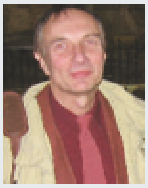
Abstractions



FIRST AUTHOR

The composition of our planet has long fascinated Bernard Wood. Currently based at Macquarie University in New South Wales, Australia, Wood has spent the past ten years trying to determine the chemical processes that occurred as the Earth's core separated from the mantle.

This work had led him to most of the reactions that were responsible for the composition of the planet's core. But there was one that had him stumped — how and when did sulphur get added to the mix?

The paper on page 1345 of this issue reveals how Wood solved the riddle. He reasoned that the impact on Earth of the body that resulted in the Moon's formation could also have caused the introduction of sulphur to the core. To help him clarify this, he hooked up with Alex Halliday, a geochemist at the University of Oxford, UK. Together they generated a fresh estimate for Earth's cooling age — when cooled from a molten state to how it is now.

Your paper refers back to work published in *Nature* in 1895 by Lord Kelvin. How do your results square with Kelvin's original estimate of cooling and the age of Earth?

Our 'late' sulphide addition suggests that the cooling time for Earth after the great impact was 30 million years, which is close to Kelvin's estimate of 24 million years. But, as one of the reviewers pointed out, modern numerical models indicate that Earth would have cooled much more quickly than that, becoming mostly crystalline after a few thousand years. So we think that our estimate reflects the time taken to separate the sulphide from the rest of Earth, rather than being a cooling age.

How do you think Kelvin would react to your findings?

Kelvin had broad interests and so would be intrigued by the findings. But he would recognize them as not being any vindication of his view that Earth was only about 24 million years old. He probably realized by the time of his death that his calculated 'cooling age' of Earth had ignored the most important heat source — that provided by radioactive decay of potassium, uranium and thorium.

You'd never worked with Alex Halliday before. How did he come on board?

I knew that a late sulphide addition to the core would take a lot of lead and so affect the apparent age of the core. I called Alex, told him the story and got him interested in figuring out the isotopic consequences of the model.

What's next for you?

I don't know exactly, but I am looking at other ways of testing and constraining our hypothesis of late sulphide addition. ■

MAKING THE PAPER

Joe Orenstein

A clearer picture of electron behaviour in semiconductors.

With the work published on page 1330 of this issue, Joe Orenstein and his colleagues unexpectedly managed to bring some cheer to another group of physicists.

Based at Lawrence Berkeley National Laboratory in California, Orenstein was measuring how electrons move through materials such as semiconductors and superconductors. Initially he had examined charge diffusion, the random movement of electrons that generates an overall electrical current in a given direction.

Working with his graduate students, Nuh Gedik and Chris Weber, Orenstein realized that work they had done on charge diffusion could be applied to another aspect of electron behaviour in semiconductors: spin transfer.

Electrons each have a characteristic 'spin' — for simplicity often designated as 'up' or 'down'. Much as for charge diffusion, the random motion of electrons within a semiconductor results in a 'spin current'. In effect, this is the net transfer of magnetic moment in one direction.

Collaborating with Jason Stephens and David Awschalom at the University of California, Santa Barbara, the team set to work measuring spin transfer in semiconductors. They were surprised to find that spin diffusion was always slower than charge diffusion.

"Gradually, an idea came that I thought was very pretty," says Orenstein. "Spin diffusion could be slower because spin transport is sensitive to electron–electron collisions whereas charge transport is not." In other words, when electrons bump into each other, their mutual repulsion sees them change direction, reducing their contribution to the transfer of spin.

"I thought that this would be really interesting," says Orenstein. "But then I thought that someone else must have thought of this earlier." Sure enough, a literature search revealed that another group had published on this phenomenon. "I got slightly bummed out at this point," Orenstein says.

So he tried to push the experiment out of his head and set the papers from his literature search aside. A few weeks later, his curiosity led him read the other group's work. He found that Irene D'Amico at the University of York, UK, and Giovanni Vignale of the University of Columbia, Missouri, had not only anticipated his idea, but had developed a quantitative theory of spin diffusion.

Intrigued, Orenstein and Weber compared this theoretical work with their own experimental results. Joel Moore, a condensed-matter theorist at the University of California, Berkeley, suggested an extension of the D'Amico–Vignale theory to describe spin motion at the lowest temperatures.

"Each time we improved the modelling, or found something simple we had overlooked, theory and experiment came closer," says Orenstein. "It was as if nature had already done the calculations and was testing us to see if we could get them right as well."

After they were satisfied that theory and experiment squared, Orenstein's group made the results available to D'Amico and Vignale, who were gratified by the validation. "As it turned out, getting their papers published had been something of a struggle," Orenstein says. "So for them, our work was a vindication, made nicer as it was totally unexpected. Doing science and making people happy — what more could you ask for?" ■

QUANTIFIED **JULY–SEPTEMBER 2005**

A numerical perspective on *Nature* authors.

Biological sciences dominated original research in *Nature* during this year's third quarter — accounting for 59% of all papers published between July and September. And it is three papers in the biological sciences that have attracted the most web traffic during this time.

The paper most accessed online describes how changes in a highly conserved protein in garter snakes explain the predators' sensitivity to a toxin produced by their prey, newts (S. L. Geffeney *et al. Nature* **434**, 759–763; 2005).

The second shows how genetic mutations of a protein in clams can lead to the accumulation of toxins (V. M. Bricelj *et al. Nature* **434**, 763–767; 2005). And the third sheds some light on the genes that mediate breast cancer metastasis to the lung (A. J. Minn *et al. Nature* **436**, 518–524; 2005).

1,696 authors were published in *Nature* between July and September 2005.

252 papers reporting original research were published in *Nature* between July and September 2005.

29,464 is the number of times the most accessed paper (by S. L. Geffeney *et al.*) was viewed online between July and September 2005.

38 is the number of countries in which *Nature* authors published from July to September 2005 live and work.