Popularity contested

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Popularity may be an attractive trait, but when it comes to evolving networks, Fragkiskos Papadopoulos and colleagues have determined that it competes with familiarity. The emergence of scaling in networks is often cast within the framework of preferential attachment — the idea that popular nodes accrue links more frequently than their poorly connected cousins. This assumption recovers the power-law scaling of connection distributions in several real-world networks, but falls short of accurately describing their evolution.

Papadopoulos *et al.* have developed a model that plays popularity off against similarity — demonstrating that evolving networks optimize the formation of new attachments by trading links to popular nodes with those that connect similar nodes. The most intuitive example is the Internet: a model network that preferentially creates new links to Google and Facebook, based on their popularity, will omit more subtle links, such as those connecting the sites of cycling enthusiasts to their favourite *Tour de France* forum. But the framework is also applicable to the less obvious evolution of social and metabolic networks. Perhaps most importantly, it holds promise for accurate prediction of new links in evolving networks. *AK*

Mid-guide spread

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Look at a quasicrystal close up and it seems to have little pattern. But scale out and an ordered arrangement soon emerges. Yaacov Kraus and colleagues now show that an optical quasicrystal is a means for efficient photon transfer with little loss.

Kraus *et al.* investigated a one-dimensional quasicrystal comprising a series of microscale optical waveguides side-by-side. They show that light sent down the middle waveguide quickly spreads out to the neighbouring channels as it propagates. If the light is sent down a waveguide on the edge, however, the photons emerge as a tightly localized beam from the guide at the other edge of the quasicrystal.

The researchers highlight that this unexpected effect has many similarities with the electronic properties of topological insulators — where states exist at the surface of an insulating material enabling a current to flow. In both cases, a system with a small number of dimensions displays characteristics associated with a higher-dimensional one. This analogy might aid better understanding of topological states and their application. *DG*

More spookiness

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Quantum correlations challenge our classical notion of locality — measuring one particle influences the measurement outcome on its spatially separated pair. Ognyan Oreshkov and colleagues now reveal more quantum mechanical spookiness: quantum correlations that defy causal order.

The framework developed by Oreshkov *et al.* assumes no definite causal structure, but considers two laboratories inside which the laws of quantum mechanics hold. The inhabitants of these laboratories are each given a particle and start playing a game, trying to guess each other's random choice. They can communicate their choice only by sending their particle to the other lab. Causal order restricts this communication, forbidding bidirectional signalling, therefore the success probability of the game is bounded.

However, it turns out that correlations can exist beyond those predicted by standard quantum mechanics. These do not obey causal order, allowing the players to improve their probability of success. Interestingly, this bears similarity to the violation of Bell's inequality — that is, violation of local realism. Moreover, causal order seems to emerge in the classical limit. Whether these exotic quantum correlations can be found in nature is not yet clear. *IG*

To be or not to be

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Data from CERN would now seem to have answered the question posed last year by the laboratory's Director General, Rolf Heuer, about the Higgs boson: "To be, or not to be?" In July this year, the ATLAS and CMS collaborations reported signals touching the five-sigma significance level for a Higgs-like particle with a mass of 125 GeV c^{-2}. Meanwhile, the CDF collaboration have been completing their analyses of the final set of data delivered by Fermilab's Tevatron accelerator before it was shut down last year. Although their statement is not as definitive as that from CERN, the CDF collaboration have also found the hint of a signal in the same mass region.

The Tevatron's proton–antiproton collisions at a lower centre-of-mass energy than the proton–proton collisions at CERN offer a complementary system for the Higgs search, and one in which the decay of a Higgs boson to b quarks is more easily detected. Seeking the signature of a Higgs produced alongside a W or Z boson, with the Higgs then decaying to a b and anti-b quark pair, the CDF team found an excess in the data, peaking at a significance of 2.7 at a mass of 125 GeV c^{-2}. *AW*

Computer says nova

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A star shines, loses energy and then collapses to a compact remnant, which could be a white dwarf, a neutron star or a black hole. Given that stellar masses form a continuum, it's reasonable to expect a similarly smooth distribution of remnant masses — but that is not the case. There is a marked gap between the heaviest observed neutron stars (at two solar masses) and the lightest black holes (five solar masses). Krzysztof Belczynski and co-workers use this curious fact in their modelling of supernova explosions.

During gravitational collapse, the formation of a rigid proto-neutron star can stall the process, as infalling material 'bounces' off the core and sends out shockwaves. But neutrinos within the core heat up the turbulent layer around the proto-neutron star. The resulting temperature and density gradients lead to a Rayleigh–Taylor instability that violently mixes the layers, thus starting the supernova engine.

The timing is critical, say Belczynski *et al.*, if the observed mass gap is to be created. A sufficiently rapid growth time of the instability (10–20 milliseconds) and sufficient energy lead to a supernova explosion within 100–200 milliseconds; this ejects most of the star and leaves behind a lower-mass neutron star. Otherwise, the star collapses into a heavier black hole. *MC*

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