BIOMATERIALS

Shell stress

J. R. Soc. Interface **12,** 20150738 (2015)

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It's difficult not to be attracted to the exquisiteness of marine cone snail shells. And yet, the shell's function is obviously not to be beautiful, but to provide protection for its invertebrate inhabitant. As a result, cone shells are mechanically tough and hard — properties that arise from an intricate microstructural arrangement of calcium carbonate crystallites and organic components.

The microstructure of the shell of the gastropod mollusc *Conus marmoreus* (marble cone; pictured) consists of crossed lamellar layers and is highly anisotropic. This results in residual stresses that Jan Bonarski and colleagues have now studied in detail. The authors cut a piece about 9 cm long out of the shell wall of a *C. marmoreus* specimen. The sample was obliquely shaved so that one end had the full wall thickness of 6.5 mm and the other end had zero thickness. X-ray diffraction measurements along the sample's length provided information on crystallographic texture and residual stress. Positive stresses of the order of 1,500 MPa were uncovered, which might be due to the need to accommodate organic materials. Stresses along the spiral direction were largest, possibly accounting for the mollusc's ability to grow a strongly curved wall. *BV*

TOPOLOGICAL PHASES

Call the tune

Nature Commun. **6,** 10042 (2015)

Strong spin–orbit coupling is an essential ingredient of topological insulators and several other exotic electronic states, but it's not clear what happens in systems that have both strong spin–orbit coupling and strong electron–electron interactions. Boasting a combination of both ingredients, pyrochlore iridates may provide some insight.

Using photoemission techniques to image the electronic structure, Takeshi Kondo and colleagues found evidence for a node with a single point at the Fermi level of the pyrochlore iridate $Pr_2Ir_2O_7$. With a quadratic dispersion and strong Coulomb interactions, this looks like a strongly correlated non-Fermi liquid version of mercury telluride quantum wells, which exhibit quantum spin Hall states.

What makes the observation fascinating is that we may be able to tune this material into a range of different states. Using a combination of alloying, hydrostatic pressure, strain and quantum confinement, this system could become an antiferromagnetic Weyl semimetal, a topological insulator or a quantum or anomalous spin Hall state. Kondo *et al.* may therefore have found a parent material for strongly interacting topological phases. *LF*

QUANTUM MECHANICS

The lone traveller

npj Quant. Info. **1,** 15007 (2015)

Time travel, it seems, is little more than fantasy — particularly for those of us with a healthy respect for causality. But in the quantum regime, solutions to the equations of general relativity, known as closed timelike curves, are capable of breaking causality. The implications are rather drastic: these solutions permit the violation of uncertainty principles and the cloning of quantum states. As long you respect causality though, these crimes against quantum mechanics are deemed null and void. But what if there were a way to get all these causality-breaking effects without actually breaking causality?

Xiao Yuan and colleagues have come up with a scenario for realizing this paradox. The team considered a time-travelling particle that is isolated from its causal past while it's going back in time. So, in principle, the particle itself can break causality — it just never actually does, as a result of its complete isolation. If the particle is initially entangled with another, it can still violate uncertainty principles and clone quantum states. The solutions corresponding to these particles may even afford quantum processors additional computing power — at least, in theory. *AK*

ČERENKOV RADIATION

Quantum matters

Phys. Rev. X (in the press); preprint at http://arxiv.org/abs/1411.0083

Since its discovery more than eighty years ago, Čerenkov radiation has been treated as a classical phenomenon: a charged particle travels through a dielectric medium faster than the speed of light in that medium, producing a characteristic bluish glow. But what if the particle is described as a quantum wavepacket? This question was addressed back in the 1940s and the general agreement at the time was that the quantum and classical treatments would yield the same results for the wavelengths of interest. But Ido Kaminer and colleagues have now revisited the problem to find that in fact quantum corrections do matter.

Kaminer *et al.* predict that the orbital angular momentum and spin of the particle would come into play, leading to intriguing effects such as a radiation frequency cut-off in the optical region, the splitting of the Čerenkov cone into two, and the backward propagation along a reverse cone. These predictions could be observed in electron vortex beams and may also be put to use in designing new types of Čerenkov detectors. *IG*

COSMOLOGY

X marks the spot

Astrophys. J. Lett. **815,** L8 (2015)

Given that stars form when clouds of dust and gas collapse, the most active star-forming regions are, unavoidably, obscured by dust. Fortunately, dust does not block radio waves, making radio telescopes a powerful probe of massive gas-rich galaxies with intense star formation activity, which many believe are the progenitors of today's large elliptical galaxies. To better understand the history and evolution of these submillimetre (corresponding to radio wavelengths) massive galaxies (SMGs), Hideki Umehata and co-workers have taken advantage of the high resolution of the Atacama Large Millimeter/submillimeter Array in Chile.

The authors focused on a particular region known as SSA22, 11.5 billion light-years away in the constellation Aquarius. They were able to resolve eight SMGs from a background of a huge web of dark matter filaments. Moreover, they showed that these bright galaxies lie at the intersections of the filaments, suggesting that they are located at high concentrations of dark matter. It could be that we are seeing the growth phase of stars and supermassive black holes that lurk in the centre of huge elliptical galaxies. *MC*

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