chem@cam

Chemistry at Cambridge Newsletter

Spring 2010

Changing the rules of **synthesis**

Colloid science in the 1960s

Measuring gases from the sea

Chemistry in **zero gravity**

Ever fancied doing chemistry in space? Al Sacco is one of the very few lucky people to have been in orbit, and he tells Sarah Houlton what it was like – and his take on the future of science in space

How did you become a scientist?

It was an interesting journey! I grew up in Boston and my parents were immigrants – one from Italy and one from Ireland – and never graduated from high school. But it was very important to them that their kids went to college. My brother is 10 years older than me, and he became an electrical engineer. That got me excited about science – we would wire up all kinds of crazy things in the house. I got into chemistry at high school, and loved it. I had always thought I wanted to be a nuclear physicist, but after starting the course at I decided it wasn't for me as the maths was too intense, so I switched to chemical engineering as I liked chemistry and my brother was an engineer!

Having graduated from Northeastern I then went to MIT for grad school, and my PhD was on regenerating life support systems for the projected 1989 mission to Mars – this was back in the 1970s. We were studying the conversion of metabolic carbon dioxide back into oxygen and carbon. The idea was to use the carbon as a radiation shield, and recycle the oxygen. I was going to NASA sites on a regular basis, and it was fascinating.

You then got a faculty position at Northeastern in Boston. How did that take you into space as an astronaut?

I started out working on carbon nanotubes – though we called them carbon filaments at the time! This led on to getting involved in zeolite materials, and I came across a paper that said you could grow very large crystals over geological time. I wondered if it would be possible to suspend them in low gravity, and alter the defect concentration which would be interesting for catalysis. I then discovered NASA was planning to fly some scientist astronauts, and they wanted an expert in crystal growth as one of them. I was nominated, and went through all the testing, and was lucky enough to be chosen – just four were picked out of 80,000 applicants!

What experiments did you do there?

In my own experiments, I was trying to control convective flows. Our theory at the time was that, just like ice crystals will form a shape that largely depends on its transport properties rather than thermodynamic or kinetic properties, we thought zeolites might be the same. It turned out they were – we could form crystals that were very uniform and had very few defects, and we were trying to grow quantum wire arrays using titanium silicate materials. The idea was that if there were no defects in the titanium, we would have a titanium–oxygen wire surrounded by silicious material – SiO – giving the perfect quantum wire, 6.7Å across. Since then, we've been trying to prove that they really were quantum wires – it's not that easy to prove!

I wasn't only doing my own experiments – 120 other groups had experiments up there. I grew gallium nitride crystals, and even grew the world's first HIV protein crystals that were used for structure determination. I really loved it – I was like a kid in a candy store. It allowed me to optimise conditions; there were no convection flows, just diffusion limited growth. That's basically what I did for

16 days – I grew all the crystals I could grow! About 180 papers came out of it, and I was an author on maybe 20. It was pretty productive from a basic science point of view, and we learnt a lot.

What was it like being in space?

If you can imagine what it's like to be a leaf on the breeze – that's what it's like to float in space. The body adapts to it very quickly, and I felt really comfortable there! Flying in space is awesome because it's mind opening – not just in terms of the science you can do, but just the environment itself. Your body changes shape, even in a couple of weeks – men lose their musculature and become more sinewy. And because of the way your blood redistributes, you lose all the lines in your face and look younger. It only took a few days to get back to normal after I got back – it's pretty short lived! In the first three or four days after getting back, the muscles in my legs were pretty weak as I'd not used them for 16 days.

We worked 12 hour shifts and we were time-tagged to five minute intervals with tasks we had to get through, but when I did have chance to look out of the window, the earth was just beautiful. It's a robin's egg blue sitting in the highest intensity black, and there are billions of stars. Multiply the number of stars you see in the middle of the ocean or at the top of a mountain by a billion, and you get a sense of the number you can see from orbit. Not only do you see them twinkle, but occasionally you can see the colours of ageing stars. It's a very humbling experience – it comes like a cold slap in the face that the earth is pretty insignificant in the universe. And that means that we're really insignificant and you realise, in a way, that you're nothing.

With the shuttle soon to be grounded, what's the future for science in space?

Science is still happening on the International Space Station, and I'm hopeful it will pay for itself long term. I look it as another international lab, although it's very expensive – the same order of magnitude of cost as one of the beamlines. I believe you should be able to write a proposal, which is peer reviewed, and then you get to go up and do the science. The thing I didn't like about NASA science – and it's true of the European space agency too – is we beat the science to death so much that by the time we flew it, it was old science. It takes five years to plan a space mission, but the science and equipment are evolving. And now they're not even flying scientists any more – everything now has to be automated, and as you have to anticipate exactly what you're going to see, it takes all the discovery science out of it. I would claim what we fly in space now is actually verifying science. You can't discover things that way.

What sort of science is going on at the space station?

There's not a lot of physical science or material science any more – most of it is medical science and physiology, looking at the effects of weightlessness and radiation on the human body, and a lot of behavioural science studying people with heavy workloads living in a constrained environment for long periods of time. The original intention was to go to Mars, so the Bush administration got rid of much of the basic science, and poured all the money into the medical side to support a Mars mission. But the Obama administration has stopped that, and now they're trying to figure out what's next.

Even to design an experiment for space takes a lot of experience; things behave differently in zero gravity. They cut out a lot of young scientists 10 years ago, and lost some of the best and the brightest. It's going to take decades to be able to do physical science in space. We were starting to get a handle on the sort of thing I was involved in, like developing quantum wire arrays. Most of that is now gone. You can't get into orbit – or even write a proposal to get into orbit.

Is space science a good training ground for young scientists?

Absolutely – it really gets you to think. In chemistry and materials science, there's no design book telling you how to mix fluids that have significantly different surface tensions and don't want to mix. On the ground, it's easy. In orbit, they rotate around each other. When making protein crystals on the ground, you can use syringes; try to do that in orbit and unless the contact angle on the edge of the syringe is complementary to the liquid, it rolls around the outside and crawls up it. You take the basics and have to apply them in a different way – you really have to think outside the box. Concepts like inertia become clear – when someone throws you a heavy camera just by tapping it, and it moves very slowly towards you but you can't stop it, that's inertia in action. The velocity is insignificant, but the mass is huge! I say to my class all the time that I thought I understood physics until I really lived it.

But they really have to find a way to get experiments from conception to flight in three months, not years. And they have to fly them with the people who developed them – the best and the brightest. I'm a great believer that as long as you're reasonably healthy, you can fly in space, as long as you are OK in a constrained area. Professional astronauts are extraordinarily bright people, but they're not scientists. You know your science better than anyone else in the world, and if you're used to looking for the unexpected and evaluating in real time, you're much more likely to be able to determine what's going to make a difference for us here on earth.

Happy memories

Dear Editor,
I really enjoyed the references to Lab 287 by Messrs Baker and Quarrie and the reference to Peter Cann. I followed immediately after their 'era' in 1970 and there was abundant evidence of their having been there; the story of the solvent cupboard had passed down into the folklore of 287.

I have fond recollections of my three years there; Hyder Khalil hurtling up and down the lab with his arms whirling furiously and uttering foul imprecations against 'the great nitroon' (he was allegedly studying nitrones); the Dudley Williams group's preoccupation with football; the occasional appearance of the otherwise nocturnal Jeremy Sanders; Jim Wills' occasional habit of leaving droll written messages on his overnight chemical reactions in case the reagents forgot what was necessary of them in his absence; Chris Samuels habit of eating his lunch next to enough strychnine to kill most of Cambridge etc etc.

I was also pleased to see the picture of Stuart Warren, Tony Kirby and Ian Fleming still working and quite clearly still friends. Although they seemed like proper grown-ups at the time, from my own advancing years I now see that they, together with the likes of Dudley Williams, must have been a lively young team at that time and the nucleus of the department for many years to come.

It would be nice to have a reunion with Lab 287 Alumni of that era – it was a really entertaining working atmosphere in which new techniques and skills were acquired from fellow '287ers', but the major recollection of my time there was having a good laugh. As Steve Quarrie said, happy memories.
Dave Howells
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Baffling equations

Dear Editor,
I very much enjoy *Chem@Cam*. The reference to E.A. Moelwyn Hughes reminds me of the time when he was my supervisor during the 1950s. He had written a book in which he had included a large number of equations relating to thermodynamics. I recall working through all of these until I came to one which I did not understand at all. I showed him what I had done and then asked if he would explain the one which had puzzled me.

I think he was flattered that I had spent so much time going through his book. Consequently he was keen to demonstrate how he had arrived at the equation in question. It soon became clear that he was also puzzled and, after mumbling something about misprints, he said 'Well done – nobody else has ever noticed that!'
Derek Palgrave (1954-1957)
DerekPalgrave@btinternet.com

Hairy procedures

Dear Editor
During the early part of my PhD years in the department (1966-69) when several avenues of research ended without bearing fruit, I delved a little into rhodium chemistry – rhodium trifluorophosphine complexes to be precise – and examined their NMR spectra on the Varian 40MHz machine described in the recent issue of *Chem@Cam*.

The preparation of these complexes involved some fairly hairy procedures, all of which left me unscathed I'm pleased to say. Firstly, there was the fluorination of PCl_3 with a mixture of antimony trifluoride and antimony pentachloride to give PF_3. This was followed by treating rhodium trichloride in an autoclave at 170°C with 40 atmospheres of hydrogen and 110 atmospheres of the PF_3 to produce $HRh(PF_3)_4$. We called the autoclaves 'bombs' – I wonder if this is still acceptable? I know Martin Mays (my supervisor) always had a gleam in his eyes when there was a hint of danger in the laboratory.

$HRh(PF_3)_4$ was a fascinating compound for the NMR machine as all the nuclei have a spin of one-half. I ran both the ^1H and ^{19}F spectra and watching the pen move on the paper was great – seeing all those peaks and then interpreting them in terms of coupling constants. I still have the original spectra and I remember it being a big deal requiring some persuasion to have the machine switched from ^1H to ^{19}F.

I then reacted the $HRh(PF_3)_4$ with tetrafluoroethene (again, good fun to produce by the pyrolysis of Teflon); I believe this synthesised $Rh(PF_3)_4CF_2CF_2H$. Both the ^1H and ^{19}F nmr spectra were consistent with this.

None of this was ever written up and it's probably too late to think of doing so. I also fear it wouldn't get through current peer review requirements, but it's still of interest.
Barry Prater
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Bicycles and beer

Dear Editor
It has been very interesting reading all the 50th anniversary reminiscences about the new Lensfield Laboratories which I frequented in the 1960s.

My own memories seem to less about the chemistry learnt there and more about how the Lensfield road traffic was forced to a halt as we students made a mass exit on our bicycles and of the pub down the road that we often went to for a 'pie and pint' lunch.
Norman Sansom (1964)
Lewes, East Sussex

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Liuhong Chen from Chris Abell's group setting up an isothermal titration calorimetry experiment to look for binding on RNA

Photograph:
Nathan Pitt and Caroline Hancox

This newsletter is published three times a year by the University of Cambridge Chemistry Department. Opinions are not necessarily those of the editor, the department, or the university.

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Radiological decontamination...

Photo: Nathan Pitt

How the lab used to look – it's now decontaminated and ready for refurbishment

The work on modernising the department's south wing basement to create lab space for Clare Grey is well under way, with the most complex part of the project now complete – decontamination. Not only has a large amount of asbestos been removed, but so has the radioactive contamination.

The basement originally housed Alfie Maddock's lab, where much of the chemistry involved the radioactive isotope protactinium-231. ^{31}Pa is an alpha-emitter with a half life of more than 32,000 years, and Maddock isolated more than 100g of the newly discovered element in order to study its properties.

Although this work ended in 1965, the main lab was not fully decommissioned until 1993 – and even then the exhaust ducting from the fume cupboards that extended through the basement and up a service riser was left intact, along with the associated ducting within the plant room to the filter bank, exhaust fan and stack. This left a significant radioactive contamination problem that needed to be dealt with before the space could be refurbished.

The most complex part of the project involved lifting the ductwork out of the riser. First,the metal landing platforms had to be cut away within the riser so the duct sections could be manipulated. The duct sections were then dismantled, and hoisted out of the riser onto the roof.

'This project has removed a legacy from the 1960s that the department has long fought to remedy,' says safety officer Mags Glendenning. 'It was a long, complicated and noisy process, but we are now able to develop the long-disused southern basement.'

Watch out for more about the decontamination project from Mags in the next issue of *Chem@Cam*, when she's had chance to recover!

A BBSRC prize for Shankar

Photo: Tim Gander

Shankar Balasubramanian has won two innovation awards from BBSRC – commercial innovator of the year, and overall innovator of the year.

They recognise his work on high-speed genome sequencing technology. This was commercialised through the spin-out company Solexa, now part of US biotech specialist Illumina.

'I'm delighted to have won these awards,' he says. 'It would not have been possible without the important contributions made by many others, particularly Solexa co-inventor and co-founder Dave Klenerman. I hope it will help support the case for continued funding of blue-sky research as a means to underpin longer-term wealth creation.'

Shankar was recently appointed as the first Herchel Smith professor of medicinal chemistry, a joint appointment with the medical school. He's pictured below giving his inaugural lecture on sequencing genomes and sequences in the genome back in February.

Photo: Nathan Pitt

A rewarding symposium

In February, the department played host to a Royal Society of Chemistry awards symposium, where several prizes for materials chemistry were presented.

Entitled 'Designing new materials: processes and applications', among the awardees giving a talk was Oren Scherman, who spoke about his work on dynamic functional materials and new routes to copolymers.

He's pictured below receiving the Harrison-Meldola medal from Manchester University's Stephen Yeates, president of the RSC's materials division.

Photo: Nathan Pitt

Prize technology

David Spring has won the first discovery chemistry and new technologies award from the Royal Society of Chemistry. As well as a medal and a cash prize, he will be giving a UK prize lecture tour.

Administered by the RSC's high throughput chemistry and new technologies subject group, the award recognises research in synthesis and technology suitable for high-throughput applications, particularly in the pharmaceutical, agrochemical and catalysis sectors.

He's delighted to have received the prize. 'It is really nice to be recognised from all the other very obvious candidates,' he says.

Chemistry added to Microsoft Word

A new free plug-in for Microsoft Word that makes it easy to embed chemical information into documents has been developed by Joe Townsend, Peter Murray-Rust and Jim Downing in the Unilever Centre, with support from Microsoft. Officially called Chemistry Add-in for Word (but more snappily referred to as Chem4Word), it is based on CML, or chemical markup language, and was inspired by the plug-in that's already available for mathematical equations in Word.

Chemical names and formulae can be automatically converted into chemical structures – and vice versa – and it also aids the archiving of chemical information. It was launched at the American Chemical Society meeting in San Francisco in March, and was downloaded 62,000 times in the first 22 days,' Joe says. 'The next step will be to release an open-source version of the software.'

If you'd like to download Chem4Word and try it out for yourself, it can be downloaded at bit.ly/c4w. At the moment, it's only compatible with the PC versions of Word 2007 and 2010, but watch out for a Mac version in the future.

Meanwhile, Peter and his colleagues are working on an artificially intelligent fume cupboard. The idea is to use technology such as speech optical recognition to capture information about how a reaction is set up and proceeds, and allowing much of the tedium of keeping a lab notebook up-to-date to be carried out automatically.

We'll have more about this project in the next issue, but in the meantime Peter is looking for pilot scheme ideas. If you've got any brainwaves – whether you're in the department or even teaching in a school – he would love to hear from you. There may even be a prize for the best project suggestion. Contact him pm286@cam.ac.uk

Photo: Nathan Pitt

Chris Dobson's talk in our series of lectures for a non- academic audience celebrating the university's 800th anniversary explained some of his pioneering work in the field of protein folding

Bill's whistle-stop Indian lecture tour

Head of department Bill Jones visited India in March as one of two inaugural Cambridge–Hamied Visiting Lecturers, along with mathematician Frank Kelly, master of Christ's.

The first stop on his week-long whistle-stop tour was Bangalore, where he met C.N.R. Rao at the Jawaharlal Nehru Centre for Advanced Research, and then visited Professor Gautam Desiraju at the Indian Institute of Sciences, where he also gave a lecture on his work in pharmaceutical materials science.

From there, he went on to the University of Hyderabad, where he gave a University Distinguished Lecture on the application of materials chemistry in the development of new pharmaceuticals.

Bill finished the week in Mumbai, where he spent time with Yusuf Hamied and his colleagues at Cipla, and gave a presentation to research staff. Yusuf is a Cambridge chemistry alumnus, having worked with Lord Todd in the 1950s, and he's also an honorary fellow at Christs. His name will be familiar to those in the department, having funded the transformation of G14 into the Todd-Hamied seminar room.

'I was very impressed by the facilities, and the range of drugs they manufacture there,' Bill says. 'It was good to see the strong overlap between my own research interest and what is going on within the company. I will be returning in December to visit Cipla's production facilities in Goa, and we hope to be able to arrange for Indian scholars to make a return visit to Cambridge chemistry.'

Above: Bill and Yusuf with a group of Cipla scientists; left: Bill poses with photos of Lord Todd's visit there back in 1963

Understanding nanobots

The third Alex Hopkins lecture took place during Science Week, and was given by polymer nanotechnologist Tony Ryan of the University of Sheffield. He enthralled the audience with a talk about what nanobots might look like.

The lecture is held in memory of Alex Hopkins, who was a much-loved teaching fellow at Churchill and Fitzwilliam, and also played an important part in the inorganic teaching of the department. His father John supports the lecture in his memory. The idea is that the lecture should relate chemistry to everyday life, and contain an element of humour.

Tony was an ideal choice to give the lecture – he is very active in promoting the public understanding of science, and gave the Royal Institution Christmas lectures back in 2002 when his theme was the science and technology of everyday things..

■ This year's Science Week was once again a roaring success, with another large attendance at the department's open day. Look out for a full report in the next issue of Chem@Cam!

Breaking the rules of org

Organic chemists have been designing their molecules in the same ways for decades. Matt Gaunt is thinking differently

Photos: Nathan Pitt & Caroline Hancox

For decades, chemists have applied the same set of rules have applied when deciding how to make molecules. Matthew Gaunt is trying to break those rules, and develop a new blueprint for synthesis that could change the way chemists think about how to put molecules together. 'We're trying to do this in two ways,' he explains. 'The first is to use flat aromatic molecules, such as benzene, and create chiral centres – carbon atoms that are attached to four different groups – using asymmetric catalysis. Our second focus is on trying to make molecules using metal-catalysed carbon–hydrogen bond functionalisation – turning an unreactive bond into something more useful for synthesis.'

When a chemist looks at how a molecule might be made, they always look to make bonds based on conventional reactivity, he says. 'While the three fundamental reactivity concepts of positive, negative and radical remain – though it would be interesting to try and define a fourth realm of reactivity! – we're trying to get away from the perception that a carbonyl group will mean you would immediately think of using an enolate reaction, or creating a new carbon–carbon bond by reacting a nucleophile with carbon–iodine bonds, for example. We want to get away from the need for this sort of functionality to be present in the starting material, and instead find ways of making molecules directly from the hydrocarbon – functionalising a carbon–hydrogen bond in simple alkanes. This would be the holy grail!'

Over the past couple of years, his group has been developing reactions around these concepts, and he says they're starting to bear fruit. On the asymmetric catalysis side, the strategy is to take an aromatic molecule that is completely flat, and transform it into a complex chiral molecule, with features that resemble natural products or pharmaceutical molecules – in a single step. 'It's based on the idea of dearomatisation – breaking the aromatic nature of the ring – using a catalyst,' Matt says. 'We can build molecules with four or five stereocentres in this way, and when the reactions work, they tend to work very well. They create complex structures very quickly, cutting out numerous different reaction steps. We've worked out how to get this key reaction to work in a variety of different aromatic rings, and then transform them into natural products. We'd love to be able to do this for the four key classes of natural products – terpenes, alkaloids, polyketides and steroids – all using the same concept of transforming the carbons in an aromatic ring into all these chiral centres.'

The reaction itself is pretty straightforward. First, the aromatic ring is oxidised, giving a reactive intermediate. This is then intercepted using an asymmetric catalytic reaction – a simple Michael addition reaction that is catalysed by a chiral secondary amine. This instils all of the chirality into the molecule, going from a simple, flat molecule to something much more complex.

This catalytic enantioselective dearomatisation chemistry takes up maybe a quarter to a third of his group's efforts, and the rest of their work is in the area of C–H bond activation. 'This really does revolve around trying to find new ways to put molecules together by changing the perception of chemical reactivity,' Matt says. 'So instead of starting with bonds that are easy to break, such as carbon–iodine and carbon–boron, we want to take carbon–hydrogen bonds, which are usually unreactive, and use metal catalysts to get between the carbon and hydrogen atoms. This will then give you an active intermediate, which can be reacted with another molecule to give something more complicated. We can even couple two unfunctionalised fragments together in this way – we're making things you'd think are unreactive react with each other.'

The ultimate example, he says, is the conversion of methane into methanol – one of the fundamental processes that underpins the entire chemical industry. 'The reactions used to carry out this transformation by the petrochemical industry are a long way from being perfect,' he says. 'They are catalytic reactions, but they require very high temperatures and large amounts of expensive catalyst. If you could find a way of doing the reaction at room temperature with only tiny amounts of catalyst, it

Matt Gaunt CV

Born: Stafford, but grew up in Darlington

Status: His wife, Nadine Bremeyer, is a fellow Cambridge PhD chemist, and is currently working as a postdoc in Matt's group.

Education: First degree at Birmingham, followed by a PhD with Joe Spencer at Cambridge

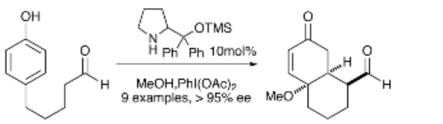
Career: After a year's postdoc with Amos B Smith III at the University of Pennsylvania in Philadelphia, he returned to Cambridge in April 2001 as a college research fellow at Magdalene, in Steve Ley's group. He's been a lecturer since 2006 (but I have been a URF since 2004), with a Next Generation Fellowship from Philip & Patricia Brown

Interests: Matt's a glory-hunting Liverpool supporter thanks to a childhood love of Kenny Dalglish, and still plays regularly, albeit recreationally with friends and students these days. He's also been skiing for the first time in a while this year. 'I also love spending quality time with my wife, though that tends to be in the lab now!' he claims.

Did you know? Despite getting married last year, they've still not been on honeymoon. 'We've got four weddings to go to this year, and we're hoping to combine one with a wedding out there in September – in time for our first anniversary!' he says. 'I want to go to Yellowstone, Nadine wants to go to central America, so we might do a bit of both – though we'll try to avoid the hurricanes in Belize…'

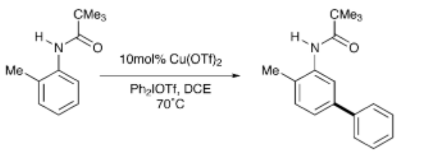
anic synthesis

would be a very important step. By applying the underpinning mechanism of a transformation like ours – breaking an inert molecule, and making a reactive intermediate – it could change the way chemicals are made. In the case of methanol, the reactive intermediate is oxidised, but if it were coupled, say, to another hydrocarbon, it might be possible to turn methane into octane – giving an alternative source of petrol.'



This dream is a long way off being reality, and Matt's currently focusing on working out the best way of functionalising a whole range of different hydrocarbons, both aromatic and aliphatic. Part of the work is identifying the best catalysts for the reaction. 'We've mainly been working with palladium and copper catalysts. Palladium is a very popular catalyst as it has remarkably versatile reactivity, but many of its reactions require forcing conditions. Ultimately, we'll need to find ways of doing them under mild conditions. The delicate functionalities and architectures of complex systems aren't going to survive being hit with a hammer at 150°C under a stream of oxygen gas! We've already had some success in developing mild reactions with both palladium and copper catalysts.'

However, he says, their biggest breakthrough thus far is finding a way to, essentially, reverse some of the underpinning rules of aromatic chemistry. Electrophilic aromatic substitution is one of the most important reactions of aromatic rings, and for decades it's been drummed into chemistry students that electron rich aromatic rings react at the ortho and para positions, and electron deficient ones at the meta position, if they react at all. 'We've found a way to persuade electron rich rings, such as anilides, to react at the unexpected meta position. We use copper catalysts to activate hypervalent iodine reagents so that they react in a novel way with the anilide, giving the valuable meta-isomer. The reaction is working in a range of systems, although we're still trying to pin down the mechanism!' he says. 'We're now finding ways of expanding this chemistry to other simple hydrocarbons, so we can functionalise them in different ways. This has been really exciting – we can now transform half a dozen different molecules using this reaction. We're hoping now to develop a strategy that will allow us to functionalise an aromatic ring at every single position. That would be really exciting.'

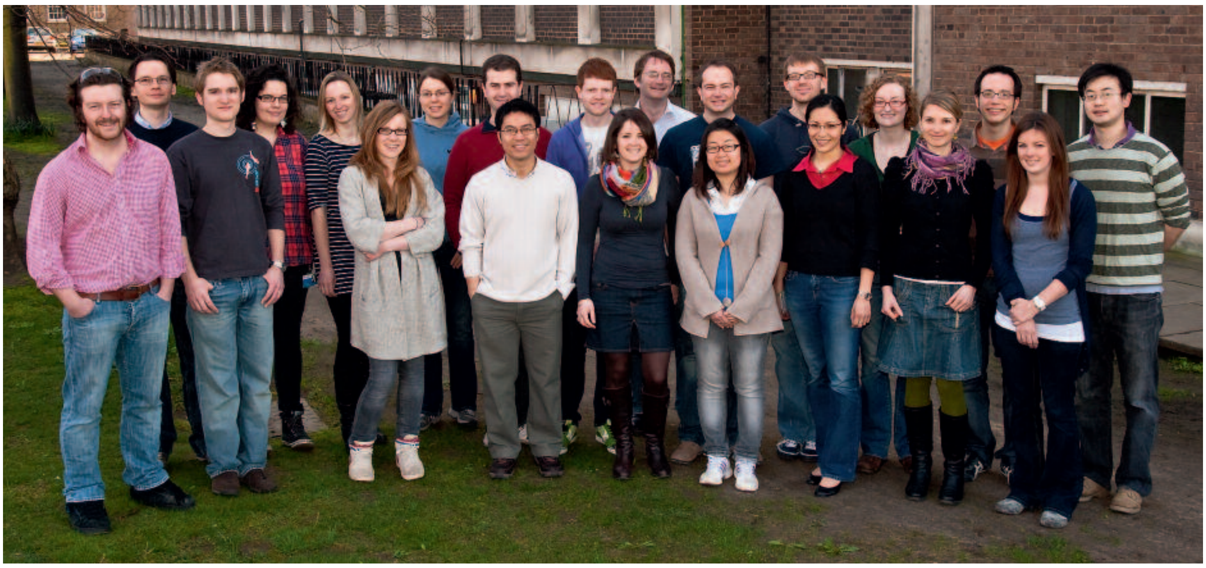


Ultimately, he says, they'd like to be able to take a simple molecule such as benzene, and turn it into a natural product or a pharmaceutical molecule, where all the positions on the aromatic ring have been functionalised in sequence. 'We call this iterative C–H activation, and we're working on a couple of projects along these lines. We're now close to making a natural product in this way. This could have a lot of impact in terms of synthesis – and it should also be possible to make analogues of natural products or pharmaceutical molecules in this way.

Matt is always looking for the next challenge, and he speculates that it might be possible to use the technique to functionalise proteins. 'Synthetic biology would be a fascinating area to get into – the "synthetic" part of synthetic biology doesn't usually involve chemical synthesis, and it would be nice to make it live up to its name!' he says. 'But this would throw up enormous challenges. Can we do our chemistry in water, at a maximum of 37°C? And transition metals can cause havoc in biological systems, so we'd have to use a metal that was compatible with biology.

This is definitely a long term goal, but in the nearer term, he believes if it were possible to achieve these C–H activations, the result would be a paradigm shift in synthesis. 'It could definitely change the way people make molecules,' he says. 'It would be impossible to solve all the problems ourselves – C–H activation is going to be a community endeavour, and alkanes are so unreactive that very little has been done with them yet. There's no way there will be a single solution, and numerous other groups around the world are working on aspects of the problem. Chemistry is changing – we have to think what else we can do with synthesis. There are very many great reactions, but we're still not very efficient at making molecules. The perfect reaction would be between two hydrocarbons reacting with oxygen in the presence of a metal, in water and at room temperature, and only take 10 minutes. We are a long way away from being able to do that, and I'm excited by the prospect of bringing that dream a little bit closer to reality.'

Two key reactions: catalytic enantioselective dearomatisation (above) and copper(II) catalysed meta-selective C-H bond arylation of anilides (below)



The Gaunt group: Jamie Jordan Hore, Pavel Tuzina, Robert Phipps, Alice Williamson, Nadine Gaunt Bremeyer, Beatrice Collins, Fionn O'Hara, Rafael Leon, Hung Duong, Mark Archibald, Annabelle Nicolas, Matt Gaunt, Ben Haffemayer, Qioa Yan Toh, Michael Cooke, Tifelle Ngouansavanh, Ruth Gilligan, Stafanie Ritter, Jochen Brandt, Lindsay McMurray, Louis Chan

The ocean's role in the atmosphere

Photo: Nathan Pitt

It's not only human activity that affects the chemistry of the atmosphere – nature emits halogenated molecules, too. Neil Harris is measuring them

The effects of chlorofluorocarbons on the ozone layer are well documented, but these manmade chemicals are not the only halogenated substances emitted into the atmosphere – nature makes them, too. Neil Harris is looking at the levels of these chemicals in the atmosphere, where they come from, and how they get there.

'CFC levels are coming down, so we are now less worried about them,' he explains. 'Natural ones like dibromomethane, bromochloromethane and some iodine compounds are now much more of an issue. They are emitted by the sea – there is a lot of chlorine, bromine and iodine in seawater, and organisms have evolved to use them.

'When seaweeds are stressed, for example, they give off iodine. While halogenated compounds are only present in low concentrations – like CFCs – during storms they can be sucked up into the stratosphere, and we think that about 10% of the ozone-depleting bromine reaches the stratosphere in that way. Big storms can lift air from the surface to high altitude very quickly – it can rise up to 15km in an hour. This provides a way for very reactive species with short half-lives to get up to parts of the atmosphere which they wouldn't otherwise reach.'

It's uncertain whether human activity is having an effect on the levels of these chemicals, although factors such as increases in sea acidity and surface temperature have an impact. 'The monsoon in south-east Asia is another effective way of pumping pollutants up into the upper troposphere and lower stratosphere,' he says. 'The industrial growth in that region is changing the mix of reactive chemicals, both from nitrogen oxide pollutants and the chemicals that are used in agriculture running off and reaching the oceans, which in turn affects the chemicals that the oceans emit. How the natural compounds and the pollution affect the chemistry in the lower atmosphere and hence climate change is a fascinating problem.'

Part of the problem is that it's unknown how the concentrations are altering – and we don't even know the background concentrations of these gases, either. 'Measurements have been beset by two problems,' he says. 'One is how to calibrate the data – these gases are present at parts per trillion levels and it's hard to keep the instruments stable. There can be orders of magnitude of difference in calibration between different people's readings over the years, which is a big problem.'

There is a lot of natural variability in the measurements. In the past, people typically made just a few measurements in canisters, which they then took back to the lab for analysis. If, say, measurements are made at weekly intervals, the variability over a day or a week will never be seen, so the true picture of how much is around is impossible to figure out. There is no way of knowing which measurement is closer to the average amount.

OCEANIC EMISSIONS

Along with colleagues Bryan Gostlow, Andrew Robinson and John Pyle, Neil has been developing a new set of instruments to study the oceanic emissions of these natural compounds, which are now being deployed in the western Pacific. 'This is where the convection giving upward transportation is at its strongest, and various gases are fairly poorly measured there.

'We've had a couple of older instruments making measurements in Malaysia for nearly two years, and two newer ones are now being operated by our collaborators at the University of Malaya, one at a site near the Thailand/Malaysia border, and a second for case studies focusing on their expertise in seaweeds. The idea here is to find out which seaweeds emit most, and whether any conditions lead them to emit more.'

Neil's main role – and interest – is in interpreting the data. 'The aim is to look at the climate variables that alter emissions,' he says. 'To start with, I'll be looking at temperature and solar radiation, and then wind effects. If the predomi-

Kunak in Malaysia, one of the sites the team is making measurements at

Photo: Andrew Robinson

nant wind changes, how do the emissions alter? And how do major wind systems like El Niño change things?'

The instruments are gas chromatographs, which were designed and built by Bryan. They were originally designed for a project on a Montgolfier infrared balloon as it went around the world rising and falling naturally in the atmosphere, so it had to be extremely lightweight – and thus extremely low power – and completely autonomous as the balloon was unmanned.

MINIMAL INTERVENTION

'Unfortunately, all communication was lost with the balloon soon after it was launched in the Seychelles, and it's now at the bottom of the Indian Ocean,' Neil says. 'But it left us with this instrument design, which we then made smaller, and we now have high precision, high sensitivity instruments that need minimal human intervention, and so are ideal for measuring gases in remote locations.'

Malaysia isn't the only place they're doing measurements. 'Bryan is about to go out to New Zealand to work with collaborators looking at seaweed emissions there,' he says. 'Compared to the northern hemisphere, there are very few measurements of these gases in the southern hemisphere. We'll be using one in Darwin, Australia, which is in the tropics. Another is going to Taiwan, and we also plan to install one on a container ship belonging to Taiwanese shipping line Evergreen.'

The idea with the ship is to measure the gases as it sails around the world, with its location tracked by GPS. They also need to know the altitude of the instrument above the sea, as this will change depending on how heavily the ship is laden, and some of the emissions are very short-lived so the concentration gradient above the sea drops off quite quickly.

'Our Taiwanese partners will check the instrument while the ship is in port, but other than that it's largely controlled over the internet through a satellite phone,' he says. 'The software can be rebooted remotely, and Bryan has designed an interface that allows us to diagnose and operate over the internet. It will also be modular, so spare circuit boards and so on will be easy to install if anything goes wrong with the hardware.'

Thus far, Neil's had one trip to Malaysia, but his five-year NERC advanced fellowship includes a two-month stay out there, and he expects there will be other, shorter trips too, as well as spending time with collaborators in New Zealand and California. 'However, the aim has to be to use automated systems as much as possible, so we can simply leave them running on their own,' he says. 'While most of the big atmospheric observatories produce very good data, the staff and running costs are high. But if we are going to get a good picture of what is really going on, then multi-year records of frequent data from different locations will be essential, so being able to make accurate measurements with minimal physical intervention is vital.'

CV Neil Harris

Born: Birmingham, and grew up in Stourbridge

Education: He went to Shrewsbury School before studying chemistry at Oxford. After two years selling farm buildings while he decided what he wanted to do with his life, he returned to academia for a PhD at the University of California at Irvine on the statistical analysis of ozone trends.

Career: After six years in California, he returned to the UK in 1990, working with John Pyle in the European Ozone Research Coordination Unit. His five-year NERC Advanced Fellowship studying oceanic emissions of natural compounds began in January.

Status: His wife Diane is a Californian lawyer, and they have three sons – 17-year-old Adrian, Duncan, who's 14, and Theo, 11.

Interests: Cricket – he plays occasionally for the department team (2009 average of infinity!), and watches keen cricketers Duncan and Theo playing, Duncan for the county and Theo the district.

Did you know? Neil is chair of the governors at Adrian's school –the Royal National Institute for the Blind's Rushton special school and children's home in Coventry. 'The children there all have visual impairment and a lot of other special needs, and as learning is 70% through visual means it's a real challenge,' he says. 'The school also provides physiotherapy and other specialist care, and there is a major development to expand the school from 20 to 60 or 70 pupils, and reach out to other schools. It takes a fair amount of my spare time, but I believe it's very important.'

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Photos: Nathan Pitt

Cambridge hosts med chem event…

The third Royal Society of Chemistry biological and medicinal chemistry postgrad symposium was held in the department just before Christmas. Nine PhD students from around the country gave talks on their science, and 19 more presented posters at lunchtime.

The students weren't the only speakers – talks were also given by Pfizer's worldwide head of medicinal chemistry Tony Wood, Malcolm Stevens of the University of Nottingham, and our own Herchel Smith professor of medicinal chemistry, Shankar Balasubramanian.

The prize for best talk was won by Tam Dang of Imperial College. She's pictured front left in the photo.

Tony Wood in action (left), and the student speakers pose with Tony, Shankar and Malcolm (right)

…and RSC macrocycle conference

Photo: Nathan Pitt

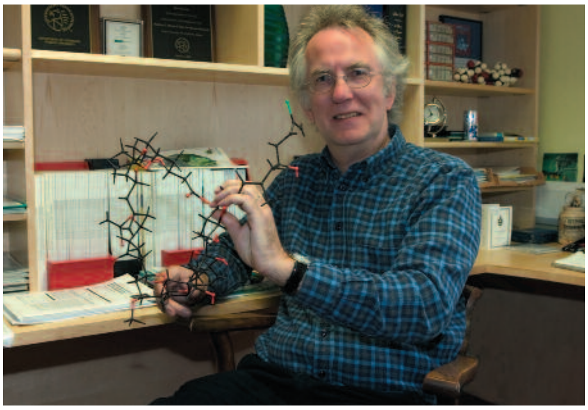
The speakers pose with organisers Oren and Jonathan in the Wolfson lecture theatre

December was a busy time for conferences in the department – we also hosted the scientific programme for the RSC's 2009 Supramolecular and Macrocycles meeting.

Organised by Oren Scherman and Jonathan Nitschke, delegates at the two-day conference stayed at Jesus College.

One of the highlights of the event was the Bob Hay lecture, given by Stephen Faulkner from Oxford. His chemistry centres on designing and making systems with interesting photophysical properties, which can be used for assay in drug discovery and diagnosis *in vitro* and *in vivo*.

Ian's Scottish award



Ian Paterson has been elected as a Fellow of the Royal Society of Edinburgh, the national academy of science and letters in his native Scotland.

He joins a diverse, distinguished list of fellows from the arts and sciences, with past luminaries including Walter Scott, Charles Darwin, John Logie Baird, William Wordsworth, Francis Crick and Niels Bohr. Cambridge's Brian Johnson is also on the list, having spent time at Edinburgh University

Photos: Nathan Pitt

Department members were given a special Christmas treat – as part of the 800th anniversary celebrations, he gave one of his famous chemistry demonstration lectures. It was open to all staff and their families – and went off in characteristically noisy fashion!

Balloons, trivial names and scant regard for safety

Dear Editor,

Paul Stickland's letter in your last issue concerning Frederick Mann's lectures on Heterocyclic Chemistry interested me greatly, since I believe I was in the last of Dr Mann's classes before his retirement. As I recollect, his lectures were entirely innocent of any mention of mechanism; instead, he was a great advocate of what my tutor, Malcolm Clark (not a man with an excess of charity for those of us less intellectually accomplished than himself) derisively called 'Balloon Chemistry'.

One drew the components of a ring synthesis in a tortured contortion, rather reminiscent of J.J. Audubon's picture of a flamingo, and by dint of using the correct tautomeric form so positioned them that an oval balloon could be drawn around, say, H and OH or H and Cl, and, Bingo!, a heterocyclic nucleus appeared. Very satisfying, and no unnecessary complications with electrons!

Mann had one habit that sent me beserk; he would use trivial non-systematic names for heterocycles. Since he set some of the Part II papers, one had no chance of answering the questions unless one could remember what for example, carbostyryl was; I guess this guaranteed attendance at his lectures!

It seemed to me then, and still does, that the function of an examination is to reveal the depth of the candidate's knowledge and understanding of the subject rather than to do some sort of Trivial Pursuit quiz game. In 40 years as a research heterocyclic chemist in the Canadian chemical industry I have never had occasion to use the word carbostyryl, though I've made a lot of quinolones.

I may also have been one of the last years to be lectured by Dr E.A.Moelwyn-Hughes. His lectures were reputed never to change from year to year, and rumour had it that one Newnham girl of my year was following his lectures using her father's notes.

I was most grateful to Dr Moelwyn-Hughes; he always set one Part II question about the derivation of one of the partition functions. I was very vague then about what a partition function was, and now have no idea whatsoever, but by memorising the relevant section of his textbook and parroting it out at the appropriate time I staggered through the Physical Chemistry paper in Part II.

Immediately after graduation I went on a prolonged bird-watching trip to North Africa; by the time I got back I had forgotten all of what little physical chemistry I ever knew, and have been vastly healthier for it ever since.

Incidentally, I still have my copy of 'Mann & Saunders', smelling distinctly of benzaldehyde.

David Bronnert's letter about laboratory safety (and the lack of it) certainly rang a bell, particularly since I spent a lot of my research career in industry doubling as laboratory safety officer. Goggles? Never heard of them!

I well remember inorganic labs which required the identification of a halide by heating with concentrated sulphuric acid over a bunsen; on one occasion my mixture superheated and then shot out of the test tube, describing a graceful parabola across the lab until it came to rest on a nearby bench, where it happily charred a small pit in the woodwork.

Organic labs weren't much better; one of my neighbours was heating a round-bottomed flask – full of something organic – with a bunsen when he turned around to speak to the person opposite. At this point the bottom fell out of the flask. The contents sloshed across the bench, striking him in the same place that Hamlet stabbed Polonius, while catching fire.

He turned around to see his books and notes in a pool of flames, while initially unbeknownst to him a small personal tongue of fire was decorating his anatomy. Fortunately he was wearing blue jeans at the time and didn't suffer permanent damage.

And of course the infamous Lassaigne test was the signal for a series of explosions and itinerant balls of yellow flame all around the laboratory... but we all survived!

Yours sincerely,

David Brewer (Caius 1960)
mbrewer@albedo.net

A lavatorial danger

Dear Editor

My Cambridge chemistry was in 1950–53, so I enjoyed the old chem labs and the lecture hall, with Emeléus, Mann and Saunders, 'Flash' Porter and Norrish et al. Todd himself gave lectures on vitamins.

Thinking back, the carelessness with toxic chemicals was incredible; solvents were often just poured down the sink, and we were warned not to smoke in the men's room because the sink drainage went into the same outlet and ether vapours might be ignited underneath oneself...

Yours sincerely

Neil McKelvie
Emeritus Professor, organic chemistry
City University of New York
mckelvie@sci.ccny.cuny.edu

Dear Editor,

I qualified for my PhD in chemistry in 1971. I thought that this old photograph might be of interest to my old colleagues. It was taken during the year 1969 in lab 287, where we all used to work.

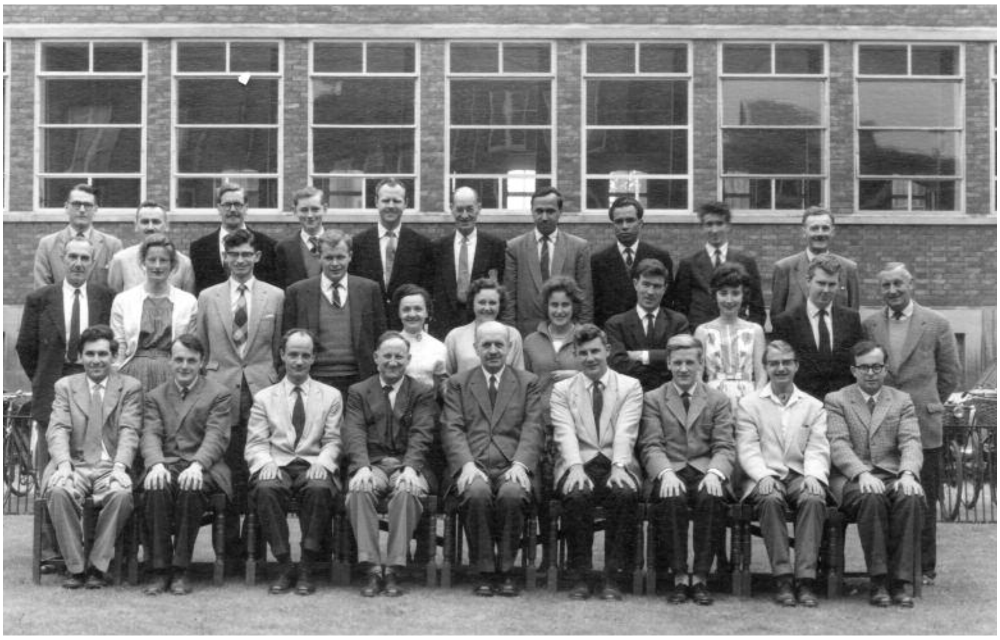
A contract had been given for the colour/whitewashing of the laboratory, and we thought to take advantage of that scaffolding stage to take a group photograph of us all.

From left to right, front row: Gul Niaz (C.B. Reese group), Hasibullah (Peter Sykes), D.P.L. Green (D.M. Brown), Anthony Clark (Peter Sykes). Back row: Roger Titman (D.W. Cameron, now in Australia), M. Younus (A.R. Kirby), Rodney C. Owen (Ian Fleming), Roger Bishop (Neil Hamer), Ivan Mensah (Ian Baxter).

With regards and all good wishes,

Gul R. Niaz.

Colloid science – 1960s style



And the search for 1961 colloid science names begins… we have a few of them, but can any readers supply us with more?

Vincent Gray (*Chem@Cam*, Summer 2009) might have described the location of his photo of the members of the department of colloid science, 1944. This was just within the main entrance of the old Cavendish, when one turns right after the archway.

The department's rear entrance was at the corner, directly behind E. Hutchinson in the photo. It occupied three floors, plus basement of the front facade of the Cavendish building on Free School Lane and was neighbour to David Tabor's department of surface physics. The department was thus quite close to chemistry, before the latter left Pembroke St for Lensfield; afterwards, it often seemed quite isolated!

The building to the left of the group in the photo was the Mond Laboratory, the home before the war of research into low temperature physics, led by Russian-born Nobel laureate Peter Kapitza. Kapitza 'returned' abruptly to Stalin's domains in 1934 when his passport was cancelled during a visit to his homeland. His senior colleague Lord Rutherford generously allowed Kapitza's research equipment to be sent on to him.

Vincent Gray's picture also shows that the support staff (technician Len Saggers, glassblower Cyril Smith and secretary Miss Morgan), who were all regarded as integral parts of the Department. I believe the work of such people has been grossly under-acknowledged, as in those days the technicians were producing instruments and glassware which were simply not obtainable commercially and few academics could type with more than one finger.

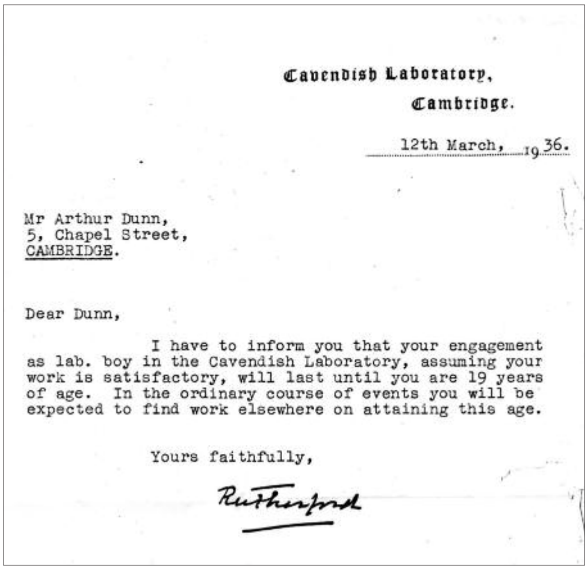
The group photo above was taken 17 years later (and closer to my own time, 1966), and shows the same two men occupying identical positions, but with Prof F.J.W. Roughton now in the chair of honour, in place of Eric Rideal. A third technician, Arthur Dunn (rear row, third from left) had joined in 1948, and provided another link with Rutherford's Cavendish, having started with the great man's group in 1936 as a 16 year old. The job offer from Rutherford – reproduced below – with its haughty mode of address, makes interesting reading today.

Arthur Dunn remained with the department to the end, working with Denis Haydon's group (which I joined in 1966). After being known for a few years as the department of colloid science and biophysical chemistry, it broke up around 1971, with most of Haydon's group moving to the physiological laboratory where Haydon (seated, 3rd from left) was given a specially created chair.

The move to physiology reflected Haydon's burgeoning interest in the application of surface physical chemistry to biological systems. Soon after the department's demise, the Cavendish itself, led by Brian Pippard, was leaving Free School Lane for its new home on Madingley Road.

Thanks to Joy Dunn, widow of Arthur, for permission to reproduce the Rutherford letter, and for the 1961 departmental photograph.

Brendan Carroll (Trinity Hall 1963-1970)



Cavendish Laboratory,
Cambridge.

12th March, 1936.

Mr Arthur Dunn,
5, Chapel Street,
CAMBRIDGE.

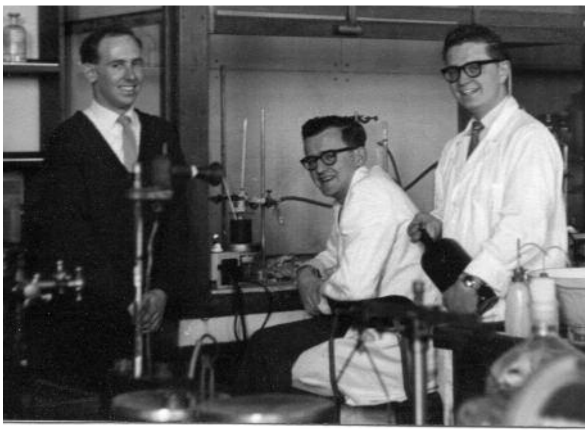
Dear Dunn,

I have to inform you that your engagement as lab. boy in the Cavendish Laboratory, assuming your work is satisfactory, will last until you are 19 years of age. In the ordinary course of events you will be expected to find work elsewhere on attaining this age.

Yours faithfully,

Rutherford

The appalling stench of arsine



Dear Editor

The 'History of Lensfield Road' articles that you have been publishing have brought back many memories – most of them good.

You may be interested in this photo, taken on my new camera and developed in the basement of the labs, of three of my colleagues from the early 1960s. From left to right, they are the late Mike Davis (whose best man I was in 1959), Mick Galla(g?)her from Australia, and Doug Carson from Canada.

We all worked in F.G. Mann's lab, and were responsible for many of the appalling stenches which wafted around the corridor between us and the analysts' lab, and also pervaded other floors because of the extractor system that was in operation at that time.

But then, phosphines and arsines never did have pleasant odours!

Yours sincerely

Bill Collier

Silverdale, 28 Seaton Down Road,

Seaton, Devon, EX12 2SB

Nathan speeds out of the Pitt lane

That's Nathan under the helmet… honest!

When he's not wielding a camera around the department, photographer Nathan Pitt has dreams of wielding other equipment – fast cars. Over the years, he's been to loads of historic car races, and more recently has got into watching touring cars. A trip to watch a British touring cars championship race at Brands Hatch last October really sparked his imagination, leaving him desperate to have a go on the track himself. At the end of January, he got the chance.

'It's definitely my favourite circuit, and I've always wanted to have a go at driving fast round a track, so it was too good an opportunity to miss,' he says. The day started off with Nathan driving a BMW M3, with an instructor to tell him the best lines. 'It was a cold, wet and miserable day and the track was greasy, so I was told it was important to make my mistakes in the BMW with its traction control and ABS.'

The next car he drove – a Formula Audi single-seater – didn't have such luxuries. 'Sadly, it was limited to 90mph – apparently they can do 155 unlimited as although they only have 1800 engines, they're very small and light,' Nathan says. 'But I still managed to hit the limiter three times on my final lap, once I'd got to grips with it. It was a bit hairy the first time I got to Paddock bend as I couldn't see a thing. I've been there lots of times for different race meetings, but when you are on the track yourself, it's something else entirely.'

The experience ended with two flying laps in a BMW with one of the instructors. 'That was great fun,' he says. 'I somehow managed to miss the presentation of certificates as I was out on a flying lap – so I got an extra one afterwards as well. It was incredible.' And fortunately his sister Abigail was on hand to take over photographic duties to prove he was there.

It was all a far cry from the diesel Golf Nathan normally drives, and he's definitely got the bug for speed. 'I'm now saving my pennies so I can have another go!' he says.

Baby Milo makes an entrance

Just the one baby to report this issue, but he's a real cutie. Laetitia Martin is a postdoc in Steve Ley's group, and also works for Novartis in Basel, Switzerland. Milo made his appearance on 11 December in Saint-Louis, France – just over the border from Basel in Haut-Rhin – weighing in at 3.14kg, which is a respectable 6lb15oz in UK baby-units.

Milo is the first baby for Laetitia, who's French, and her English biologist partner, Alan Jackson. 'He is a very smiley, talkative baby!' she says. 'He loves standing up, and is already trying to walk. The doctor is convinced he will skip the crawling stage, and try to walk straight away.'

Comings & goings

New staff

Przemyslaw (Tomas) Sobiesiak

Philip Ward

Retired

Roger Ward

Roger bids farewell

The department's chief electrical and mechanical technician, Roger Ward, retired in March. He'd spent more than 20 years in Lensfield Road, repairing electrical equipment, testing new equipment and buying such electrical things as fridges for the labs.

Although he professed not to want a fuss, there was no way he was going to get away unrecognised, and at his send-off party he was presented with a pocket watch to help him remember his friends in chemistry. It was also a good excuse for a group photo of some of the assistant staff!

From the left: Emma Graham, Clare Rutterford, Dan Fisher, Andrew Milner, Richard Preston, Wayne Bailey, Tina Jost, John Coston, Roger Ward, Steve Wilkinson, Anne Railton, Chris Ironmonger, Marita Walsh, Paul Skelton, Simon Dowe, David Plumb, Liz Alan, Oliver Norris, Sian Bunnage, Sheila Bateman and Chris Sporikou

Photos: Nathan Pitt

Christmas spirit!

What better to do when it's coming up for Christmas than celebrate with assistant staff old and new? Nathan Pitt took the photos

Left: Brian Johnson with Jane Snaith, Liz Alan, Vicky Spring, Anne Railton and Julie Lee; right above: Mike Todd-Jones, Phil Gallego and Derek Edwards; right: Bill Jones, Harry Percival and John Coston

From the left: Tim Dickens and Frank Lee; Alessio Ciulli and Howard Jones; Paul Skelton and Steve Wilkinson

Left: Don Flory, Dick Barton, David Watson and Alan Battersby; above: Tim Layt plus a glass of wine (what else?) and Marita Walsh eye up the buffet

Last issue's winners

ChemDoku

Chemdoku once again attracted plenty of entries – more than 30 this time – and several of them even answered my plea for green ink – or its electronic equivalent. Correct entries came from: J.G. Buchanan, Richard Moss, Jim Dunn, Audrey Herbert, Robin Cork, Keith Parsons, Bill Collier, R.N. Lewis, John Turnbull, Robin Foster, A.J. Wilkinson, Ian Fletcher, Helen Stokes, Tim Dickens, Paul Littlewood, Tom Banfield, Norman Sansom, Mark Alderton, Richard Brown, Godfrey Chinchen, Mike Barlow, Nat Alcock, Richard Chambers, Chris Shorrock, Ian Threlfall, John Billingsley, Alison Griffin, Pat Lamont Smith, Don Stedman, Neil McKelvie, Karl Railton-Woodcock and Annette Quartly. The prize goes to Audrey Herbert, who submitted an entry filled in using a rather fine green felt-tip.

Elementary recognition

Graham Quartly's elementary recognition puzzle received numerous admiring comments from solvers. A couple of readers reported having been sidetracked by Perkin for a while, but the solution was 'Nicolaus Copernicus, Revolutionary Thinker', and plenty of you managed to decipher the puzzle. These were: Richard Chambers, Mike Barlow, Godfrey Chinchen, Richard Brown, Robert Walter, Pat Lamont Smith, Huw Vater, Simon Morgan, John Billingsley, Chris Shorrock, Annette Quartly, Julian Langston , Karl Railton-Woodcock, Ian Threlfall, Simon Black, Mark Alderton, John Nixon, Paul Littlewood, Tom Banfield, Michael Goodyear, Paul Stickland, Robin Foster, Keith Parsons, A.J. Wilkinson, Audrey Herbert, Richard Moss and J.G. Buchanan.

We also asked why Copernicus had been in the news recently, and the answer here was that the heaviest element so far made by Sigurd Hofmann's group at Darmstadt – the soon-to-be-former ununbium – now has a proposed name, Copernicium, which has been recognised by IUPAC. The Darmstadt team suggested the name to honour 'an outstanding scientist who changed our view of the world'. Several solvers thought the answer here was that archaeologists discovered a skeleton in Frombork cathedral in Poland in 2005, which has since been identified as Copernicus by DNA analysis and forensic facial reconstruction, and is to be reburied there later this year. They've even decided he had blue eyes. While that's correct, we were after the chemical news story. And the prize goes to… Simon Morgan. Congratulations!

Scrappage selection

The 'Scrappage selection' puzzle from Keith Parsons also drew plenty of entries. The solution is:Alan bought a red Jagro Flier powered by hydrogen; Brenda now has a white petrol Morsko Gazelle; Colin's car is a black hybrid Nissaud Sprint; Dorothy has a green electric Toylex Cheetah; and Edward's is a grey Vaumaz Racer with a diesel engine.

Correct solutions came from: Robin Foster, Julian Langston, Annette Quartly, Richard Brown, Godfrey Chinchen, Mike Barlow, Nat Alcock, Richard Chambers, John Billingsley, Huw Vater, Pat Lamont Smith, Don Stedman, Neil McKelvie (who points out the irony of the Racer having a diesel engine!), Norman Sansom, J.G. Buchanan, Mark Alderton, Ian Threlfall, Karl Railton-Woodcock, Helen Stokes, Paul Littlewood, Michael Goodyear, Tom Banfield, Richard Moss and Audrey Herbert. And… the lucky winner is Helen Stokes.

£20 prizes are on offer for each puzzle. Send entries by email to jsh49@cam.ac.uk or by snail mail to Chem@Cam, Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge, CB2 1EW

Where on earth is ChemDoku?

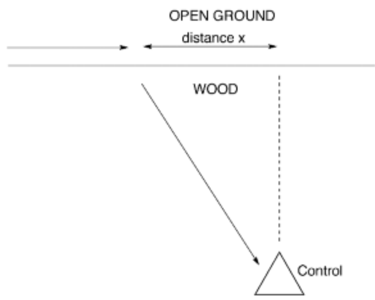
Many of the elements that have been discovered in more recent times are named after places, either where they were discovered or created. This issue's ChemDoku features nine of these. We've only included one of the four elements named for the small Swedish town of Ytterby, which is on an island in the Stockholm archipelago – they were all first found in its extremely productive quarry, which also provided the first samples of gadolinium scandium, holmium and thulium!

Cf	Am				Db		Eu	Yb
Bk			Cf					Db
				Fr				
	Po					Am		
			Po		Eu			
		Db					Fr	
				Cf				
Eu					Po			Ds
Fr	Yb		Ds				Db	Bk

The orienteer

This teaser was submitted by reader David Wilson, who says it is a problem he set some years ago to occupy an A-level chemistry class on the last day of term. At first sight, it doesn't appear to be science-related, and he adds that he had expected a quiet half-hour while they waded their way through some calculus. However, one of the students (whom he regrets to say ended up going to Oxford to read physics!) solved it in his head in less than a minute by using a well-known physicochemical principle. We're looking for a solution that eschews the delights of calculus in favour of one that relies on said physicochemical principle.

An orienteer is running in open ground along the straight edge of a wood. The control point that he is heading for is 100m inside the wood. He can run twice as fast in open ground as in the wood, and (fortunately for us) is blessed with perfect navigation. Where should he turn off the path to arrive at the control in the fastest time – i.e. distance x in the diagram below?



Drunkard's walk

And finally, a little puzzle from Keith Parsons. Draw the continuous path, in straight line segments, which passes through the central point of every square once only, in accordance with the following rules:

1. The path never crosses over itself, nor runs along an edge of any square, although it may pass through a corner

2. When leaving a numbered square, the path takes a direction that is not a straight line continuation of its entry direction.

3. If there is an un-numbered square adjacent to a square having a number greater than one, the path must pass through the un-numbered square in a straight line, and continue in the same straight line through any further run-numbered squares until it enters a numbered square, when rule 2 takes over again. The number in a square indicates how many further squares the path enters/passes through before reaching the next 'instruction'.

Clear?! Keith adds that these rules apply only to one direction along the path. Good luck!

3		2	1			3	2		2
	1			3	1	1			1
	1	2	2		1	1	1		1
1		1	1	1	2	1	1	2	
4				1			1	3	
2	2				4	2			
			2		1	2			4
1	1	2	1	1	1			1	1
1		2	1		1	1	4	1	
2		1	1	2	4				2

When you said that bromoform was transported into the stratosphere, I didn't think it was by ship...

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