CHAPTER 1

FIRST LOVE RUNS DEEP

THE BEGINNING

Did you know that we are all stars? I don't mean that in a Simon Cowell-type, doing-it-for-my-dead-nan way. I mean that people, real people, are quite literally made from stardust. It sounds like the most ridiculous sort of science fiction – but this is the world we live in, seen through the eyes of science.

Let me explain. You, as well as everything around you, are made from atoms. You can think of them as the basic building blocks of nature. There was probably a chart on the wall at school called the Periodic Table that showed them in order of increasing size: the smallest, like hydrogen and helium, up at the top, and the big boys, like lead and uranium, down at the bottom. You'll probably also have a vague recollection that these atoms were themselves made up of even smaller parts; to be precise, there was a small, dense, electrically positive nucleus at the centre, surrounded by a swarm of negatively charged electrons. Well, have you ever wondered how those atoms were made?

The answer, incredible as it may seem, is that they were made inside stars. The reason that the stars shine is that there is an enormous nuclear reaction going on inside them, where smaller nuclei are fused together into bigger nuclei, releasing huge amounts of energy as heat and light. The bigger the star, the bigger the nuclei it can make. And once you've got a nucleus, all you need to do is sprinkle on a few electrons – which, frankly, are ten a penny – and you've got a beautiful, life-giving, electrically neutral, works-straight-out-of-the-box atom.

A star like our Sun, it turns out, is a little on the small side. This means it can produce only the smaller sorts of atoms, like helium. Bigger stars are capable of producing much bigger atoms, like iron and carbon – the sort of stuff that you and I are made of. So how do these bigger atoms get from the inside of a star into our bodies?

The answer is that the life cycle of big stars ends with what Noel Gallagher calls a supernova, a huge explosion that flings debris out across the galaxy. Over billions of years, this debris slowly clumps together due to gravity, sometimes forming new stars, sometimes forming planets. On these planets, if the conditions are right, life can form.

In other words, the atoms that make up our bodies were formed billions of years ago in the centres of real, genuine, 100 per cent stars. Those stars then exploded in ruddy great explosions, the debris became planets, life began on our planet – and then, thanks to a particularly slack period in popular music, Simon Cowell evolved. That's science. It's big, it's bold, and – according to every experimental test we've been able to make – it's true. If that is the sort of thing that gets you going, this is the book for you.

MR BAILEY

I've always loved the arts as well as the sciences, and I've always found it strange that the two subjects are separated by some weird sort of educational apartheid. If you were to generalise about where we stand on this issue today – and what the heck else is a book like this for? – you'd say that the arts have an aristocratic, high-church, Royalist air about them, while the sciences seem altogether more egalitarian, plain-speaking and Puritan. We seem to find ourselves on one side or the other of these cultural tracks, centrally cast either as foppish, airy-fairy creative types or unwashed, unapproachable, socially challenged geeks.

Needless to say, this schism is a very modern invention. For a kick-off, no king was ever more loving of the sciences than that lovingly restored fop-to-end-all-fops, Charles II – and, conversely, it's hard to imagine someone less likely to dissect a frog or launch a weather balloon than Oliver Cromwell. Yet the entire education system seems to buy into the contemporary myth that we are all either artists or scientists from birth. Can it really be that there are two types of human intelligence, one ideally suited to composing haikus and the other perfect for mucking about with a chemistry set? Why does science become such a passion for a few and yet such a mystery for so many?

I think a lot depends on your earliest experiences of science, and I was extremely fortunate in having one of the finest teachers of natural philosophy that anyone could hope for. His name was Mr Bailey, and the things that he taught me and my fellow infants at Willaston County Primary School have stayed with me throughout my entire adult life. If you'll let me, I'd like to tell you a little bit about how, under his influence, I came to study the sciences.

There is not a lot to say about Willaston, the village where I spent my first few years. There were about half a dozen shops, which all appeared to sell newspapers; a railway level-crossing, which provided the lion's share of the local entertainment; some concrete playing fields with generations of children's broken teeth embedded in the tarmac; and a large housing estate where several hundred young families, of which we were one, clung to the lowest rung of the Cheshire housing ladder.

Willaston County Primary School had been recently built to cater for this sprawl of cookie-cutter housing, and was 'modern' – which, in 1971, basically meant that it had a flat roof. If you haven't grasped it yet, I'm trying to paint a picture of a thoroughly ordinary state school, of the kind that can be found anywhere in the country, unremarkable in every way. Except that, in my opinion, what was going on in the classrooms of Willaston County Primary was anything but ordinary, and that was largely due to our rather unconventional Deputy Headmaster.

Mr Bailey was an unlikely schoolteacher. He cut quite a dash, tall and thin, with pepper-grey hair, a neat moustache and a sartorial mien that hovered just the right side of Basil Brush. He was boundlessly enthusiastic, loved a field trip and practically lived for the opportunity to tell anecdotes. But, of all his many passions, one reigned supreme: maths.

Maths, Mr Bailey said, was just about the most fun you could have next to British Bulldog. Practically the first thing he introduced us to was number bases. The non-mathematicians among you might think you know nothing about number bases – but, of course, you do. In fact, you are absolute experts in one of them: base ten. As Mr Bailey explained, the reason we count to ten, and then in multiples of ten, is because we have ten fingers. But why stop there, asked Mr Bailey? For fun, why not count in base eight, as if we were Mickey Mouse and had only eight fingers? Why not count in base sixteen?

The point being that, from our very first encounter with numbers, we were encouraged to see them as things we could play with. In fact, the home-made woodblock number base sets that Mr Bailey provided for our infant school were just as popular as the Lego or the sandpit. To Mr Bailey, numbers were more than just a necessary evil; they were entertainment. And, though he can't have known it at the time, a knowledge of number bases was going to be very useful to a generation of children whose computers would be designed to run on base two.

The rite of passage for any child in one of Mr Bailey's classes was the day you qualified for your tables licence. This was done just as if you were taking a driving test, with two chairs placed side by side. The 'examiner' – one of your classmates – sat next to you and quizzed you on your multiplication tables. If you 'passed' by getting them all correct, a serious little ceremony would take place whereby an official-looking booklet would be signed and countersigned, and your photo glued haphazardly on the cover. The small print declared that 'Ben Miller, the undersigned, has hereby been judged by Philip Buckley to be proficient in times tables one to thirteen, and is now free to use them in perpetuity as he sees fit.' Occasionally, Mr Bailey would make spot checks.

'Excuse me, young man. I see you are multiplying numbers together. Have you got your tables licence?'

The usual fumbling about looking for the vital document would follow. 'Here it is, sir!'

Mr Bailey would study it like an overzealous border guard. 'Very good! Carry on.'

One of Mr Bailey's favourite touchstones was the louche, devil-may-care attitude of the numerate. 'Mathematicians', Mr Bailey would say, 'are lazy.' By his reckoning, the arithmetical profession can't be bothered to add up lots of numbers, so they multiply them instead. After all, who wants to add up eleven fours when you can just use the eleven times table – provided you have the appropriate documentation, of course – and get the answer straight away? And why learn multiplication tables for all numbers when you can get away with learning only the tables for the first thirteen? And had we heard that grown-up mathematicians were so lazy that they had published whole books of answers to sums and called them logarithmic tables?

Willaston County Primary was one of a dozen or so feeder schools for Malbank Secondary School, the comprehensive in nearby Nantwich where I ended up taking my O and A levels. We were a streamed comprehensive, where pupils were grouped according to ability. And this is the bit that makes me wonder how much of what we think is innate about our proficiency in maths or science or anything else depends solely on whether we happen to come across a particularly gifted primary-school teacher. After an especially gruelling set of tests, assessments and best-of-three arm wrestles, I was put in the top stream for maths. There were about thirty-five of us in all. I needn't have worried about making friends; nearly every other child in the class was from Willaston. Needless to say, they had all been taught by Mr Bailey.

THE IDLER

Now I look back on it, one of the main reasons that I chose to study the sciences was laziness. After all, one question about, say, gravitation is pretty much like another; all you need is a few general principles and you're off to the races. Most importantly, no one expects you to remember anything; these days, they even print the formulae on the exam papers to save you the effort of scratching them into your shatterproof ruler.

Not so in the arts, of course. When I finally joined the sixth form, I signed up for A levels in English, History and French, and I got the shock of my life. Everyone talks about learning lessons from history, but we all know that's just a bit of empty salesmanship; sign up for an A level and you are staring down the wrong end of four millennia of random events with dates, times and places to match. There's no shape or form to any of it, frankly, and to make it worse half the kings of England had the same ruddy name. Add to that a Matterhorn of novels from the English reading list and an epidemic of irregular French verbs and you've really got your work cut out.

Needless to say, I beat a hasty retreat to the science block and threw myself upon the mercy of those trusty stalwarts, maths, physics and chemistry. The other thing that lured me back to the fold was, of course, the goodies that awaited at degree level. I was under no illusion about the privations of undergraduate English; my father was a lecturer in English Literature at what was then Birmingham Polytechnic and I had sat in on enough of his classes to know that you didn't spend your time reading out loud from *Fanny Hill*. It seemed to me, in fact, that the further upstream you swam with that particular school, the less it became about character and story, and the more it became about, well, just about anything else: sociology, feminism, Marxism – take your pick.

In science, on the other hand, we knew that our A levels were the grunt work and that the real treats lay beyond – impossibly glamorous things like Relativity and Quantum Theory. If, like me, you had no game plan other than to delay for as long as possible the moment when you might have to actually work for a living, the prospect of a degree in science held very great lustre indeed. Increasingly, for me, a degree in science was coming to mean a degree in physics. And if you wanted to study physics there was only one place to do it: Cambridge.

Why Cambridge? Well, frankly, that's a bit like asking someone why they want to record their album at Abbey Road. Cambridge is to physics what Madison Square Garden is to Simon and Garfunkel. It was at Cambridge that Isaac Newton formulated his theories of optics, motion and gravitation, as well as discovering calculus, a mathematical tool that remains at the heart of practically every equation in modern physics. The famous physics laboratory, the Cavendish, was founded there by one James Clerk Maxwell, arguably the world's most influential physicist after Newton and Einstein, and the first to discover the interconnection of electricity, magnetism and light. And, even more importantly for a spotty teenager in 1985, Cambridge was where Stephen Hawking currently lived.

I had seen a BBC documentary about Hawking and his work on black holes while I was still a sixth former, and it seemed beyond comprehension that I might somehow be permitted to study under the same roof as this god-like figure – or at least, if not under the same roof, in the same city. At that time, Hawking held the Lucasian Chair in Mathematics, the same position that Isaac Newton had occupied, and his reputation was growing by the year. He was on the brink of publishing the best-selling book, *A Brief History of Time*, and was making extraordinary progress in updating General Relativity by combining it with quantum mechanics; that success, together with his battle with motor neurone disease, had made him a strikingly prominent media figure. The documentary I had seen had showed him working closely with a wide range of young graduate students, cajoling and inspiring them as they worked together on theories at the very forefront of human knowledge. Could it be possible that this was what my future held?

Would I end up as one of Stephen Hawking's right-hand men, helping him solve the deepest mysteries of the Universe?

COOL FOR CATZ

The Cambridge interview is not to be taken lightly. I had two. The first was with a very pleasant Admissions Tutor, Dr Carl Baron. He asked me why, with my extraordinarily brilliant A level results, did I not wish to study to become a doctor or a vet? I can only assume he was looking at someone else's application form; with the mixed bag of As, Bs and Cs that I had, I'd have been lucky to become a chiropractor. I mumbled something about how much I loved physics and how the sight of blood would quite possibly make me retch.

My academic interview was, to say the least, hit and miss. I should explain that you can't actually study physics at Cambridge; in fact, you can't study any solo science subject. Everyone applies for one enormous mash-up called Natural Sciences, the idea being that you get a broad grounding in a number of sciences before specialising in your final year. I'd already registered my interest in physics, so my interview was with Dr John Shakeshaft, a physicist, and Dr Paul Raithby, a chemist. It started badly. Dr Shakeshaft asked me a very simple question about Newton's second law; I freaked out under the pressure and I came out with the only thing I could think of: 'We didn't do that at my school.' This is a bit like saying that no one taught you to shampoo at Vidal Sassoon. He tried another tack and asked me something about electromagnetism; I claimed never to have heard of that either. Out of sympathy, I think, Paul Raithby took two objects from his pocket and laid them on the table in front of me: a squash ball and a piece of hard plastic. 'If I told you', he said, 'that these two objects have the same chemical composition . . . '

I zoned out. I couldn't believe my luck. As it happened, that morning on the train from Cheshire I had been reading a crammer book about how to pass an Oxbridge interview, and that exact question had come up. The answer was all to do with molecular structure: in the case of the squash ball, the molecules were long, thin and springy, and loosely bundled together; in the case of the hard plastic, they were a rigid lattice.

I paused. If I were just to give the answer as I had read it that morning, wouldn't that be cheating? Outside, in the cold corridor, were half a dozen other hopeful eighteen-year-olds, each praying for their chance at academic glory. Didn't we all deserve a level playing field?

'I need to own up to something,' I heard myself saying. Silence. I blinked. 'We didn't do that at my school.' I looked Paul Raithby squarely in the eye. 'Though I am willing to have a crack at it . . . '

A letter arrived a few weeks later, offering me a place. I was as excited as I'd ever been, and for several nights slept with it under my pillow. I had achieved a life ambition: I had won a place at Cambridge to study physics.

In actual fact I was mistaken; what I had in fact won was a place at Cambridge to study chemistry. For on my first day in harness, I realised that my ambitions didn't necessarily tie in with those of my new college, St Catharine's. I presented myself to John Shakeshaft and announced my intended speciality. 'Really?' he said, with some surprise. 'But you gave such an elegant answer to the chemistry question. I'm afraid Paul rather had you down as one of his!' I begged to differ. 'But you didn't even know what momentum was.' An off-day, I explained. I lived for Newtonian physics. 'Very well,' he said with a sigh. 'Welcome aboard.' He didn't look up until I was nearly at the door. 'Mr

Miller?' I turned with great hope in my heart. Could this be the offer of a scholarship? 'What exactly *did* they teach you at your school?'

THE INTERESTING STUFF

Studying Natural Sciences was one of the hardest things I've ever done, and without any doubt one of the most rewarding. I was lucky enough to attend lectures by Stephen Hawking, Richard Feynman and Karl Popper, and to study alongside some of today's most prominent scientists. As far as the course went, we were thrown in right at the deep end, with Special Relativity, the theory where Einstein proposed that matter is a form of energy with his famous equation $E = mc^2$, which will come into play in the next chapter when we discuss the brand-new Large Hadron Collider at CERN. We synthesised deadly poisons so toxic that one drop would be enough to kill the audience of a medium-sized fringe theatre. We learned how stars and galaxies were formed – more of that in Chapter 3 – and what causes volcanoes and earthquakes and global warming, which I shall treat you to in Chapter 7. It's this little treasure trove of knowledge that I want to share with you in this book; my own little mix-tape of scientific greats. It's an eclectic selection. There are some tub-thumpers in there, no question, as well as one or two forgotten album tracks that I always felt deserved greater attention – but, without exception, each and every one of the goodies I've included is a bona fide classic.

By the way, a quick word about footnotes. Now and then I just couldn't stop myself from adding a little bit more detail, and rather than break up the flow I've tended to put it in a footnote. Sometimes they act as a sandbox for me to do a little bit of maths; sometimes they are just a handy place to park an anecdote; hopefully the book reads as well with or without them, so please feel free to dip in and out of them as you wish. If this book is about anything, it's about enjoying science on your terms, purely for pleasure.

NOVEL QUANTUM EFFECTS

I don't want to give the impression that my entire time at university was spent working; that would have been a dreadful waste. I spent a very enjoyable year as my college's Entertainments Officer, turned out for the Second XI football team and consumed an awful lot of what I can only describe as cooking lager. I was even instrumental in encouraging the student body to purchase a mirror-ball, which, I was very pleased to see at a recent reunion, still graces my old college's bar. Uncool as it may be, however, I adored my subject, and some of my happiest days were spent holed up in the library surrounded by textbooks, or in lectures hanging on the every word of the very men who had written them. I couldn't believe my luck. By the time it came to take my finals I was convinced my future lay in academic physics, and what better place to begin a PhD than the Cavendish Laboratory?

The PhD I signed up for was unfeasibly peachy; in fact, in 1988, it was one of the peachiest PhDs on offer. Professor Mike Pepper had founded the Semiconductor Physics Group ten years earlier, and it had grown to become one of the largest groups of its type in the world, employing some one hundred graduate students. It had something called a Molecular Beam Epitaxy Machine, which was able to make crystals of extremely high quality, and it had low-temperature fridges – huge great thermos flasks filled with liquid helium that were capable of reaching temperatures of a few thousandths of a degree above Absolute Zero.[1]

So: semiconductor physics. Most people have a good idea of what a conductor and an insulator are, but what, I hear you ask, is a semiconductor? A conductor, after all, is something that an electrical current can easily flow along, like copper wire. An insulator is something that electricity won't flow through, such as plastic – which is why, incidentally, we

1 Temperature is one of those funny things that seems very straightforward at the everyday level, but when you get into it is really rather odd. Whereas there's no limit, as far as we know, to how hot something can be, there is a limit to how cold it can get – because, at some point, you will have removed every bit of heat it is possible to remove. This is the temperature we call Absolute Zero, and it crops up at about –273°C. That's an unsatisfactorily random number, but, of course, at the time that we invented the Celsius scale we were looking for something that conveniently described the temperature range of water; 0°C being its freezing point, and 100°C being its boiling point. Once you have to deal with larger temperature variations than that, you tend to use the Kelvin (K) scale, where Absolute Zero = 0 K, and 0°C is, you guessed it, 273 K. The surface temperature of the Sun, for example, is roughly 10,000 K.

use plastic to coat copper wire, safe in the knowledge that if we touch the plastic coating we won't get electrocuted.

A semiconductor, as you might have guessed, is something that conducts electricity a bit; not quite as well as a conductor, and not nearly as badly as an insulator. The best-known semiconductor is silicon – the main component of sand, glass and quartz – and it forms the basis of a huge variety of electronic devices. You might have heard of 'Silicon Valley', a nickname for the Santa Clara Valley area of San Francisco, coined because of the number of electronic-chip manufacturers based there. One popular alternative to silicon is gallium, and the group that I joined was in the habit of making very pure gallium crystals, adding different amounts of chemical impurity so as to vary how well they conducted electricity, and sandwiching them together.

Do this right, and you'd end up with a two-dimensional electron gas at the interface between the two sandwiched crystals, where, if you could get the temperature low enough, the mean free path of the electrons – that is, the average distance that they travel before banging into something – was very large, something like a thousandth of a millimetre. (I know that sounds ridiculously small, but the average distance travelled by an electron in a metal like copper would be about a hundred times shorter.) My PhD consisted of making tiny gold patterns on minuscule chips of gallium arsenide; when I charged up the gold patterns with a variable power supply, I would be able to create little patterns in the electron gas underneath.

The pattern that I was most interested in creating was a dot, the point being that weird things start to happen when you put very small things like electrons in very small boxes; in fact, you start to see a whole new landscape of behaviour that is nothing like the way that objects behave on the scale of everyday life. This is the strange world of quantum mechanics, of which we shall learn a lot more in the next chapter. Running an experiment was a lengthy process; cooling a chip down to near Absolute Zero could take the best part of a day and would quite often destroy my dot pattern in the process. Often the experiments would run through the night. I spent many thrillingly silent evenings camped out with just my sleeping bag and a pile of cheese sandwiches, watching and waiting, and – ever so occasionally – seeing quantum behaviour at first hand.[2]

ABSURD PERSONS PLURAL

Before we crack on with the briefest of descriptions of how this book will work, I do, of course, need to address one question that will no doubt have crossed your mind. How is it, you may very well ask, that after studying so much science, for which I had so great a passion, I ended up in sketch comedy?

2 The working title of my PhD (sadly, never completed) was 'Novel Quantum Effects in Quasi-Zero-Dimensional Electron Systems'. If you haven't guessed it by now, 'quasi-zero-dimensional' is just a fancy word for 'dot'.

It's a hard thing to admit, but by the end of my first year as a graduate student I was beginning to recognise that, although I had a huge passion for the subject and a great deal of competency as an experimental scientist, I was never going to be in Stephen Hawking's research group. To put it another way, I was the physics equivalent of a session musician: technically able, perhaps, but it was never going to be my face on the album cover. At the undergraduate level it was fine just to be a fan of the subject – but, at the graduate level, it felt as if I needed to be leading the herd, not just following it. Somewhere, deep down, I couldn't help wondering whether I was on the right path. I'd never really tried my hand at anything else, and I was at a loss to know what to do.

Then, by chance, in the summer of 1989 the circus came to town.

The National Student Drama Festival was an annual event that toured the country, taking up residence at one or other of the British universities for a period of two years before moving on again. In 1989 it upped sticks and moved to Cambridge, and it just so happened that one of my friends at the time, Carole-Anne Upton, had landed the rather onerous task of trying to organise it.

Rather kindly, she offered me the opportunity to drive the judges around for the princely sum of £10 a day. Needless to say, I didn't have a lot of other offers and leaped at the chance. One of the perks of the job was being able to attend the workshops at the festival. The playwright Charlotte Keatley, author of *My Mother Said I Never Should*, was running one of the writing classes. Throughout the course of one very bizarre afternoon I found myself writing a sketch, having it performed by some actors and hearing an audience fall about laughing. It was a thrill like no other and I wanted in.

Unbeknown to me, Charlotte had taken up a residency at St John's College and had started a student writing group. When the festival ended, she invited me to join. Everyone else was writing rather serious plays about race and disability; I was the light relief, I think, and started to perform my sketches for the group. Slowly, I formed the idea that somehow, somewhere, there might be a future in it.

By the end of the following year I joined the Footlights, the university sketch society, as a writer, and was chosen to be one of the writer-performers in its centrepiece show, the summer tour. It was called *Absurd Persons Plural*, and during our run at the Arts Theatre in Cambridge, Griff Rhys Jones paid us a visit. He was incredibly enthusiastic and supportive, expressing an interest in buying some of the sketches from the show, one or two of which I had written. I started to get a trickle of work writing for *Smith and Jones* and even managed to wangle a bit part in one or two of the episodes.

A research group is a close-knit thing, and some of my extra-curricular activities were starting to raise a few eyebrows among my colleagues. This was in the early nineties, well before everyone had mobiles, and it was getting a bit embarrassing to be called to the department office with the news that it was my agent on the phone. When I landed a full-time job in Arthur Smith's comic play *Trench Kiss* alongside Caroline Quentin, which was booked for a month-long run at the Edinburgh Fringe, I decided it was now or never. After all, the delights of science would always be available to me, whatever career I chose, since – as I hope this book shall prove – the joys of science are open to everyone. Comedy, on the other hand, might not come knocking twice.

Quitting a PhD is a big deal, as academic funding is unpredictable at the best of times and having a student leave before submitting doesn't look great on next year's grant application. Nevertheless, at twenty-five, I was already getting on a bit if I wanted to make it in the fickle world of showbiz, and my thesis was going to take at least another eighteen months to complete. I decided to bite the bullet and tell Professor Pepper the bad news: that I was going to leave the Semiconductor Physics Group and make a go of it in the world of comedy.

I'm not sure who was more relieved, him or me. 'Good for you,' he said, beaming like the Cheshire Cat. 'Do you ever watch that show, *Whose Line is it Anyway?* Chap who plays the piano, Richard Vranch, he was one of mine. Used to wear a dinner jacket to the lab. Really brightened the place up. If you bump into him, do give him my best.'[3]

If I was in any doubt about whether or not I had made the right decision, I soon got the confirmation I needed. That summer I directed the Footlights tour, *Cambridge Underground*, which, just like *Absurd Persons Plural* the

3 Richard Vranch, incidentally, unlike me, did complete his PhD. Show-off.

previous year, played at the Cambridge Arts Theatre. Front row and centre for the opening night was my all-time hero, Professor Stephen Hawking. He seemed to be enjoying the show immensely. I may not have been able to join him at the forefront of human knowledge, but at least I could give him a ruddy good laugh.

A LOVE AFFAIR WITH SCIENCE

I am a big fan of science, but I am the first to admit that there are vast swathes of it that do nothing for me whatsoever. What gets me going – and what I suspect gets you going too – is the big stuff: DNA, black holes, aliens and the end of the Universe. So this book is going to do something that books about science very rarely do: we are going to eat the pizza topping and leave the crust. By the crust, I mean ticker-tape timers (if you don't know, don't ask), osmosis (what is it with biology teachers and osmosis?) and anything to do with oxbow lakes (possibly just me). We are not going to fuss over the detail, except where the detail is delightful. We are going to talk broad strokes. We are going to get fancy. You and Science are going to blind yourselves to one another's shortcomings and have a wild, passionate affair.

As you begin this new exciting relationship, I know that you are, in some sense, damaged goods. Science has hurt you in the past. Not to begin with, of course. As a child, you and Science adored each other. After all, what toddler doesn't marvel at the Moon and the stars, and boldly thump whatever buttons it can get its hands on at the Science Museum? But as you grew older, your relationship became more difficult. Despite your efforts to build bridges, Science confused you, patronised you or, worst of all, bored you. Meanwhile, the arts – with their wafty libertine wiles – seduced you shamelessly. Possibly there was peer pressure, which, for teenagers, can be hard to ignore. Science, giggled your friends, is 'uncool'. You tried hard to resist. Maybe, for old times' sake, you made one last attempt to make it work – you did science A levels, perhaps – and for a while you rekindled some of the old magic. Sadly it was not to last; you lost touch after university and have since become little more than strangers.

Science, for you, is Unfinished Business.

Of course, your old flame has little direct relevance to you these days. There is probably not much call in your everyday life to go off hunting for the so-called God particle, otherwise known as the Higgs Boson. Whether there are many Universes or not, the kids still need taking to school and the bills have to be paid. Whether or not we are all falling slowly into a black hole (incidentally, we are) there are pictures that need hanging and parcels to be collected from the post office. But there's a niggle. Some part of you just can't forget how exciting the world of science once was, and can't help wondering if maybe, just maybe, it might be worth tracking your old friend down for one last ridiculous fling.

Well, I'm here to help you do just that.

I'm not for one second suggesting that you and Science should have made a go of it. I think the choices you have made – the responsibilities you have shouldered, the life you have built – are sacrosanct. I just think that the two of you could benefit from some, shall we say, easy company. And so – at the risk of stretching a metaphor gossamer thin – intellectually speaking, consider this book as a spare key to my place in town. It's opulently decorated, the fridge is well stocked, and I rarely use it during the week. You and Science are both welcome to drop by any time. If anyone asks, I shall swear blind that the two of you were never out of my sight, and we spent every evening *à trois*, watching subtitled Eastern European films – or reading Virgil in the original Latin: whichever feels the most plausible.

I see a flicker of disapproval in your eyes. Please don't think me improper. I don't want to break up your happy home. In fact, I want nothing to do with your home. I simply suggest that, once in a while, in order to appreciate it all the more, you open a skylight and look up at the stars.

FIRST PRINCIPLES AND LAST CHANCES

So let's get down to business. This is a book about science.

Quite possibly, the thought of that excites you; equally possibly, it makes you want to run a mile. Either way, let me reassure you: from here on in there is nothing but pure pleasure. Every idea within these pages is just as thrilling as the concept that we are all made from dead stars, and nothing in it is going to be any more difficult to understand. And none of it is going to be even remotely like hard work; rather than trudge wearily to the top of a mountain of scientific knowledge, we are going to parachute onto the summit and ski down.

In other words, what I'm promising is something slightly different to the way these things are usually done. As you will know from the science you studied at school, and quite possibly from some of the popular science books you've had a spirited stab at, most science is taught according to a basic template known in the trade as First Principles.

The idea is to teach science from the ground up, starting with the basics (ticker-tape timers and graphs) and gradually adding complications until you get the full picture (Newton's laws of motion). It's the way that most of us were taught science at school and for the uninitiated it can often seem like some sort of cruel joke.

For example, take atomic theory. It went something like this: in our first year of secondary school, we were told that all stuff – trees and houses and small plastic models of David Tennant – was made up of ridiculously small particles called atoms and these were the smallest things you could divide matter into. The following year, we were told that actually there were plenty of things smaller than atoms, such as nuclei and electrons. The year after that, we were told that we had once again been lied to, and that nuclei were made up of protons and neutrons . . . And so the whole sorry story continued, right the way through undergraduate physics and graduate physics, until you began to (a) lose faith that any scientists actually knew what they were talking about; and (b) wonder whether the entire profession were inveterate liars and con-men.

Using First Principles in a book like this is, in my view, massive overkill in terms of what a non-scientist needs to understand. After all, if someone is interested in Formula One, you send them to watch a race at Monte Carlo, not to the University of North London to study the mechanics of the combustion engine. Those of us who wanted to be scientists studied the dry nuts-and-bolts stuff, the Newton and the uniform motion in a straight line, because we knew that the real treats (String Theory, multi-dimensional space, quarks and gluons) lay ahead – and, in order to be able to understand them properly, we needed the basics. If you want to build a Large Hadron Collider, you'd better hunker down and get a physics post-doc. If you want to gawp at one and imagine how cool it would be if it blew up . . . Well, you've come to the right place.

So that's the aim of this book: to throw you in at the deep end with lots of fully-fledged, fascinating science so you can learn on the job. Because it turns out that, although the thing that underpins all science – the maths – will be a closed book to us, lots of what scientists call the 'hand-waving' stuff isn't. After all, just because we don't speak the language doesn't mean we can't hang out for a couple of weeks on holiday and get by with hand signals.

What's more, as part of my covenant to you, I am going to give you the ultimate get-out-of-jail-free card. You don't need to understand anything. The purpose of other books may be to educate you, or provoke you, or challenge you; the purpose of this one is simply to entertain you. Relax. Breathe. There is no test. I want you to give yourself permission to have it all go right over your head, to grasp the odd fragment, to get the gist. If you find yourself reading a paragraph over and over again, unable to grasp it – and I'll be doing my level best to make sure that doesn't happen – then it's my fault, not yours; move on. This is not a science lesson. It's a science orgy.