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Professor Sir Michael Berry describes his intellectual habitat as 'the borderlands between physical theories'. The author of more than 400 publications, he has received ten honorary degrees and dozens of major prizes and awards, from the Royal Medal of the Royal Society to the Wolf Prize in Physics. The 25<sup>th</sup> anniversary of the publication of one of his most famous papers (*Quantal Phase Factors Accompanying Adiabatic Changes*), which has had a huge impact in the world of quantum mechanics, falls in 2009.

## **My (nearly) half-century in Bristol**

by Michael Berry

The H H Wills Physics Laboratory is the highest point in the centre of Bristol, so it can be seen from many places across the city and is easy to find ('Keep going up'). When I arrived in 1965, damp behind the ears with a new PhD from St Andrews, I was impressed not only by the location of the building but also by its imposing 1927 design as a mock castle. Then, the physics department was clamorous with builders constructing the 'new wing'. Four decades later, as my retirement looms, the builders are back, renovating the whole laboratory.

With a young family, it seemed sensible to consider buying a house. One that we viewed was, in the estate agent's clichés, 'In need of some redecoration' (we glimpsed a dead cat on the rotting staircase leading to the basement), and 'in the up-and-coming area of Kingsdown'. He was right on both counts, but we decided we could never afford the princely asking price of £1,200.

With a post-doctoral fellowship, and a physics project different from what my colleagues in the department were studying, it was easy to settle into research with few distractions. But I soon discovered that physics has a surreal side. A mathematical enquiry from a research student in the veterinary department was channelled to me. He had spent three years measuring electric signals on the surface of a horse that he had covered with detectors, with the aim of deducing the electrical properties of the heart, which acts as a weak battery

whose functioning gives a good indication of health. The mathematics he did not understand deduced what was happening inside the horse from measurements on its outside. His first question was 'Do these formulae apply to a real horse, or only an ideal cylindrical horse?' Thus I found myself applying calculus to horses. A year later, I received the student's published paper, in which he expressed gratitude: for help from me, and funding from the Horserace Betting Levy Board.

An early responsibility was as co-ordinator of staff meetings, that is, custodian of departmental democracy. We introduced practices that were unfamiliar in the university then but are commonplace now, such as having an agenda circulated beforehand, and inviting student representatives with equal rights to speak and vote – though votes were (and still are) rare in a department with decisions made largely by consensus. We agreed to the unheard-of practice of allowing students to bring notes into examinations, so questions could probe understanding as well as memory. In an extreme application of this principle, still remembered by some of the students, I held an 'infinite examination', in which there was no time limit. This was a failure: the best results were obtained by those students who had finished within the usual three hours; and I had forgotten to bring anything to eat and so was starving, unlike the weaker students who had taken my advice and brought sandwiches to sustain them during their largely futile scribbles, which for the stragglers lasted eight hours.

In those days, academic appointments were made differently. After I had been in Bristol for nearly two years, John Ziman, who had arrived in 1964 as the new professor of theoretical physics, called me into his office and pointed out a fact that I was dimly aware of but whose significance had not sunk in, namely that my research funding would soon come to an end and I would be out of a job. 'You seem to be able to teach, so would you like a lectureship?' I mumbled that it seemed a good idea. 'OK, but you will have to go through the formality of an interview by an appointments committee'. And so, with no advertisement, no references taken up, and no citations scrutinised, I found myself with a permanent appointment in the same university that in 1959 had rejected my application to enter as an undergraduate.

The 1960s was the decade of the counterculture in America and riots in Paris. In December 1968, the turbulence reached Bristol University, in the form of a student occupation of Senate House. The 'great cause' that raised passions and inspired the sit-in was not opposition to the war in Vietnam or apartheid in South Africa, or the wish for a root-and-branch restructuring of society; rather it was outrage at students from other colleges in Bristol not being allowed to use the facilities of the university Students' Union building (I joke not). But passions there were, on both sides. Professors who had fled from the Nazis and fought with the British Army, but happened to disagree with the aims or tactics of the students, were denounced as fascists. And I, as almost the only lecturer who entered Senate House to listen to the interminable spontaneous seminars that were (un)organised by the students, was denounced by some of my colleagues as a traitor to academic freedom by giving legitimacy to the students who were threatening it. But the protest fizzled out after a week, as the occupiers gave higher priority to going home for Christmas.

A good result of the occupation was the setting up of a university Committee for Communications and Relationships, including students and lecturers (I was the youngest), and chaired with wisdom and sensitivity by our Nobel prize-winning recent head of physics, Professor Cecil Powell. Following our recommendations, many changes were made in the organisation of the university. Some had been pioneered in the physics department. Others, including the setting up of a University Newsletter, were new. This was inspired by the university's response to the student occupiers' very effective distribution of information about the progress of the sit-in. In recent years, the Newsletter has mutated into several university publications and our website – sources of news that in this information age we take for granted.

Some of my colleagues complain about the bureaucracy, largely imposed from outside the university, associated with research (too much time applying for grants) and teaching (too much time spent documenting). As a research professor for the past 20 years, I have not suffered in this way, but I think my colleagues are right. One can call it the Heisenberg principle of accountability: time spent measuring a creative activity can soon inhibit it.

It is easy for criticism of government attempts to micromanage intellectual activity to spill over into more local criticism, of the university administration. This is a negative view that I do not share. It is true that I am largely ignorant of the administration and how it works – indeed, for my first few years in Bristol I did not even know the name of the Vice-Chancellor. But this is meant as a compliment: the best administrations are largely invisible. On the few occasions when I have needed specific help from Senate House, this has been effective, pain-free and good-natured.

There are many ways of doing theoretical physics. Over the years, mine has changed. When I arrived, my style was algebraic: a typical day would be spent writing pages of equations. But soon, under the influence of senior Bristol physicists, I realised that richer understanding of concepts and phenomena could be achieved by supplementing the algebra with pictures. A massive boost to this emphasis on the visual came in the late 1980s, with the arrival of small computers, powerfully equipped with graphics capabilities. Now, images have become a valuable way of exploring the mathematical content of physical theories (and mathematics itself), and have led to discoveries that were only later verified by more traditional methods.

I was always concerned with the beauty of equations, and now this aesthetic has been transferred to the pictures that represent them. In this I am not alone: ‘science and art’ and ‘the art of science’ are terms increasingly being used to describe appealing images originating in scientific research. I prefer the more accurate descriptions in the title of a research project on this theme: ‘Envisioning Science’; and the name of a series of conferences on the topic: ‘Image and Meaning’. We increasingly recognise images as powerful tools, not only for furthering our own understanding but for communicating between scientists and to people who are not scientists.

I consider myself fortunate to have spent all these years in Bristol University. Occasionally, possibilities arose to move to other institutions, in the UK and abroad, including some that are superficially more prestigious, but I always concluded that the working environment in the physics department was as close to perfect as I could imagine, so I stayed. In large measure, these conditions were created by my colleagues. I am referring not only to my

research students, from whose direct collaboration I have benefited enormously, even though my approach to physics has sometimes appeared solitary. In addition, my fellow professors and lecturers have displayed generosity and congeniality, perfectly exemplifying the co-operative spirit that animates science, contrasting sharply with the competitiveness that the media loves to emphasise but which is in fact relatively rare.

Physicists, especially theoretical physicists, have the reputation, perhaps not entirely unjustified, of adopting an attitude of intellectual superiority. I have already mentioned the fact that our department is at the top of Bristol. An even more appropriate location occurred to me during one of the balloon rides for which our city is celebrated: ballooning is the perfect occupation for a theoretical physicist: looking down on the world, supported by hot air.