Great balls of fire!

On Tuesday 3 August 1982, Cambridge University’s Cavendish Laboratory was struck by lightning. Although no serious damage was caused, according to Sir Brian Pippard an assistant on the ground floor was startled by “a bright sparkling object ... that entered [a small window] by her head, rebounded from a machine and left as it came” (Nature 286, 702; 1982).

Despite this and many other historical accounts, the phenomenon of ‘ball lightning’ has remained largely the stuff of myth. But Vladimir Dikhtyar and Ei J. Jerby’s demonstration of the behaviour of fire balls generated by an industrial ‘microwave drill’ could provide an explanation (Phys. Rev. Lett. 96, 045002; 2006).

Such fire balls (pictured) mimic two of the most perplexing aspects of ball lightning — they persist after the initial source of energy is removed and they float in air. This supports previous suggestions that ball lightning could be driven by the oxidation of particles in a cloud generated by an energetic event, such as a conventional lightning strike.

Colour effect

The mass of the W boson is 80.415 ± 0.042 ± 0.030 ± 0.009 GeV, according to the OPAL collaboration (Eur. Phys. J. C 45, 307–335; 2006). One of four experiments at CERN’s former Large Electron Positron (LEP) collider, OPAL is the first to produce its final measurement of this fundamental quantity in particle physics.

That data-taking at LEP ended in 2000 gives some indication of the difficulty in pinning down the W mass by direct measurement (to test the precise inferred value, which constrains the mass of that other boson, the Higgs). The first error quoted by OPAL is statistical; the third reflects the uncertainty in the centre-of-mass energy of the e+e- collisions in the 27-km LEP ring.

The remaining, systematic error includes, alongside predictable detector effects, a contribution from final-state interactions, such as colour reconnection. This arises when each W boson, produced pairwise in e+e- annihilation above 160 GeV, decays into a pair of quarks. The colour forces between the quarks can lead to gluon exchange, a reconnection that effectively blurs the information from which the W mass is reconstructed. Frustratingly, there is no firm evidence in the LEP data that reconnection is taking place, but as it is established in other systems the effect must be taken into account in the W-mass error.

Four strikes and you’re in motion

The four-stroke cycle is the most common sequence used in combustion engines. Now Vincenzo Balzani and co-workers present an artificial molecular motor — only some five nanometres in length — working to a similar rhythm (Proc. Natl Acad. Sci. USA 103, 1178–1183; 2006).

Instead of moving valves and pistons, the four-stroke nanomotor is a rotaxane molecule, in which a ring encircling a dumbbell-shaped structure moves back and forth between two stations placed 1.3 nm apart. The shuttling is induced by light excitation. At the end of the cycle, the initial configuration is restored, and the process can start over again. In these experiments, the motor ran in a stable manner for at least 1,000 cycles, at a frequency of 1,000 Hz, generating a power of about 10^-17 W per molecule.

Conveniently, sunlight can serve as the sole energy source, and as long as the nanomotors are exposed to it, they keep operating autonomously, without producing waste products.

Small-world induction

Complex three-dimensional structures can be crafted on the microscale by multiphoton absorption polymerization (MAP); laser light is focused on a resin containing a ‘photoinitiatior’, which is excited whenever two or more photons arrive simultaneously at a single spot, leading to local polymerization; washing away the unpolymerized resin afterwards leaves behind the desired structure. But using the technique with materials other than polymers — to produce, for example, electrical structures — has proved difficult.

Writing in the Journal of the American Chemical Society (128, 1796–1797; 2006), Richard A. Farrer and colleagues report that the ‘functionalization’ of polymeric microstructures might be the way forward. They used two different types of polymers and deposited metal selectively on one of them, to fabricate a tiny inductor (pictured).

Roughly 100 µm in length, the device is formed from a copper-coated polymer; the supporting structure is made from the second polymer and lacks electrical functionality. Farrer et al. also fabricated wires and connected up the inductor, turning it into a functional device.