric.

Each day began with a series of six half-hour lectures given by the laureates. The themes of the lectures included historical accounts of the laureates' paths to Stockholm, "words of advice to young people" on what it takes to do good science — with Iver Giaever providing the most comprehensive list of advice including to be curious, competitive, creative, stubborn, self-confident, sceptical, patient and, most of all, lucky — to their take on emerging developments at the cutting edge of scientific research, from carbon electronics to particle physics. All the lectures can be viewed online at http://www.lindau-nobel.de/.

But the real magic occurred in the afternoons, when the young researchers were given the opportunity to engage face-to-face with the laureate (or laureates) of their choice. We and other members of the press weren't allowed into these meetings. But we did get a flavour of these interactions from more intimate meetings between laureates and researchers that we'd arranged for *Nature*'s documentary vodcast on the event (soon to appear on the nature.com website). In each of these encounters, the initial star-struck awe of young scientists to being sat next to a real-life Nobel prize winner (and to our cameras) was quickly forgotten by their shared excitement for physics and the challenge of getting to grips with such weighty subjects as subatomic supersymmetry, solar energy production, the search extra dimensions, Bose–Einstein condensation, quantum mechanics and the Anthropic Principle, and the future of optical telecommunications.

Ed Gerstner