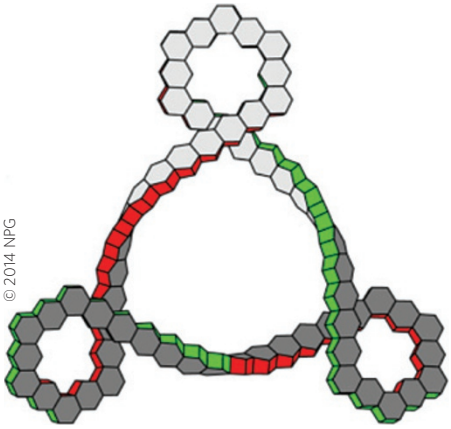
Do the writhe thing

Nature Chem. http://doi.org/s7t (2014)



You name it, they'll synthesize it: organic chemists are adept at producing the most amazing and challenging molecules.

Synthesizing Möbius annulenes — completely conjugated cyclic hydrocarbons with the geometry of a Möbius strip — is a continuing challenge. Gaston Schaller and colleagues have now found a route for preparing multiply twisted annulenes. Inspired by the notion that twisted structures often wind around themselves to release strain — think of a twisted telephone cord that got all wound up — they set out to synthesize a triply twisted Möbius molecule featuring three loops (pictured), which should be more stable than the loop-free variant.

The net amount of overlap induced by the loops can be quantified by a parameter known as writhe; likewise, the degree of twistedness is quantifiable. According to the Călugăreanu theorem, the sum of writhe and twist is constant throughout topological transformations (stretching, compressing or bending). In other words, a shape can convert twist into writhe by making loops.

The authors chose precursors that have the right writhe, and at the end of a chain of reactions that took several weeks to complete, obtained the desired [24]dehydroannulene. *BV*

Cloud in a cloak

Mon. Not. R. Astron. Soc. (in the press); preprint at http://arxiv.org/abs/1404.3209 (2014)

The Smith Cloud is a high-velocity cloud of hydrogen gas on a collision course with the Milky Way (reaching our Galaxy in about 27 million years). It is as wide as Orion, though invisible. The cloud last passed through the Milky Way roughly 70 million years ago — an encounter that should have disrupted it. That it survived with a well-defined substructure has led to suggestions that it is surrounded by a halo of dark matter. Matthew Nichols and colleagues use analytic calculations and numerical simulations to sound out such an enshrouded cloud.

In their model, Nichols *et al.* start with a progenitor cloud of neutral hydrogen, roughly three times the present size of the Smith Cloud. They then compare collisions with the Milky Way with and without a dark-matter halo around the cloud. Only when the dark matter is present can they reproduce the observed structure, which includes a compact 'head'. Their results suggest that the Smith Cloud is actually a failed dwarf galaxy from beyond our Galaxy, rather than left-overs from star formation within the Milky Way. *MC*

Half the battle

Nature Commun. **5,** 3974 (2014)

The spintronics community has been searching for materials exhibiting half-metallicity for a number of years: the prospect of a material that conducts for one spin orientation but is insulating or semiconducting for the other has remarkable technological potential. Several Heusler alloys — intermetallic compounds that crystallize in a Heusler phase — have been predicted to be half-metallic at room temperature, but experimental evidence for such behaviour is scarce. Now, Martin Jourdan and colleagues have demonstrated the half-metallicity of a Heusler-alloy thin film.

Using *in situ* ultraviolet photoemission spectroscopy, the authors measured a spin polarization of approximately 93% at the Fermi energy at room temperature in epitaxial Co_2MnSi films. Combined with band-structure calculations, these results provide the first direct observation of half-metallicity in the surface region of a Heusler compound.

Unlike conventional estimates that are based on transport measurements, this technique provides a direct probe of the spin polarization. Therefore, these results not only pave the way for more powerful spintronic devices but also raise questions about the suitability of using such transport measurements for determining a material's half-metallicity. *LF*

Safe deliveries

Science http://doi.org/s7r (2014)

It's annoying when a letter is lost in the post. Even if a potentially erratic mail service is replaced with teleportation — as is the case for quantum communication — losing what we wish to send is just as frustrating. And unfortunately, this is what happens when quantum data are stored in and teleported via photons — most of the time they just get lost.

Deterministic data delivery can be achieved by means of unconditional teleportation. However, in contrast with the 143 km record distance for standard teleportation, this has previously only been realized in single-system table-top set-ups. Now, Wolfgang Pfaff and colleagues report the unconditional teleportation of a qubit encoded in nitrogen vacancy (NV) centres between two diamonds separated by over three metres.

The key elements required to make the protocol unconditional — a deterministic Bell measurement at the source and a sufficiently long coherence time of the receiver's qubit register — were achieved thanks to the high controllability of NV centres, once more reaffirming the great potential of diamond impurities for applications in quantum information and communication. *FL*

Package deal

Proc. Natl Acad. Sci. USA **111,** 8345–8350 (2014)

Here's a packing problem for you: how do you squeeze a polymer measuring tens of micrometres into a volume spanning tens of nanometres? Ask your favourite virus. The DNA contained in many viruses undergoes a 10,000-fold volume compaction, battling against bending and repulsion with the help of a molecular motor capable of bearing some pretty hefty forces. Simple quasistatic thermodynamic models have had remarkable success in describing this process, but as Zachary Berndsen and colleagues have now shown, a full understanding pushes the problem well out of the realm of equilibrium physics.

Berndsen *et al.* used optical tweezers to investigate the dynamics of the motor responsible for packaging DNA in a type of virus that infects bacteria. When they stalled the motor and then let it resume, they found that the packaging rate increased dramatically, implying that the DNA had been kinetically constrained and that stalling had allowed it to relax — a proposal supported by timescale variability across different complexes. The effect was most pronounced when the DNA was densely packed: the authors' measured bound on relaxation time at 75% packing exceeded the time required to package the entire genome. *AK*

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