When walls collide

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When an electrical current or magnetic field is directed along a ferromagnetic nanowire, it can drive the movement of domain walls that separate regions of different magnetization. Such control has obvious potential for new magnetic logic gates and memories, but realizing these devices will require better and more sophisticated mechanisms to control the interaction of multiple domain walls in a single wire. By simulating the magnetic-field-induced motion of domain walls in a permalloy nanowire, Andrew Kunz demonstrates what happens when two domain walls collide and suggests a way of controlling the outcome when they do.

When domain walls of opposite topological charge whose magnetic moments are aligned in the same direction collide, they annihilate; but when their moments point in opposite directions, they pass unaffected. Kunz shows that this behaviour can be used to release a domain wall that has become pinned by a notch in the nanowire. Conventionally, it is only possible to release a pinned domain wall using a high magnetic field — but by injecting a second wall of opposite orientation into the wire and driving their collision, the pinned wall can be released using a field only one-eighth the size.

Long life!

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The latest data from the Super-Kamiokande collaboration have lengthened the limit on the lifetime of the proton. Proton decay is possible, although still a rare process, in grand unified theories (or GUTs). Two quarks in the proton can transform, through the exchange of a heavy gauge boson, into a lepton (such as an electron or muon) and an antiquark (which forms a quark–antiquark pair, such as a pion, with the other quark from the proton).

Super-Kamiokande is a huge, underground Čerenkov detector, filled with 50 kilotons of water and thousands of photomultiplier tubes. Data collection began in 1996, but in 2001 a shockwave inside the detector wiped out about half of the photomultiplier tubes. Nevertheless, data collection was able to continue using the reduced detector, until full reconstruction begun in 2005.

Searching the data from these two periods, and accounting for background signals such as those due to neutrinos, cosmic rays and radioactivity, the collaboration have found no evidence of proton decay to a positron and neutral pion, or to a positively charged muon and neutral pion, and set limits on the partial lifetime in each channel of 8.2×10^{33} and 6.6×10^{33} years, respectively, at 90% confidence level.

A better memory

Nano Lett. doi:10.1021/nl900250g (2009)

The atom-like properties of quantum dots can be controlled by combining these tiny structures with nanowires. However, the structural quality of dots embedded in nanowires has been much poorer than that of those grown in isolation. Now, Maarten van Weert and co-workers have grown InP quantum dots in InAsP nanowires with sufficient quality to make the selective excitation and detection of single exciton spins possible.

Van Weert *et al.* used gold nanoparticles to seed the growth of vertical nanowires in a metal–organic vapour-phase epitaxy reactor. The linewidth of these structures — a good assessment of a quantum dot's quality — was a hundred times smaller than previous experiments on nanowire-embedded dots, small enough to resolve the splitting of the line induced by magnetic fields of 1 T or more. The dot can be prepared in either of these two states by excitation with a photon of the correct polarization and energy. In this way the quantum dot acts as spin memory — albeit it a very short (less than a nanosecond) one.

Mobile viruses

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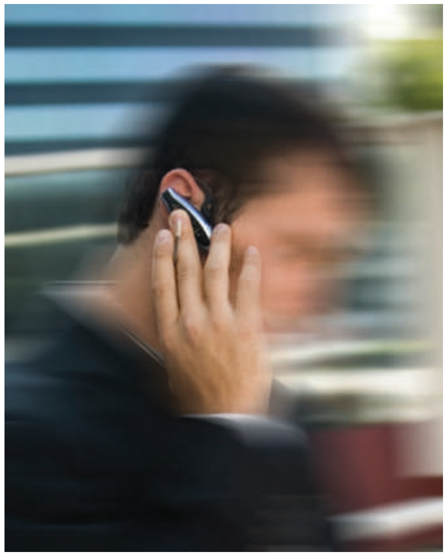

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The Conficker computer virus has infected approximately 15 million computers around the world in just six months. It is strange then that mobile-phone viruses, based on similar technology, aren't so prevalent.

Pu Wang and colleagues investigated the spread of mobile-phone viruses by running simulations based on user-mobility and communication-pattern data obtained from the billing record of 6.2 million mobile-phone customers. They show that the spread of a virus is strongly dependent on the market share of the phone operating system. In the case of viruses spread by Bluetooth, if an operating system has a 1% market share, it can take several months to spread to all susceptible phones — long enough to develop antivirus software.

A virus can spread much faster through MMS (multimedia messaging service) by sending itself to every number in the phone's address book. However, Wang *et al.* show that because the network is fragmented into 'islands', the spread is limited to a small fraction of susceptible phones. But the authors warn that the threat of a major virus outbreak grows as more smart phones with a common operating system hit the market.

Molecular giants

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The internuclear distance in 'everyday' diatomic molecules, such as O_2, is a few ångströms. However, in laser-cooled gases, at temperatures of a few microkelvin, molecular states can spread more widely, as Vera Bendkowsky and colleagues report. They observed molecules with a bond length of several thousand Bohr radii — more than 100 nanometres.

These molecules are formed by two rubidium atoms, one in a Rydberg state (in which the valence electron is in a state with a very high principal quantum number) and the other in its ground state. It has been predicted that at the temperatures and atom densities typical for a Bose–Einstein condensate, low-energy scattering of the Rydberg electron from the ground-state atom can give rise to binding between the two atoms.

Bendkowsky *et al.* have now confirmed this effect, and characterize the resulting 'ultralong-range Rydberg molecules' spectroscopically. Although the information obtained about the scattering process should be useful in itself, the authors expect that their approach should lead to the realization of related states, including trimers and molecules with substantial electric dipole moments.