

Sciencewatch

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Maxwell's equations yield knots of light

Everyone knows that light is supposed to travel in straight lines, so it comes as a surprise to find that light can be tied in 3D knots. Hridesh Kedia of the University of Chicago in the US and colleagues have found solutions of Maxwell's equations where the field lines encode all possible torus knots (knots that can be tied around a donut) and links (collections of such knots that link to each other).

The solutions are stable and retain their topology as they evolve in time. They are also stunning examples of topologically non-trivial structures in a linear field theory.



The fields are null, with electric and magnetic fields always orthogonal to each

The core magnetic-field line (orange) of a trefoil knot of light, wrapped in blue field lines confined to a torus (purple) that encloses the core.

other and of equal strength, and could be produced by suitably focussed laser beams. If implemented experimentally, they could be used to manipulate plasmas or quantum fluids in ways that have never before been possible.

● Further reading

H Kedia *et al.* 2013 *Phys. Rev. Lett.* **111** 150404.

Alzheimer's breakthrough

Many neurodegenerative diseases, including Alzheimer's, involve the production of misfolded or otherwise faulty proteins called prions. As part of its defence mechanism against viruses, the brain can detect viral proteins and shut down the production of proteins – including viral ones – to prevent the spread of the virus. This mechanism can also respond to other faulty proteins and the shutdown can lead to the death of brain cells.

Giovanna Mallucci of the University of Leicester and colleagues have shown that an orally administered drug that blocks this response can completely prevent prion-induced neurodegeneration in mice. This is the first time that neurodegeneration has been prevented completely and it is being hailed as a turning point that could lead to an effective treatment for Alzheimer's disease.

● Further reading

J A Moreno *et al.* 2013 *Sci. Transl. Med.* **5** 206 206ra138.

Why we sleep

All animals sleep and it has long been established that sleep plays a role in the consolidation of memories. Now it looks as though there is another reason to snooze. Lulu Xie of the University of Rochester Medical Center and colleagues used real-time assessment of tetramethylammonium diffusion and two-photon imaging in mice to show that both natural sleep and anaesthesia increase interstitial space by 60%, boosting convective exchange of cerebrospinal fluid with interstitial fluid. This boosts β -amyloid

clearance and suggests that sleep is the brain's way of clearing out potentially toxic metabolic waste products of neural activity. Sleep deprivation not only impairs cognitive function, it kills rodents and flies in days to weeks and causes dementia and eventually death in humans within months to years.

● Further reading

L Xie *et al.* 2013 *Science* **342** 273.

Snakes and vision

Many people are afraid of snakes – indeed, humans and primates can detect snakes faster than innocuous objects. Quan Van Le of the University of Toyama and colleagues have found neurons in the primate medial

and dorsolateral pulvinar that respond selectively to images of snakes. Compared to three other categories of stimuli – monkey faces, monkey hands and geometrical shapes – snakes gave the fastest and strongest responses, which were not reduced by low spatial filtering.

The response to snakes seems to be hardwired and the parts of the brain involved are unique to primates, among mammals. This gives hard neuroscientific evidence for the “snake detection theory”, which suggests that primate vision evolved in part driven by the need to recognize snakes.

● Further reading

Q V Le *et al.* 2013 *PNAS Early Edition* www.pnas.org/cgi/doi/10.1073/pnas.1312648110.

The RNA of noble rot

Plant pathogens often cause disease through protein effectors, a case in point being the fungus *Botrytis cinerea*. Arne Weinberg of the University of California at Riverside and colleagues have now elucidated the exact mechanism. The fungus infects tomatoes and strawberries, causing grey mold, and is also the “noble rot” that is essential in the production of desert wines like Sauternes. The researchers have found that it uses small RNAs (sRNAs), typically 20 to 24 nucleotides long, to disrupt plant cell functions. More than 800 sRNAs are produced by *Botrytis* – a remarkable fact to contemplate over some Chateau d'Yquem.

● Further reading

A Weinberg *et al.* 2013 *Science* **342** 118.



Vineyards of Chateau d'Yquem, famous for its desert wine. (Image credit: Hel080808/Dreamstime.com.)