Sir Martin Taylor

Ton Yeh

Sir Martin Taylor, FRS, has been Warden of Merton College since 2010. Francesca Lovell-Read and I are glad to have had the opportunity to interview this eminent Mertonian and mathematician before he retires, and this interview is reproduced below.

Tell us about your life.

When I was about ten, I got a chemistry set. I became increasingly interested in doing chemical experiments then I became interested in the theory behind the chemistry. At some point (and I can't put my finger on this) it became important to know what logarithms were. At this point I suppose I might have been 12 or 13, and we hadn't done logarithms, so I had to go to the local library to find out about logarithms. Little by little, as I started to look at the mathematical tools I needed to further my chemistry, I realised that I was more and more interested in the mathematics. Again, another thing that interested me very early on was calculus. I think I was really only interested in it though for doing pure mathematical things, like calculating tangents and working out areas. It was wonderful that with such elementary rules you could go a very long way. All the time I was doing these things, I was probably a year or two in advance of the school curriculum. If anything, this gave me a flying start at learning how to teach myself things which is what researchers really have to do. So that was a great start. Then little by little, not every teacher but one or two of the teachers would take me or my parents aside, and they would say, 'Martin's really very good at mathematics', and they may well have been a little surprised.

My school thought I was really outstanding at German. The school's advice was to send me to university to do German. It's a very good language for mathematics because it's algorithmic in many ways. I never made a mistake in all these inflections, for a whole year, and they couldn't believe this. Anyway, there was one particular teacher, who was the newest teacher in the school, and he had an idea to teach to people at school things like set theory and group theory. We had special lessons for what you might call extra-curricular mathematics. I found that very inspiring and he thought that I had hidden talent. They didn't think I flourished as well as I might have. The head of maths, someone I didn't get on with at all, said he thought I wasn't sufficiently talented for Oxford or Cambridge, that I should apply to Manchester. Whereas the young chaps stuck up for me and wanted to give young Taylor a chance. In those days schools were wonderful. They would give you the form and tell you exactly what to write, and they might say 'You seem to be missing something on the sports front, so we've arranged for you to join the house cricket team on Thursday, you can stand at long off or something, so that you can put that down on the form'. So they guided my application like this, then I did the exam to get into Pembroke College, Oxford. It's true to say that again, on the whole I didn't do terrifically well in the entrance exam, but they thought I showed some spark in the interview and they said they were willing to take a

risk on me.

When I got there, I was amazed – it might have been all those lessons in group and set theory, but I hit the ground running, whereas all these people with scholarships and exhibitions were stuck at level zero for a long time. Quite quickly they decided I was so good, I had to have one-to-one tutorials because otherwise it would put others in the shade. The tutor at Pembroke was really good at algebraic number theory and he had a very elegant style. I was beginning to realise that this was what I liked. There's a French book, not sure if it's current anymore, called 'Thorie algbrique des nombres' by Samuel, who excelled at commutative algebra. It was very cleanly done and I thought I would be happy doing things like this. Then I told my tutor this. He said he'd been at Manchester, East Anglia and Oxford (so he's seen the world a little) and he told me that the biggest mistake was to think that just because you're in Oxford you must stay in Oxford or Cambridge. Some of the best things in the world are happening in King's College London. 'So why don't you go down to see what it's like?' I did so, and I got along like a house on fire with Albrecht Frhlich: it was one of those chemistry things and I knew it was going to work. So I did my degree at Oxford and got a very good First-class. In those days they weren't quite as good at telling you exactly where you were, but I did a little interpolation calculation and I might have got the fifth First-class. Not too bad!

Then I went to London. I realised that Frhlich, my supervisor, who got nicer and nicer, had this whole emerging theory with questions and conjectures, and on the other hand I realised how little I knew for the world of research. It was a bit daunting. I'd done Galois theory and algebraic number theory. But then I was told to read these papers. The speed in these papers really knocked me back a bit. There was no paper I had for the first 18 months where I could tell you the details of everything in the paper. I got a little fed up with just reading things that I was half-understanding. So I asked the professor for a problem. He gave me a nice one to do with the signature of units in algebraic number theory. I remember getting up and thinking, 'This is your first problem, Martin. Sharpen your pencils, and put the paper out nicely.' I solved it in two hours. I went back to see him, and he proposed that we write this up as a paper. And I thought, 'is it always going to be as easy as this?' I'm telling you highs and lows, shall we say. Then he suggested that I should get into an area now. In the area he was working on, there were some finite groups where people can do things, like generalised dihedral groups. The hard case was p-groups. I thought about p-groups, and I remember finding it very hard. For almost a year, I proved nothing. I started to get really nervous – that after that amazingly quick start, it's drying up. And then I was doing a calculation, I think on a Saturday morning, and I realised a congruence between various determinants. I went back and told him, and he thought that it was a really new idea. This congruence led me to one of the greatest things that happened in my life. I found a version of logarithm which was very good for congruences. The problem with the normal logarithm, if you think about the power series, is that the denominators mess up congruences. But I managed to swerve round that one, using clever p-th power operations. I was able to use the logarithm to solve problems in algebra that people were stuck on. Little by little over the coming year, I thought about how it could address the professor's big conjecture. I got my PhD for this logarithm and one or two applications in number theory.

I should add that I got my first proper job at Oxford as a junior lecturer. I only had it for one year because I had got one or two really good papers out, picking off bits in my professor's area. This conjecture here, that conjecture there: little by little, I was getting the swing of it. They turned into papers in really good journals, like Inventiones, and the Journal fr die reine und angewandte Mathematik. So this made me look very good to prospective hiring committees. I was tapped up by Queen Mary College, London. My job in Oxford was only for three years, and they asked me if I would like to come for interview for a proper job through to when you retire. I went along and said my little piece. That was on Friday. On Monday, came a letter appointing me to a job for life. It was a huge relief because by that time I had a wife and two children and I didn't worry as much as I ought to have, but I still was mindful of the fact that I had to look after them, in a very uncertain world – this was the era of Margaret Thatcher, when there were maybe 4 or 5 jobs in Britain in maths per year. They were thin times, and I got a job for life and felt lucky. No sooner had I arrived at Queen Mary College than the French government wrote to me about annual positions they had, where someone just goes and visits a French university of their choice. They'd choose a place where I could work with someone in my area. They indicated a place called Besançon in the letter; that was just beyond Burgundy and near the Swiss border, not too far from Geneva. The good thing in this was that I would have a good salary, and all my time would be for research. I took this along to my new boss at Queen Mary. He said 'it's a great thing for you, we'll back you'.

I had a wonderful time there. I used to walk in the hills just thinking about maths and writing it up. One day, I was standing in what was originally a bus queue (and then when the bus came, everyone just churned around) and my head was elsewhere. I was thinking about using the logarithm to use the professor's problem: here's the trick! So I sat up and worked it out. It seemed to work. So I wrote to him about the sketch of how it should go. I got a telegram back saying, 'Congratulations, I think you did it'. The next day I realised there was a mistake in what I had done, but I had learnt that maths has always got mistakes, that it is a constant process of refinement. There was a lot of excitement in my world, in Germany, France and Britain. The problem had been done and people can see a lot of other things you could do. Bordeaux then contacted me to ask whether I would like to talk to them a little. I became very popular suddenly. I thought, 'Maybe, Martin, this will make you something like a stand-out person in your generation, at least a bit'.

Then I came back to Britain, where lots of people wanted talks on what I had done. Meanwhile, Trinity College, Cambridge, realised that maths at Cambridge was getting a bit stagnant, and they wanted some fresh blood. Trinity rang me up and told me they'd be interested in hiring me. The problem, however, was that technically it was a 5-year job, but they said, 'Trust us, we will make it permanent'. I trusted them, and again the ideas behind the big proof kept proving other things. I had lots of good publications. Probably after two years in Cambridge, somebody came up to me to inform me that the College Council looked at my position and made me permanent. That made me feel good. About that time, it was decided I should be put forward for Fellowship of the Royal Society. The Royal Society is a funny thing – they nominate you, and you are 'suspended'

for seven years. Andrew Wiles was probably elected in his first year, Tim Gowers in his second year I think, but most people were elected in their fifth, sixth, seventh year. So I knew I had a period of waiting and watching.

Then I went to Manchester, to a place called UMIST. They were delighted to have me. They said my job was to do research and to give UMIST profile. The principal said, 'I get all these invitations to Royal Society dinners and things, so perhaps you could go in my stead!' He was a very gentle northerner and he didn't like the socialising aspect. I was then made a Leverhulme Fellow. In those days, the Royal Society said, 'we regard you as maybe a bit on the edge, but you're part of the Royal Society family, so we'll invite you down to various events and would like you to come'. I started doing things for the Royal Society, and then I got elected a Fellow, which was quite a sensation in UMIST, because I had think we had 4 Fellows, 2 of whom were retired, the other of whom were really senior, in their 60s, and here I was aged 44. Things were going very well at that point. Quite quickly, I realised there weren't that many Fellows of the Royal Society in maths. People would ask me to do things, and lo and behold, within a year of my being elected, I got a letter from the London Mathematical Society, saying that they would like me to be their president. I hadn't the faintest idea what it really involved. I had been on the council of the LMS but I always sat at the far end, I only vaguely understood what was going on. But they were wonderful and believed in me, and I believed in them. The LMS had just bought new premises on Russell Square, so clearly there was a job to do. We needed to acquire not a big, but an efficient administration. We needed to establish a vision as to where we were going, and we needed to make our presence felt politically. Mathematicians tend to live on their own in their own quiet way, their big dream being not to be bothered by other people. Whereas they should out there bothering the Minister of Education about maths education, bothering BIS to make sure the researchers were getting their share of the cake. There was a job to be done and I quite enjoyed doing that.

After I stopped being President, someone in Government decided there should be an international review of every subject, and they asked whether I would lead the UK's review of maths. 'Lead' meant that I was to facilitate it. There would be an external chair because only foreigners are allowed to evaluate, otherwise the whole thing would be corrupted. The man with whom I worked, and I got on with him, was Jean-Pierre Bourguignon (now head of the European Research Council, so he doesn't like talking about Brexit). That was a great success. We had presentations from all sorts of people, giving their people of how they thought maths was doing. One of the great catches was Lord May, Robert May from this College, who was President of the Royal Society, who said he would give a little presentation on how he thought maths was doing in the UK. He was amazing. He knew how to speak a subject up. At the end, somebody wanted to know how maths helped with national security. He said, 'Well, ask the chief mathematician at GCHQ.' But it was pointed out that he couldn't come, and he said, 'You leave that to me.' Within an hour, we had a call from Downing Street saying he's on the train. It went amazingly well, this review, and you can imagine how impressed the foreigners were, the PM's office having intervened and the head of GCHQ and so on. Then Robert May took me aside and told me that a new Vice-President

for Physical Sciences was needed, and that I'd be his choice. I was then en route, as it were, to the Royal Society. That happened very quickly because in those days they didn't have careful nominating committees. It was just who caught the head official's eye and what the president had to say. So then I appeared at the Royal Society, which was really one of the best times of my life.

There was a group of us – the President, Bob May, and 4 Vice-Presidents, and we all worked together extremely well. I used to go to the pub to watch football with them. They're still some of my best friends. I had so many things to do that were interesting, especially maths education, because I thought a lot needed to be done. The first thing I was able to do, with a lady called Celia Hoyles, was to get together something called ACME, the Advisory Committee on Mathematics Education, and it was perfect: the maths community working confidentially with the Government to understand each other and improve things. Maths education has come quite a way. I thought, if this has worked so well in maths, why not something like that in physical sciences? We set something up which no longer exists, called SCORE, but towards the end of my period at the Royal Society, when normally you get knighted at the end, I was knighted, and it was in particular for my work in maths education, so it caught someone's eye. When I stopped being the vice president, I thought that that was the end of that. But it wasn't. They said, 'We're facing a huge problem. The government has to cut a lot of its spending. Every section of the government has been asked to prepare a 10 percent cut, a 20 percent cut and a 40 percent cut, to say what it would look like. At the moment, we think the sciences will get a cut between 20 and 40 percent. We want you to head a committee to make the case, especially to the Treasury, as to the economic benefits that science brings in.' This was a good and interesting thing to do, and I was given a very good team to work with. There was David Sainsbury, who can be said to come from the Labour Party; and for balance William Waldegrave, a past Minister of Science on the Conservative side; Paul Nurse, who was going to be President of the Royal Society; Mark Walport; Helga Nowotny, president of the European Research Council; and many others, making up a very talented team. We wrote up a case, and when the Government were discussing it, we noticed all the officials always had a copy of our report under their arms, because they trusted it. It doesn't mean that it made the case, for others had to do a lot of fighting. But it had all the details. In the end we were told very excitingly on the last day – and this was the hard work of David Willetts – that we were getting a zero percent cut. I think we and Foreign Aid were the only two to be spared. We'd all collectively done a good job. Quite quickly, they said that we needed a vision for maths and science education, and I'd be put in charge of that one. Again we had very good people: Charles Clarke, former Minister of Education, who was extremely good; Alison Wolf; John Holman. We produced a report on that.

But what about the research I was doing in the meantime? Going back to the 1990s, there was an idea, to use the techniques that Frhlich and I had developed in more geometric situations. The first thing – entirely Frhlich's idea – was to try and use elliptic functions. There were some old German papers on how you evaluate elliptic functions at special points, and they will spit out algebraic values that have all sorts of special properties – they might be units, or divisible only by a predesignated prime number. That led to a new area. But then some colleagues in America

started to think in terms of algebraic geometry with these techniques. That's what I've been doing ever since, with all sorts of degrees of success (it's such a vast area, it's not really clear that there's some absolute jewel result, you keep finding nice and interesting things). This morning, before I came in, I spent an hour trying to write a very elegant paper, one of the best I've done in the last ten years. It won't shake the world: when you get to 66, as a mathematician, you learn to be a little more humble, and slower.

Any words of advice to people who might be thinking of applying to Oxford or Merton, to study maths?

I am not the only one in the world, but I am a manic preparer. Before I came up to Oxford, this very kind tutor I told you about sent me a reading list of 20 things. I'll bet you I read a dozen of them. That taught me all sorts of bits about algebra, the basics of analysis. If you'd quizzed me, you'd say 'He's not learnt very much', but I got the ideas turning in my head, and that was all part of my hitting the ground running when I got here. So, prepare a bit over the summer before you come up. It's a terrific investment.

How can algebraic number theory be justified as having real-world value?

Ten years ago or so, I was approached by GCHQ to ask if I would be interested in helping to set up an institute, now called the Heilbronn Institute, the idea being to have a physical institute where people from academe could come – they're especially interested in young people, like postdocs – for about 3 years, but it would be flexible. Half the time would be spent doing work that can be published in journals, the other half on closed research, which would be secure. I was Chairman of the Science Advisory Group, I had a very big hand in setting it up and launching it, making sure the hoops span properly. I did my spell, and I resigned. About 3 months ago one of the new directors there came and said, 'You'll be retiring soon, would you like to spend some more time with us?' One isn't allowed to say much about this, but suffice it to say that algebraic number theory is very useful in codes and cryptography and a lot more besides. But that's not why I do it. There are many applied mathematicians who can (but not always) be driven by the application, whereas I'm never driven by application. What I'm driven by is things that are very elegant and neat and that give deeper insight.

What have you enjoyed most as Warden of Merton College?

18 months after I became Warden, they said, 'Martin you more or less know how the place works now, maybe now we need to create a new vision' – they would call it strategy, but because I come from the Royal Society, I learnt that probably you need a vision as well, and the strategy should crystallise out of that, because strategy is the pragmatic incarnation of the vision. We set up a strategic review of nearly everything the College did which I considered of prime importance. One thing I felt was massively important. When I was at the Royal Society, they used to give me jobs in biology, a subject which I gave up at the age of 12 because they were so dismayed at my bad drawings. They would ask 'would you draft a policy on animal experimentation?' I'd tell them that I had never experimented on an animal in my life, but their thought was 'people will trust your judgment; just use that good judgment and write it; we'll give you teams of people to advise you'. Then they put me in charge of synthetic biology, which at its simplest meant the engineering

of new cells for specific jobs. I still think that this is the best thing in science (though I think one or two others might disagree). Then I came to Merton and found out that they were in the process of killing off Biochemistry. And I thought that that was crazy, that it was the best thing in science! It was a hard fight, but that was one of the gains of the strategic review. They're always worrying about the shape and size of the College, because we don't want it to get very big, but then we had to create space for a new subject coming in, so that was quite difficult.

What's your favourite Merton Hall dessert?

When they do it, gluten-free pancakes. Desserts are not easy for me. I'm a coeliac, so four-fifths of desserts aren't edible by me. Sometimes, for the Shrove Tuesday dinner, the chef would make me gluten-free pancakes and I love them.

Why should people consider studying at Merton?

It took me a little time to understand this but I think Merton's community of students is one of the happiest groups of students that I've come across. They're happy and a very talented lot but they're happy to take people as they are and they all hang together. An example of this: I don't think a lot of them go out very much. They go to the bar and to bops, they do stuff together. But they don't go down to London nightclubs together, as some other students do. They're remarkable for their ethos of hard work. A lot of them tell me when they've been here for about a term, they came and they thought, 'I know my works going to be important, so I shall set aside at least 10 hours a week for it' and then they look around and think 'maybe nearer 20 hours a week'. They get this off each other. And that's good. One comes to university to study one's subject. It's not like a Swiss finishing school that turns people out into the brighter world, as it were.