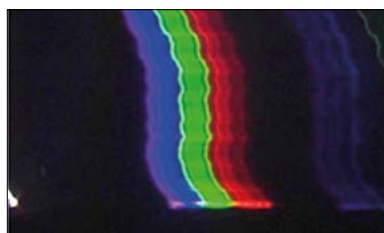


Sciencewatch

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Ball lightning reveals its secrets

Ball lightning has been an ongoing puzzle for centuries, largely because of a lack of good observations. Now, Jianyong Cen and colleagues at Northwest National University in Gansu, China, have had the good fortune to film ball lightning and measure its emission spectrum during an experiment intended to study normal cloud-to-ground lightning. In addition to having details on the size, colour and brightness as a function of time, they find significant emission lines from elements in soil, including silicon, iron and calcium. This supports various models where ball lightning is produced from a discharge hitting the ground and comprises not just atmospheric elements, but bits of soil as well.



The spectrum of a cloud-to-ground lightning strike and of the ball lightning it generated. The ball lightning is the white dot at the far left.

● Further reading

J Cen *et al.* 2014 *Phys. Rev. Lett.* **112** 035001.

First-photon imaging

A novel form of camera developed by Ahmed Kirmani and colleagues at Massachusetts Institute of Technology can capture 3D structure and reflectivity information with very little light. A pulsed laser illuminates points on the object with short flashes until a single scattered photon is detected with a fast Geiger-mode avalanche photodiode detector. The number of times the laser has to fire for a photon to come back gives a measure of the reflectivity of each point being fired at. A computer system uses expected correlations in reflectivity and the position of nearby points on an object reduces noise from Poisson statistics and constructs an image. The technique requires 900 times less light than conventional imaging and could be useful for taking pictures of light-sensitive objects, or taking pictures in the dark without giving away the photographer's presence.

● Further reading

A Kirmani *et al.* 2014 *Science* **343** 58.

Volcanic lightning

Lightning is often seen in volcanic eruptions – a phenomenon that has now been replicated in the laboratory. C Cimorelli of Ludwig Maximilian University in Munich and colleagues used rapid decompression of gas-particle mixtures to produce and study volcanic lightning under controlled conditions. The particles were actual volcanic ash from volcanoes including Popocatepetl in Mexico and Eyjafjallajökull

in Iceland (which caused so much disruption to travel in April 2010). Rapid progress is now expected in improving the understanding of this natural phenomenon. The eventual monitoring and forecasting of volcanic ash emissions should shed light on related processes such as charging in dust storms and industrial processes that involve granular materials.

● Further reading

C Cimorelli *et al.* 2014 *Geology* **42** 79.

3D graphene from sugar

A new form of graphene, assembled into a 3D network, can be made from sugar bubbles. Building on the ancient culinary art of “blown sugar”, Xuebin Wang and Yoshio Bando of Japan's World Premier International Center for Materials Nanoarchitectonics and colleagues made a syrup out of ordinary sugar and ammonium chloride, and heated it. This produced a glucose-based polymer called melanoidin, which was blown into bubbles by gases from the ammonium chloride. Syrup drained out of the bubble structure and continued heating left coherent structures made of graphene. The material is electrically conductive and mechanically robust (compressible to 80% its original size without loss of conductivity or stability) and inexpensive (\$0.50 per gram) and can be used in graphene-based super capacitors.

● Further reading

Wang *et al.* 2013 *Nature Communications* **4** 2905 doi: 10.1038/ncomms3905.

Mantis shrimp vision

Most people are familiar with human colour vision being based on three receptors covering, roughly speaking, red, green and blue. The mantis shrimp, remarkably, has 12 different photoreceptor types, each covering a narrow range of wavelengths from deep UV to far red. This, of course, begs the question “why?” Hanne Thoen of the University of Queensland and colleagues have shown that the shrimp seems to encode image colours as a temporal sequence of receptor signals as its eyes scan across an object – analogous to “push-broom” spectral analysers used in remote sensing. This reduces the need for processing in the shrimps' brains and seems to represent a unique approach to image coding in animal vision.

● Further reading

H H Thoen *et al.* 2014 *Science* **343** 411.



The mantis shrimp: its eyes have many colour receptors. (Image credit: Silke Baron / CC BY 2.0.)

Eternal data archiving

A new approach to storing data promises high density with an effectively unlimited lifetime. Jingyu Zhang and colleagues at the University of Southampton used femtosecond laser nanostructuring of fused quartz to store data in an essentially 5D format: three co-ordinates for spatial location and two to describe the axis of the induced birefringence and its degree. Hundreds of terabytes of data can be stored per disk and at room temperature should last $3 \times 10^{20 \pm 1}$ years. Even at an elevated temperature of 462 K, the lifetime for data is expected to be comparable to the age of the universe, hence the claim that this could open a new era of “eternal data archiving”. Writing speed is still slow – about 6 kB/s, but could be improved to 120 Mbit/s.

● Further reading

J Zhang *et al.* 2014 *Phys. Rev. Lett.* **112** 033901.