A walk in the park

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A random walk is a mathematical formalization of a path that consists of a succession of random steps. Among other things, it describes the trajectory taken by a molecule in a liquid or gas, or the path of an animal foraging for food. Vicious walks, however, are more constrained (and not as bad as they sound): different walkers' paths are random but cannot cross. Grégory Schehr and co-workers have now established a physical connection between vicious walkers and random matrix theory.

Using path-integral techniques, Schehr *et al.* have calculated the exact distribution of the maximal height of vicious walker paths (that is, a measure of the transverse fluctuations of the paths) with and without a wall, or boundary, nearby. Physically, the picture is akin to that of dislocations that arise at the transition between two states with lattice-based magnetic or crystallographic structures. The results not only show an explicit connection to random matrix theory but also improve on previous numerical studies.

Feel the squeeze

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Precision measurements are the cornerstone of many areas of science. Time and position sensors are capable of reaching the standard quantum limit — the lowest limit for noise levels set by quantum mechanics. But it is possible to beat even this limit, as J. Estève and colleagues have shown using a Bose–Einstein condensate.

'Spin squeezing' has been proposed as a means of overcoming quantum noise and circumventing the limits of precision imposed by Heisenberg's uncertainty principle. This approach is equivalent to rearranging the uncertainties on two conjugate variables: the variable of interest becomes better defined at the expense of increased noise in the other.

Estève *et al.* have demonstrated that this works in a Bose–Einstein condensate of ^{87}Rb atoms, which are distributed across an optical lattice. Squeezing was achieved by reducing the fluctuations in atom numbers between adjacent lattice sites, while at the same time ensuring a sufficiently large phase coherence between sites. The observed fluctuations imply entanglement between the particles and, ultimately, an improvement of 3.8 dB over the standard quantum limit.

Doping power

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One-dimensional nanowires offer a range of unique properties arising from their reduced dimensionality, and could form an integral part of future nanosized electronic and photonic devices and the basis of nanoscale wiring. That hope is now bolstered by Yasuhiko Terada and colleagues' demonstration of a new way of reversibly controlling the electronic properties of a nanowire system using light.

It works as follows: when laser light is focused onto an array of indium nanowires on a silicon substrate, electron–hole pairs are generated in the silicon (because the photon energy is larger than the silicon bandgap); photocarriers are then transferred to the nanowires, where they ultimately change the position of the Fermi level of the indium and induce a metal–insulator transition. By regulating the laser intensity and the voltage applied to the sample, the transition can be controlled and reversed.

This is the first time that charge transfer has been controlled in this way in such a low-dimensional setting, and the technique could be applied to other nanosystems.

Flying lenses

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For decades, optical lithography has been the workhorse of the semiconductor industry, and its success has been crucial in fulfilling Moore's law. A new low-cost, high-throughput approach to nanolithography has been devised by Werayut Srituravanich and colleagues — one that uses 'flying' plasmonic lenses.

Conventional lithography uses a mask to create an image of the features to be etched on a chip. But high-quality masks are expensive and time-consuming to produce. Maskless nanolithography is cheaper, but suffers from low throughput.

The alternative offered by Srituravanich *et al.* uses an array of plasmonic lenses that 'flies' above the surface to be patterned. The lenses concentrate surface plasmons into spots less than 100 nanometres across, but the catch is that these spots are produced in the near field, making it difficult to scan the array above the substrate at high speed. To overcome this, air flow above and below the plasmonic lenses is used to carefully maintain their height. The technique can hold a lens 20 nm above a spinning surface reaching speeds of 4 to 12 m s^{-1} at the outer radius, and produce patterning linewidths of 80 nm.

Spark of inspiration

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In 2007, astronomers observed a brief radio 'spark' near the Small Magellanic Cloud. The burst did not come from our Galaxy or from the Small Magellanic Cloud, and no other suitable astrophysical source has been identified. But perhaps there's a cosmological explanation?

Tanmay Vachaspati thinks that superconducting cosmic strings could be responsible. Cosmic strings are — hypothetically — elastic, current-carrying 'wires' that are scattered about the cosmos, in closed loops and infinitely long curves. They oscillate under their own tension, and can give off very strong electromagnetic radiation from certain regions that reach the speed of light. Previous studies of cosmic-string signatures have focused on high-energy emission involving, for example, γ-rays.

But Vachaspati argues that cosmic strings could emit lower-energy radio-wave bursts similar to that observed. The duration, fluence spectrum and event rate of the 2007 radio spark can be accounted for by a cosmic string that carries a current of about 100,000 GeV, although more evidence is needed to prove or disprove the theory.