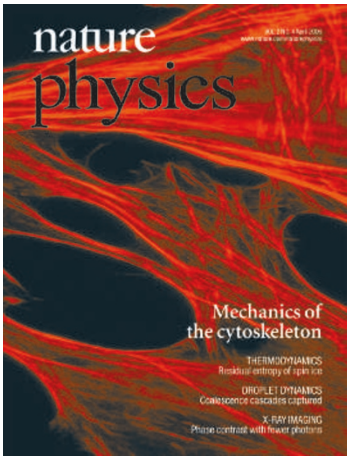


COVER STORY

Vol.2 No.4 April 2006

The biological cell is supported by a meshwork of polymers, notably the protein actin. But this cytoskeleton is no rigid scaffold — the dynamic response of the mesh is akin to a muscle, flexing and stretching, and enabling the cell to move. The physics of the polymer mesh is fascinating in itself, but biophysicists want to push further, piecing the details together to create basic components — or functional modules — that mimic the behaviour of the cytoskeleton. In this issue, Andreas Bausch and Klaus Kroy review the progress made, using physics theory, modelling and experiment, to establish a bottom-up approach to understanding the complexity of biological cells. **[Progress article p231]**

ADDING SPINS BUT NOT DISORDER?

The simplest example of geometric frustration in a magnetic system is a triangle with spins that tend to be antiparallel. If an up-spin and a down-spin take up two vertices, the third is frustrated. In the pyrochlore compound $Ho_2Ti_2O_7$, the spins freeze on cooling, but the resulting degeneracy in the system means that the entropy remains non-zero as the temperature approaches absolute zero. Is this a violation of the third law of thermodynamics? Well no, because the system is not in thermal equilibrium. Garret Lau *et al.* investigate the effect on the residual entropy as extra spins are 'stuffed' into the pyrochlore lattice. They find that the lattice expands, and the extra spins improve the connectivity of the frustrated system. But the additional disorder does not affect the entropy per spin.
[Letter p249; News and Views p219]

PARTIAL COALESCENCE REVEALED

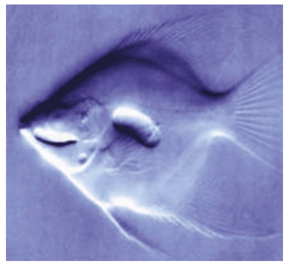
When a droplet is at rest on the surface of a larger body of liquid, it can seemingly defy surface tension by ejecting a smaller 'daughter' droplet, rather than being completely consumed in the eventual coalescence. This surprising phenomenon was first studied almost half a century ago, yet the precise details of the process, and of the repeating cascade of self-similar events that follows, have remained a mystery. By combining high-speed imaging and numerical simulations of coalescing ethanol droplets, François Blanchette and Terry Bigioni show that the pinching-off of daughter droplets is caused by the collective motion of capillary waves generated during coalescence. They also identify the conditions that place a lower limit on the size of droplets that will undergo this process.
[Letter p254; News and Views p223]

SEARCH FOR NEW PARTICLES IN 2D

Composite fermions are to the fractional quantum Hall effect what electrons are to the integer quantum Hall effect. In an applied magnetic field, electrons in a two-dimensional electron gas are predicted to drop down into a new ground state by grabbing vortices and forming new particles. These composite fermions have a charge of ½, but as each electron 'absorbs' an even integer number of magnetic flux quanta, the magnetic field is effectively reduced by a quantized amount. A number of indirect measurements have confirmed the existence of composite fermions, and now Marcin Byszewski and co-workers use photoluminescence experiments to try and 'see' them. They find new emission lines at different filling factors, which they argue correspond to fractionally charged excitons and exciton complexes. **[Letter p239]**

PHASE-CONTRAST ON A BUDGET

Conventional X-ray imaging relies on the fact that different tissues of the body absorb radiation to different degrees. This makes it relatively easy to distinguish the structure of bones and other dense bodies (such as tumours) from surrounding tissues. But for soft tissues, which absorb less radiation and therefore produce less contrast in an X-ray image, discerning fine details in their structure is more difficult. The solution lies in taking advantage not only of how an object absorbs X-rays, but of how it changes their phase. Using a technique originally developed to extract this information from an object illuminated with high-intensity synchrotron radiation, Franz Pfeiffer and colleagues show that it's possible to do the same using a low-cost X-ray source — an approach that could readily be used to improve the diagnostic potential of existing medical imaging equipment. **[Letter p258]**



Generating phase contrast in images obtained with low-cost X-ray sources could improve medical diagnosis.
p258

BE FRACTAL AND BE ROBUST

Methods developed in the framework of statistical physics have provided a completely new understanding of complex networks. Similar structural properties have been uncovered in networks found in fields as diverse as biology, technology and sociology. In particular, certain real-world networks display fractality, resembling the self-similarity in Mandelbrot's famous geometric sets. But can these organizational principles point us to potential common mechanisms underlying the growth of complex networks? Chaoming Song and colleagues show that, indeed, certain classes of networks do evolve according to shared principles, and that these can be formulated in terms of renormalization theory. Furthermore, they find that fractality provides protection against intentional attacks. For biological networks, this might suggest an evolutionary drive towards fractality. **[Article p275]**