SAMUEL BUCHMANN

Even if we found an iron catalyst for metathesis, I am not sure it would be any better because it would probably have other drawbacks — for example, it would be less stable or active than ruthenium.

What applications and developments do you foresee for olefin metathesis?
I'm particularly happy about a drug that is currently in phase III testing called vaniprevir (from Merck), which is targeted against the hepatitis C virus. Our olefin metathesis catalyst is really important for the formation of this drug. Another application that I am excited about, and that I spoke about at the Lindau meeting, is the use of metathesis in pheromone synthesis. This might allow toxic and unselective pesticides to be replaced by naturally occurring pheromones that can, for example, disrupt mating patterns in selected insects. My intuition tells me that this is going to be big — but most of it is out of my hands.

Olefin metathesis is an important part of undergraduate chemistry. Do you enjoy lecturing on a topic in which your contribution has been so important?
It's fun to talk about because you can provide a lot of background. I'm not sure the students appreciate it, but that's okay. They don't seem overwhelmed at being taught by a Nobel laureate. At Caltech we have five Nobel laureates on campus — three in chemistry — so it's not a big deal for them.

Is academic science research becoming dependent on industry funding?
Yes, but industry is having similar financial problems to academia and has also cut back on its funding of basic research. Big companies used to help the transition from research in the laboratory to commercialization. When I started doing the early metathesis work, people from big companies would show up and want to test the catalysts. Now, most of the commercialization is done by small companies who are bridging the gap between the laboratory and industry.

What advice do you have for young researchers who wish to pursue a career in academia?
It is a great career if you can get in, but it is tough right now because of funding cuts. It will require particularly dedicated young researchers. Ten years ago, when a researcher entered academia there were good start-up packages, with lots of graduate students and funding. We will probably have to reduce some of that support and make tenure decisions earlier. The day of the really big research group is over. I must admit that I am sort of glad I'm old! ■

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Q&A Richard R. Ernst
A man of many dimensions

A pioneer of one- and two-dimensional nuclear magnetic resonance (NMR), Ernst talks to Stephanie Harris about why dimensions are important in life as well as in science.

How would you explain NMR to someone without a scientific background?
First, NMR allows you to determine the structure and connectivity of molecules or even to image the human body. NMR works by probing the responses of atomic nuclei in a magnetic field. These nuclei act like spies who give you coded messages that you record with electronic equipment. Once you've recorded these messages, you can try to analyse and understand them.

The nuclei have a magnetic moment, which means they react to an applied magnetic field. When you apply an external magnetic field the nuclei start to precess, or change the orientation of their rotational axis, with a frequency that is proportional to the field strength. If you measure the precessional frequency you can determine the local magnetic field, which differs from the applied magnetic field because of shielding from the electrons that surround the nuclei. The difference between the two fields provides important information about the chemical environment around the nuclei within the molecule — whether it is electron-rich or -poor.

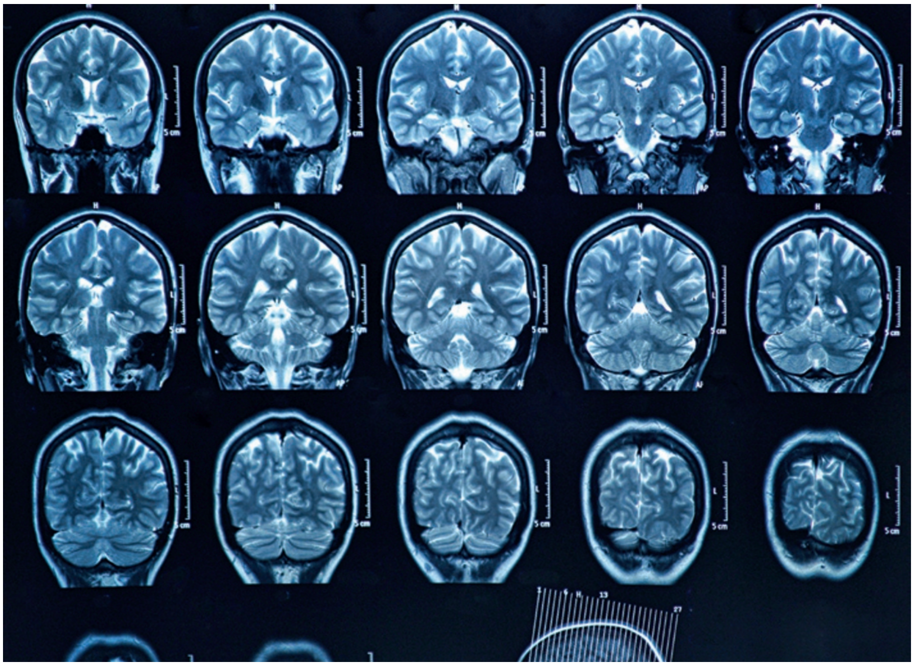
NMR can also tell us about the structure of a molecule: how the nuclei are spatially arranged. This is because the magnetic moments of nearby nuclei perturb the local magnetic field of the nucleus under study, introducing fine structure or splitting of the observed resonance. The precise nature of this splitting — whether it is split into two, three, four or a more complex pattern — tells us how many nuclei surround the one of interest. And the spacing of the lines in the pattern allows us to determine the distance between the nuclei.

You can obtain a complete picture of the structure of a molecule.

What is the most beautiful use of NMR?
That prize goes to magnetic resonance imaging (MRI), which allows you to peek inside the human body. In fact, MRI has turned out to be important for me personally. Back in 2007, while sitting at my desk, I started to become disoriented. My wife convinced me to go to hospital for a check-up. The doctors used MRI to image my brain and found a stenosis, where the blood vessels narrow and restrict the blood flow. And again, a few years earlier, I was walking down the street when a pain developed in my left leg and foot, and soon I wasn't able to walk any further. My foot turned white. The hospital used MRI to diagnose a blocked artery. By-pass surgery restored it fully.

After finishing your PhD you took a job in industry rather than staying in academia. Was this your plan?
I was fed up with the university atmosphere and wanted a change. I also wanted to leave Switzerland. California was the right place to look for another job. It had to be in industry; I wanted to become a useful member of society and not just an academic playboy. I took a job with Varian Associates in Palo Alto, California, continuing working on NMR development.

After five years I returned to ETH Zurich, where I had studied for my doctorate. That was a mistake: I'd always sworn that I would never go back. After about two years, I had a nervous breakdown. I thought that was the end of my scientific career. I considered going to work in a post office and stamping envelopes. Very slowly after a long struggle with myself, I became a scientist again. But it was hard to start over.



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Magnetic resonance imaging, based on Ernst's research, allows us to see inside the human body.

What helped you to regain your interest in science?
I kept my intrinsic curiosity, asking questions and trying to understand what was going on around me. You never understand enough or have solved all the problems so you try to improve your knowledge, and that is what I did. Also, teaching helped; students tell you what they expect from you and you have to try to become a good role model. You need more knowledge to do that. It's the same if you go to a kindergarten and give a lecture: they ask you difficult basic questions that you can't answer. You then know that you are lacking knowledge and this helps you to find your way and grow in the proper direction.

"Good teachers allow you to develop your own personality and ways of learning."

How important is it to maintain a passion outside of science?
Inspiration normally comes from an external source, from somewhere unexpected. Without this kind of inspiration you can become very narrow-minded. If you have a passion outside of science you should be proud of it — it makes life more enjoyable. Too many scientists lose their humanity, in the sense that they only have one focus: their research. Science is not the only aspect to life, there are other exciting aspects too and you have to give them a chance.

How do you try to achieve such balance in your own life?
In the early part of my life it was music that kept me alive. Initially I was playing and composing music, nowadays I'm just listening. It is important to get out of the science lab and do something more for my mind and enjoyment. Recently I have become fascinated by Tibetan painting and have started to collect, study and conserve precious art works.

What makes an effective teacher?
Good teachers allow you to develop your own personality and ways of learning — they set you off on a subject and then say, "Go look for yourself." Bad teachers, on the other hand, think that you should strictly follow what they say, and obey their rules. I have had both sorts of teachers. It's more inspiring and more motivating when you have freedom and are responsible for what you are doing, rather than just obeying orders.

What is an example of a good teaching practice?
The most important thing is that you throw the students into cold water and let them swim for themselves. Don't first teach them the motions on dry land — just throw them in and see what happens. We all learn by doing.

Social responsibility in science is also important to you. Did you take any practical measures to act more responsibly in your research?
In 2005, we held a special public teaching event to mark the 150th anniversary of the ETH Zurich university. We sent 150 professors onto the streets to talk to the public. We constructed tents in the city centre of Zurich and gave around 300 open lectures in 3 weeks. This event taught the public about science but had the added advantage of motivating the professors to think about the public, the public's response to them, and the importance of being exposed to the public. Initially they were sceptical, but by the end they liked it, and they wanted to do it again. ■

Richard Ernst is a physical chemist and emeritus professor at ETH Zurich, Switzerland. He won the Nobel Prize in Chemistry in 1991 for his work on the development of nuclear magnetic resonance (NMR) as a high-resolution analytical technique. NMR spectroscopy uses the behaviour of nuclei in a magnetic field to determine the chemical environment in which they reside.

Stephanie Harris is a graduate student at the University of Bristol, UK, whose research focuses on ultra fast transient absorption spectroscopy. This technique captures chemical bond breaking and bond making in real time, providing detailed mechanistic information about the progress of a chemical reaction.

M GRAYSON