Disorder for localization

Phys. Rev. Lett. **110,** 011601 (2013)

The existence of extra dimensions, beyond those of space and time that we perceive, is an attractive hypothesis in theoretical physics, not least in trying to fathom the apparent weakness of gravity compared with other forces. Compactification of those extra dimensions is necessary, to put them beyond our notice (even, so far, in high-energy experiments such as those at the Large Hadron Collider) — an idea that dates back to the work of Theodor Kaluza and Oskar Klein in the 1920s. Models developed since then include that of Lisa Randall and Raman Sundrum in 1999, involving branes and warped geometry, achieving localization of the graviton through the curvature of the Universe.

Ira Z. Rothstein, however, has an alternative — and 'localization' is the clue. Just as Anderson localization restricts the diffusion of waves in a disordered medium, could gravity be localized in a disordered 'crystal' lattice of branes? According to Rothstein, one or more extra dimension riddled with defects is all that is needed for gravitational localization and, consequently, for the existence of arbitrarily large extra dimensions. *AW*

Thicker than blood

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Assembling polymer–colloid composites demands careful, often tedious, fine-tuning. But there are several examples in nature that make the task look all too easy. Take blood clots: the human body is capable of forming a polymer–platelet composite within seconds of injury — outperforming comparable industrial-assembly processes. Now, Hsieh Chen and colleagues have drawn inspiration from clotting to show that polymer–colloid composites assemble via a universal process that can be engineered to obtain aggregates of variable density and microstructure.

The formation of a haemostatic plug during clotting is known to be regulated by fluid flow, and rendered more effective with increasing shear rate. Chen *et al.* studied a dilute polymer–colloid mixture, using both simulation and experiment, and found that the reversible aggregation exhibited by their system was also mediated by shear forces. Through a simple scaling argument they were able to demonstrate the universality of the phenomenon.

The authors' finding that aggregation occurs only above a critical shear rate will likely prove important in understanding how plugs are generated exclusively at injury sites — and may even inform the design of novel composites with tunable mechanical, chemical and optical properties. *AK*

Graphene exerts its influence

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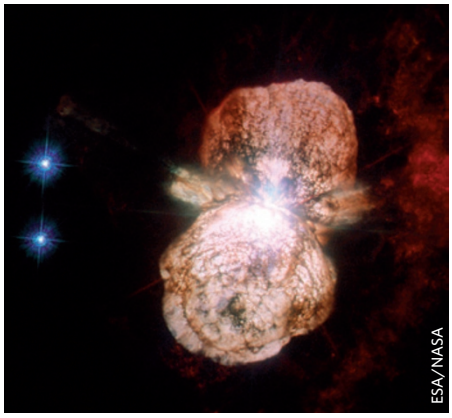
Nanoscale optical cavities offer a powerful means of controlling light. They can even modify spontaneous emission itself, if the source within emits light at a wavelength near the cavity resonance. Arka Majumdar and co-workers have now shown how graphene provides a way of electrically tuning the properties of a photonic-crystal cavity, creating a platform for unifying photonics and electronics.

Majumdar *et al.* perforated a thin silicon membrane with a hexagonal array of holes 90 nm in radius. The cavity comprised three filled-in holes plus a modified hole at each end. The researchers placed a graphene sheet on top of the photonic crystal before attaching electrodes.

The application of just a few volts shifted the cavity resonance (near 1500 nm) by approximately 2 nm, and increased the reflectivity by a factor of 4. This level of control is a result of the electric-field induced changes in the dielectric function of the graphene. The authors hope the idea might lead to small-footprint, high-speed electro-optic modulators. *DG*

Third time lucky

Mon. Not. R. Astron. Soc. (in the press)



Sometimes, an apparent supernova fades quickly and the unexploded progenitor star is downgraded to a 'supernova impostor' — such as Eta Carinae (pictured) in our own galaxy (which could erupt at any time, and appear as bright in the sky as the Moon). Another impostor is the luminous blue variable (LBV) star, SN 2009ip, located in Pisces Austrinus. However, Jon Mauerhan and co-workers argue that it is, in fact, a true supernova.

SN 2009ip first erupted in 2009, but its brightness faded in days. A second event a year later was very similar. The latest outburst occurred in July 2012, but this time after fading, it suddenly brightened again. The accompanying ultraviolet emission was even more pronounced, reaching a peak luminosity of ~ 1.3×10^9 times that of the Sun. The authors present spectroscopic evidence for broad emission and high ejecta speeds of up to 13,000 km s^{-1}, which are unprecedented for any known impostors. Instead, the large velocities are more comparable to those observed for SN 2005cs, a type-II supernova.

As a supernova, SN 2009ip raises a number of questions. Neither the multiple outbursts nor the direct transition from LBV to supernova — without first becoming a Wolf–Rayet star — are accounted for in stellar-evolution models. *MC*

Out of this world

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The 'quantum eraser' is a quirky twist to the double-slit experiment: knowing which path the photon took through the slits destroys the interference pattern; conversely, by erasing the 'which path' information the interference pattern is recovered — and that remains true whether the decision to erase (or not) is made using a past or a future measurement on a distant entangled particle. Such delayed-choice arrangements do not, however, exclude the possibility of hidden (although not faster-than-light) communication between the choice and interference event.

Xiao-Song Ma and colleagues have demonstrated a quantum-eraser experiment in which the decision is causally disconnected — communication between choice and interference is impossible because the entangled photons are so far separated that any information transfer would have to be superluminal. This was tested in different scenarios using an interferometric set-up, with entangled photon pairs distributed over 55 m of optical fibre or 144 km of free space. Their results suggest that we should abandon our classically rooted view of causally connected quantum events, as these seem to be independent of space-time. *IG*

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