High-*Q* times two

Nature **457,** 455–458 (2009)

The emerging field of plasmonics seeks to control light at scales far below the diffraction limit by exploiting its interaction with surface plasmon polaritons (SPPs). SPPs are quasiparticles that consist of both optical and electronic components, and emerge at the interface between a conductor and an insulator. Many structures for generating, guiding and focusing SPPs have been demonstrated. But, as yet, no-one has been able to construct a resonant cavity capable of confining SPPs efficiently.

Bumki Min and colleagues address this by introducing SPPs into the design of an already proven type of optical cavity: a whispering-gallery-mode, silica microdisk cavity. Such cavities can have *Q*-factors — the key measure of a cavity's efficiency — that routinely exceed 10^6. In contrast, the *Q*-factors of SPP cavities have so far been limited to less than 100.

Min *et al.* show that by simply coating a silica microdisk cavity with a thin film of silver, it behaves as a resonant SPP cavity with a *Q*-value of 1,373 — close to the theoretical upper limit for any SPP cavity. This could enable, they suggest, the development of SPP lasers as well as new plasmonic regimes for the study of cavity quantum electrodynamics.

Standard still stands

Phys. Rev. D **79,** 011101 (2009)

Yet again, the standard model of particle physics has withstood a battery of experimental testing. The latest assault has been made by the CDF collaboration, studying high-energy proton–antiproton collisions at Fermilab's Tevatron and throwing a huge amount of data (two inverse-femtobarns) into their attack.

CDF also used rather unusual tactics. It's typical to search for any new physics by testing data against a Monte Carlo simulation of particular processes — say, for example, the production of a Higgs boson. But this analysis was instead a 'global search', hunting for any deviation from the standard-model norm without reference to a specific signature.

The search algorithm looks at gross features of the collision debris, such as the number and spacings of the jets of particles that are produced. A component routinely called 'Bump Hunter' does exactly that — it seeks any Gaussian bumps on top of the standard-model background in mass distributions, which might indicate resonant production of a new particle.

But to no avail. The magnificent standard model lives to fight another day.

Transmission gained

Phys. Rev. Lett. **102,** 013904 (2009)

Extraordinary transmission is an intriguing effect in which more light passes through tiny holes than would be expected. Koray Aydin and colleagues now show that transmission can be enhanced even further by taking the counterintuitive step of placing something in front of each aperture.

The effect doesn't work with just any structure. Aydin *et al.* use so-called split-ring resonators, which consist of two concentric annuli, each with a small gap. Such an arrangement has already proved useful: arrays of split rings have been used to create materials with predetermined optical properties, so-called metamaterials.

For a single 8-mm aperture, etched into a copper plate, the transmission of microwave radiation (with a wavelength of 8 cm) increased by a factor of 740 when the resonators were placed in front of the aperture. There was no enhancement, however, when two completely concentric rings were used: the gaps are important for extraordinary transmission, as they enable the localization of the incident radiation's electric field.

Similar effects could also be achieved with visible light, by reducing the dimensions of the aperture and the resonator.

Doping control

Nano Lett. **9,** 269–272 (2009)

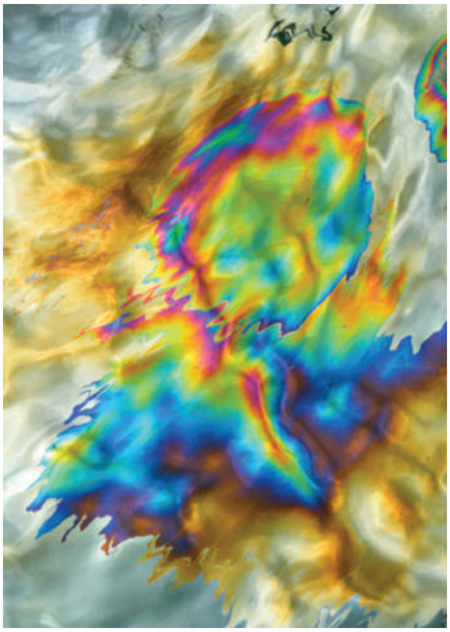
Graphene nanoribbons could be useful for spintronics applications — except for the problem that, in their groundstate, nanoribbons are antiferromagnetic. However, Keisuke Sawada and colleagues predict that the magnetic phase of nanoribbons could be sensitively controlled through carrier doping.

Nanoribbons are thin strips of graphene or single-walled carbon nanotubes, and their electronic and magnetic properties depend strongly on their edges. For the type of nanoribbons studied by Sawada *et al.*, wave functions are strongly localized at the edges, with energies close to the Fermi level. Owing to interactions and the character of the density-of-states around the Fermi level, the spins align ferromagnetically along each edge, although the two edges have opposite spin directions as a consequence of the lattice structure of the nanoribbon.

Using noncollinear, first-principles density-functional-theory calculations, Sawada *et al.* show that it should be possible to sensitively change the angle between the spins at the two edges by simple carrier doping. Their numerical analyses reveal that either electron or hole doping — in a field-effect-transistor set-up or by direct chemical means — can cause the edge spins to be tuned continuously from an antiparallel to a parallel edge configuration.

See the potential

J. Am. Chem. Soc. doi:10.1021/ja805962x (2009)



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Ions dissolve quite happily in water, but not so well in oil. This property is important when considering ion transport across water–oil interfaces — in biological cells, for example — where the solvation power changes continuously, influencing the ion's energetics and kinetics. Richard C. Bell and colleagues present an elegant and direct method for mapping out the 'solvation potential' (defined as the average chemical potential experienced by a single ion as it approaches the interface) with atomic resolution.

Bell *et al.* build oil–water interfaces layer by layer using molecular beam epitaxy. At carefully controlled distances from the interface, ranging from 0.4 to 4 nm, they embed Cs^+ ions in the oil, 3-methylpentane — a glass with a transition temperature of 77 K. The interface-building is conducted at 30 K, but as the assembly is slowly warmed to above the glass transition, the ions start moving, and from that movement (measured using a Kelvin probe) the local slope of the solvation potential can be determined.