Strange new worlds

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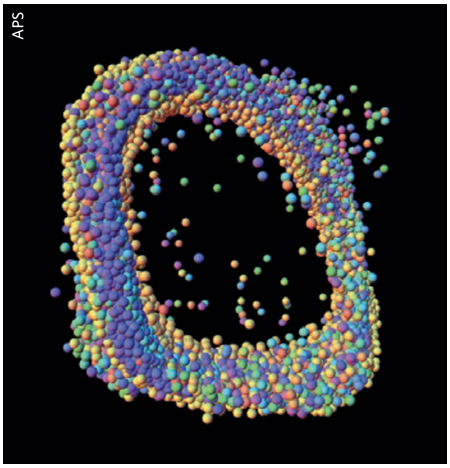

The Kepler Space Telescope has not only discovered over a thousand exoplanets, it has also found hundreds of new stellar systems — some of which are quite unusual. Take KIC 5520878, for example: it pulsates at two principal frequencies in the golden ratio. And on top of that, John Lindner and colleagues have now shown that it exhibits strange non-chaotic behaviour.

In nonlinear dynamics, strange attractors usually refer to those that show an exponential sensitivity to the initial conditions, meaning that they are chaotic. Such attractors — like the famous Lorenz attractor — usually have fractal geometry. But one can also construct attractors with a fractal geometry whose dynamics are not chaotic. Called strange non-chaotic attractors (pictured), these are not mere mathematical abstractions but have been observed in experiments — albeit in rather artificial settings. Lindner *et al.* showed that pulsating stars are natural examples of strange non-chaotic attractors. *IG*

Dwarf-galaxy giants

Astrophys. J (in the press); preprint at http://arxiv.org/abs/1502.01358 (2015)

Cosmological simulations of nearby galaxies have a problem: the predicted abundance of dwarf galaxies in the Local Group of galaxies (whose centre of mass lies between the Milky Way and Andromeda) far outstrips the observed quantity. Could these young, dark-matter-dominated galaxies lie near the Galactic plane, within a region that is not accessible to optical telescopes due to obscuring dust? To find out, Sukanya Chakrabarti and colleagues sifted through a near-infrared database of tens of millions of stars — collected by the VISTA telescope, which can 'see through' dust.

And indeed, they found four Cepheid variables tightly clustered together in angle and in distance, roughly 90 kpc away. These are yellow supergiant stars that pulsate radially, with regular brightness changes on timescales of days or months. At this distance, they are most likely part of a dwarf galaxy whose existence was predicted by Chakrabarti and Leo Blitz. Their previous analysis was based on disturbances in the atomic hydrogen disk of the Milky Way, consistent with tidal imprints from the passage of a small dwarf galaxy through our Galaxy. *MC*

Phase out

Nature Commun. **6,** 6179 (2015)

As the nature of charge carriers is intimately linked to a material's symmetry, the inherent symmetry breaking that occurs at edges can give rise to states with markedly different characteristics than those in the bulk. Symmetry-induced edge states have been observed in several systems, such as graphene and topological insulators, but Kai Du and co-workers have now revealed that intrinsic edge states can also exist in strongly correlated oxides.

The correlation between lattice, spin, charge and orbital degrees of freedom in perovskite manganites leads to a rich phase diagram that includes ferromagnetic and antiferromagnetic states, so several electronic phases often coexist. Du *et al.* provided evidence that symmetry breaking of the antiferromagnetic charge-ordered state actually induces ferromagnetic metallic edge states in manganite strips, which could even survive at room temperature — well above temperatures at which the ferromagnetic phases away from the edge can exist. As these symmetry-induced states have much higher metal–insulator transition temperatures, they provide a means for tuning the electron phase separation by simply changing the sample size and geometry. *LF*

Long enough by far

Science http://doi.org/z88 (2015)

Perovskites may be poised to take the solar-energy industry by storm, but do we really understand them? One thing is certain: any candidate material needs to have hole and electron diffusion lengths in excess of a micrometre to function efficiently in a solar cell. Any shorter and the thin geometry of the device prohibits effective charge transport. So how far can they go? Qingfeng Dong and co-workers have given us striking evidence that single crystals of methylammonium lead iodide support diffusion lengths up to nearly double this lower functional limit under standard illumination conditions.

The carrier diffusion lengths in this oft-studied mixed-halide perovskite are expected to be sensitive to defects. And most defects tend to be surface proximal, which creates problems in a thin-film architecture. Dong *et al.* provided a method for growing single crystals without the high trap densities associated with their thin-film analogues. The exceptional diffusion lengths they report may even render these materials useful for X- and gamma-ray sensing, in addition to light harvesting. *AK*

Aligned and polarized

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Many organic dipolar molecules display nonlinear optical behaviour: the square of an applied electric field — associated with light, for example — contributes to the magnitude of the molecule's induced polarization. Second-order nonlinear response has many applications, including laser frequency doubling.

In three or two dimensions, however, a set of identical dipoles will arrange in a pairwise manner, with neighbouring dipole moments being antiparallel to each other. As a result, any nonlinear optical response of the whole array cancels out. In contrast, the one-dimensional equilibrium arrangement has dipoles lined up head-to-tail, leading to an enhanced nonlinear optical response. But how do you coax the molecules onto a line?

Sofie Cambré and colleagues have found the trick: carbon nanotubes can provide just the right confinement. The authors were able to encapsulate certain asymmetric dye molecules in nanotubes, and observed a nonlinear optical response enhancement of a factor of more than fifty. Tube diameter and synthesis temperature act as experimental knobs for adjusting the degree of alignment. The filled nanotubes are chemically inert, making them ideal building blocks for novel nonlinear optical materials. *BV*

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