Abstractions

LEAD AUTHOR

Since the early 1990s, physicist Steven Louie at the University of California, Berkeley, has been probing the useful properties of carbon-based nanomaterials. On page 347, Louie and his co-workers present a theoretical prediction of some potentially intriguing properties of nanoscale ribbons of graphene. The team suggests that the non-metallic graphene could be induced to take on some characteristics of a metal, such as magnetism. The result would be a 'half-metal' that could potentially be used in spintronics — a refined version of electronics that makes use of not only the electrons' charge but also their 'spin'. The calculations might pave the way for fresh approaches to spintronic devices using graphene nanoribbons. Louie spoke to *Nature* about his work.

How can a non-metallic element such as carbon have metal properties?

A graphene ribbon has a unique geometry in that it has zigzag edges. Low-energy electrons, with their spins aligned either up or down, are able to run freely along these edges. It is the edge electrons that give rise to magnetism. As the magnetic states are spatially separated across the ribbon, you can use a transverse electric field to shift their energy, thereby creating charge carriers with the same spin, making the system a half-metal. Another electric field along the ribbon length can then be used to drive a spin current.

What is holding back exploration of these properties in organic materials?

First, half-metals are very rare, and organic materials tend not to be magnetic. Typically, electrons in organic materials form covalent bonds — the spin up and spin down are paired in the bond so there is no net spin — or the spins are randomly oriented. But in a zigzag graphene nanoribbon, the atoms on the edge behave differently, forming edge states capable of having a net spin. You wouldn't find this behaviour in a perfect buckyball or a nice, long carbon nanotube.

Why would organic materials be advantageous in electronics?

The driving force for wanting organic materials is that they are composed of abundant and non-toxic elements. It would be great to have cheap, high-performance electronics that are less harmful to the environment.

Will spintronics replace electronics?

I don't know whether spintronics will eventually replace electronics, but it will enhance today's electronics. The challenge now is to create the right material to efficiently generate spin current. ■

MAKING THE PAPER

Marc Sommer

M. A. SOMMER

Tracking down the signal that provides us with seamless vision.

As we look at the world around us, our eyes are constantly on the move. But, somehow, what we see is not a series of disjointed, disconnected still pictures but a seamless film. How our brain manages to compensate for our rapid eye movements has puzzled neuroscientists for many years. On page 374, Marc Sommer and Robert Wurtz offer evidence that may help solve the mystery.

Wurtz, a neuroscientist at the US National Eye Institute in Bethesda, Maryland, had tried and failed to resolve the question back in 1968. But when Sommer joined his lab in 1998, a surprising result in a related project led them back to the problem — and offered them a solution.

The pair had been using monkeys to examine signals that travel from part of the brain's cortex that processes visual stimuli to an area of the brainstem linked with eye movement. Every now and then they saw something strange happen: a signal went in the opposite direction. A neuron in the brainstem fired, causing a response in the cortex. "The brainstem was talking back to the cortex," says Sommer.

This result puzzled the two researchers, until they realized that they might be looking at the pathway that eluded Wurtz all those years ago. Maybe the brainstem was sending a signal to the cortex to alert it to an upcoming eye movement. Based on anatomical layout, they suspected that the signal was passing through 'relay' neurons in the thalamus on its way to the cortex. A series of preliminary experiments suggested that they were right, and the thalamus was involved. But going on to prove that the whole signal pathway existed was no easy task.

The pair set up a conceptually simple, if technically difficult, experiment. They used three probes implanted into the brain of a monkey: one to stimulate nerve cells in the brainstem, one to switch off neurons in the thalamus, and one to record the activity of a neuron in the cortex. "These are fundamental techniques of neurophysiology, but the challenge was to do all three at the same time in an awake animal," says Sommer.

To get his measurements, Sommer had to painstakingly identify a single cell in the cortex that he could monitor. He then had to record its activity for three hours in a live, moving animal. As if all this was not difficult enough, Sommer had by this time begun to set up his own laboratory at the University of Pittsburgh. "I would fly back at weekends hoping to get one more neuron," he recalls.

It took six months to record signals from eight neurons. But that was enough to show that the pathway exists. The brainstem seems to send a signal via the thalamus to the cortex to warn it of an impending eye movement. In response, neurons in the cortex adjust the position of the field of vision to where the eye will move next. When Sommer used the probe in the thalamus to switch off the relay neurons, the signal didn't get through and the cortex didn't take any steps to compensate for eye movement.

Now, Sommer and Wurtz want to find out what effect blocking this signal has on vision. Will the monkeys end up seeing the world as a series of disjointed snapshots? Sommer is currently devising tests to answer this question — but he first needs to find a way to measure what the monkeys are actually perceiving. ■

KEY COLLABORATION

The seeds for the collaboration behind the paper on page 354 of this issue were sown some 20 years ago, while Miquel Canals was doing his PhD at the University of Perpignan in France. Back then he was studying the Gulf of Lions in the northwest Mediterranean Sea, mapping the region with what he now describes as "rudimentary tools".

Over the intervening years, Canals, now at the University of Barcelona in Spain, and his colleagues at Perpignan have revisited the area, refining their measurements using more sophisticated equipment.

By pooling their limited resources — including a number of small grants — they have managed to investigate the mechanisms by which sediment and organic matter are flushed from shallow to deep water through submarine canyons.

"None of the groups had enough equipment to do it by themselves," Canals says. They found that the movement of sediment could be triggered by a form of current that is driven by sea density. Their measurements of the effects of this current, the sediment movement, the changes to the ocean floor, and the presence of deep-water coral, have already led to a large grant from the European Union, which should keep the groups occupied in the gulf for quite a few years to come. ■