'A delightful and scintillating hymn to science.'
CARLO ROVELLI

THE IMPORTANCE OF BEING INTERESTED

Adventures in Scientific Curiosity

ROBIN INCE

Foreword by BRIAN COX

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Foreword

Richard Feynman once wrote that scientists' most valuable transferable skill is a deep and intimate experience with doubt. It's difficult to motivate yourself to spend a life in research if you believe you know everything, and even the most self-confident research scientist will ultimately be humbled by their encounters with Nature. This is the best argument I know for maintaining at least a small component of science throughout every citizen's education. I once half-jokingly wrote that the PPE course at Oxford, studied in the loosest sense of the word by many a cabinet minister, should be rebranded PPES; perhaps brushing up against Nature occasionally would moderate their certainty. After all, as Feynman also pointed out, democracy itself rests on the acceptance that we don't really know how to run a society; that's why we change our politicians every four or five years. If you think you *know* how to run a country, if you think your policies are absolutely right and the other lot are absolutely wrong, you are not a democrat.

Robert Oppenheimer came to similar conclusions in his 1953 BBC Reith Lectures. Nature forces us to hold seemingly contradictory ideas in our heads in order to understand what we observe. A thing as simple as an electron is sometimes best thought of as a wavy, extended object and sometimes as a point-like speck. Crucially it is neither, but both pictures are necessary components of our understanding. Similarly, society may appear to be riven by tensions between the competing human desires for individual freedom and collective responsibility: but riven is the wrong word, because both desires are present in every individual and both are therefore necessarily present in society. The democratic process gently swings the pendulum one way and the other, and the swing is both the manifestation and guarantor of our freedom.

Your freedom, then, is protected by your acceptance that you might be wrong, and science is a sure-fire way of forcing you to practise being wrong. Which brings me neatly to my friend and colleague Robin Ince. He describes his role on *The Infinite Monkey Cage* as that of professional idiot. He means this in a self-deprecating way; indeed, he has elevated heartfelt self-deprecation to something of an art form. From his wardrobe to his gait, he radiates uncertainty. But, as I have argued, there is no more valuable skill. There are two categories of idiot: the curious idiot – a category that includes all scientists – and the idiot – a category that includes all who are certain. Robin is a category one idiot, and that's why he's an engaging and wise guide.

Robin's thirst for knowledge is unquenchable, and in these pages he engages in debates and conversations with a dazzling cast of great minds in search of a little enlightenment; not absolute enlightenment, because that's not on offer. We do not understand the human mind, we do not know what it means to live a finite life in an infinite universe, and we do not know whether or not there is a God. If answers exist, they reside in unknown terrain, and that's what makes them interesting. It's important to explore that terrain with humility and an open mind. It's important to be interested.

Brian Cox

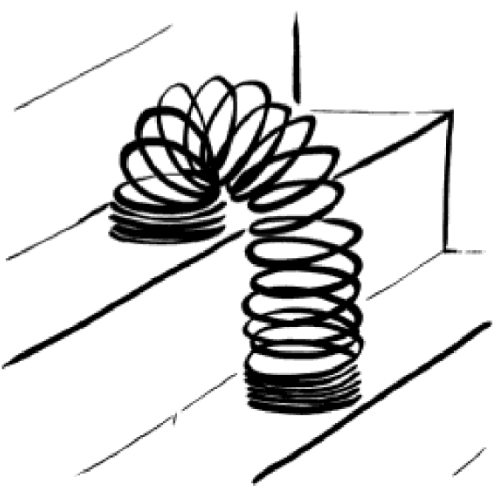
July 2021

INTRODUCTION

The Stars Your Destination

In studying how the world works we are studying how God works, and thereby learning what God is. In that spirit, we can interpret the search for knowledge as a form of worship and our discoveries as a revelation.

Frank Wilczek



The moment I put my hand in my school-blazer pocket and found it full of frog entrails, I already knew science was not for me.

As a young child, I loved science. Primary-school science classes were full of excitement, whether it was interrogating leaves or watching Robert Calvert see blood and then faint and smash in his front teeth. In secondary school, though, this joy evaporated. I think many people lose their interest in science at secondary school, and I was one of them. This is where science became serious, but also

where it became joyless. This is where the equations and explanations seemed detached from my own experience. Whatever science was, it was not *lived* experience. It was as if scientists only thought in sums. They didn't daydream and play. Each day they opened their box of numbers and symbols and moved them about until they were satisfied: 'I've carried the two and now I am satisfied that I have a testable wave function.'

That was predominantly how I felt about science at school. My curiosity about the world never went away – I just ignored it. I'd be thrilled to see an afternoon of art on the timetable, whilst to know that double physics was coming was to foresee time moving slower than Einstein could ever imagine. The division between the arty and the science subjects seemed jagged and high. The two cultures were clearly growing in separate Petri dishes.

Our physics teacher, Mr George, was a clever man, but the sort of person who didn't understand people who didn't understand. He was also easy to antagonize, and so the bullying, disruptive boys would hide his pens and see him explode apoplectically. They would giggle as he held back tears. It was a horrible sight, made worse after I read *The Lord of the Flies*, as I now knew exactly which of the boys in my class would be the ones shattering my glasses and throwing me off the cliff onto the rocks below. Putting frog entrails in my school-blazer pocket was simply the beginning of what might be possible.

My chemistry teacher had clearly lost interest many years ago. Biology had a little more pizzazz about it. There was the relative excitement of watching incubated locusts shed their skins. Then there was Mr Rouan, head of the department, who still had an enthusiasm about his subject and was always ready with a slightly inappropriate biological quip. I remember a nervous colleague of his embarking on sex-education hour, demonstrating how to use a condom with a broom handle playing the part of a priapic penis. The teacher's shaking hand lost its grip on the broom and it fell to the floor, just as Mr Rouan passed the doorway and made a rude joke. We all laughed loudly as we pretended to understand.

But mostly I remember the mind-numbing effect of an afternoon double-physics class, head on the desk, drooling over my exercise books as the teacher plugged away at speed and mass equations. A

dismal result in a physics exam, and an increasing sense that science was detached from the real world, finally put the nail into any delight in science. The tables where the science boffins sat had a strange aura of unknowable exclusivity. It was clear to me they had different brains. They understood this stuff. They were the Midwich cuckoos, otherworldly and somewhat threatening.

Now I wonder how on earth I ended up co-hosting *The Infinite Monkey Cage*, the long-running radio show and podcast. My early adult life was spent building a career in comedy, but sometime in my mid-twenties I bought a book about quantum physics. I didn't really understand it, but I realized that what I wasn't understanding was very exciting. I carried on reading books I didn't understand, with only small glimmers of occasional comprehension. I started to refer to some of the ideas in comedy routines, then I began to base whole shows around them, and from there it only seemed right to ask whether real scientists could join me onstage to make sense of my confused ramblings. This eventually led to *The Infinite Monkey Cage* with the physicist Brian Cox. Then I started joining him on tour, where he would explain high cones and holographic principles, and I would ask the dumb questions I realized I'd always wanted to know the answers to, and that others might be afraid to ask because they feared they might look stupid.

At the time of writing there have been 150 episodes of *The Infinite Monkey Cage* and it has covered everything from the theory of relativity and the Higgs boson, to how science proves that it is best to eat a pear with a golden spoon, and how to speak fluent chimpanzee. I have spoken to Nobel Prize-winning geneticists, *Apollo* astronauts, undersea explorers and one wizard. Such work has often meant that I'm in the fortunate position of usually being the stupidest person in the room. It's not always good for the ego, but it is very good for my education. W. H. Auden wrote that when he was in the company of scientists, he felt 'like a shabby curate who has strayed by mistake into a drawing room full of dukes'.[1] I am pretty happy to be the shabby curate. I've got the wardrobe full of cardigans, and I come from a long line of vicars, so I have that ecumenical gene.*

The way the guests on the show explain and talk about science – the way they make it relevant to everything about my daily life, my

existence here on this planet, the past, the present and the future – has rekindled my enthusiasm and widened my curiosity for a subject that died a death on the Bunsen burners of my youth.

I've realized, though, that whilst much can be made of what we have gained from scientific knowledge, for all the enthusiasm and passion of the scientists I speak to on the show, much can also be made of what has been lost. For some people, while science has given us the power to do things, to create, to control and to live longer lives, it has also delivered a longer life that now seems meaningless. Some say that science has robbed us of our gods, our exceptionalism, our centrality, our free will, and leaves us lost and alone in a vast universe. I can understand why some may feel this way, if they merely glance at the knowledge we have gained from science, but I believe that the deeper you explore science, the more our new knowledge creates rich stories, new enchantments and, rather than leaving us alone, connects us to everything. But I am getting ahead of myself; let's go back to the Garden of Eden and start again.

Did it all go wrong when we ate from the fruit of the Tree of Knowledge? Before then we were living in blissful ignorance, but then curiosity kicked in, and with that curiosity came questions and doubt. Some suppose that the universe was enchanting when we knew nothing of it. The lights in the sky twinkled because they were attached to a celestial sphere or shone through the holes of a heavenly curtain; but then they became nuclear reactors, shining as hydrogen became helium, some of them destined to collapse into something so terrible and mighty that even light could not escape. Your downfall begins the first time your face creases into a frown and you say, 'But why?'

'Don't ask why, just get on with it!'

The best way forward for some people is to stay exactly where they are. 'Ours is not to reason why…' Perhaps there's a fear that if we pull back the curtain, we might be disappointed by what we see. 'Pay no attention to that man behind the curtain. The great Oz has spoken,' says the charlatan in *The Wizard of Oz*, although the result of the revelation that the great Oz is simply a man with a megaphone and a smoke machine actually leads to satisfying answers for all on such issues as the heart and the brain.

Curiosity, in particular scientific curiosity, is dangerous to the powerful. Power often rests on certainties, and the scientific method encourages active doubt. There are warnings to the curious. As Oedipus found out, 'How terrible is wisdom when it brings no profit to the wise.'*

Questions can be seen as impertinent and dangerous. You may lose everything you hold dear – your god, your afterlife, your free will, your feeling of superiority, your mind… even your entire reality. Knowledge can be framed as loss rather than gain. It is a quandary I have been dealing with for the last fifteen years.

I often ask myself how scientists came to be doing what they are doing. Why weren't they bored to tears in their science lessons? Do their brains work differently? What do they see when they are explaining quantum indeterminacy? Are they born with scientific brains? Is the ability to understand supernovae or charm quarks somehow hard-wired? This was one of my first anxieties when I started making science shows. Was I allowed to think on such things? Did I have permission even to ponder these subjects, without qualifications? Scientific ideas can seem so daunting that they may feel both forbidding and forbidden. Any question from a novice like me surely has a high probability of being a stupid question.

It can be easy to believe that scientific ability is built into us by a quirk of nature – our genetics. If you find science hard, it is because your father found it hard, and your father's father found it hard, and you have inherited the 'not understanding cosmology' gene. This was how it seemed to me. I struggled with learning science at secondary school and ended up believing that I didn't have the correct configurations in my brain to check into Hilbert's Hotel or diagnose Schrödinger's cat. I don't think I'm alone in believing this; but that so many people should presume they are unfit for science perhaps suggests there is something wrong both with how we learn science and with what we believe it to be.

Even Carlo Rovelli, who is a founder of the loop quantum gravity theory and a writer of very beautiful books on physics, struggled with the tedium of some of his science education, but he was able to see beyond it. As he writes in his book *Helgoland*, 'What attracted me to physics was that beyond the deadly boredom of the subject taught in

high school, behind all the stupidity of all those exercises with springs, levers and rolling balls, there was a genuine curiosity to understand the nature of reality.' Fortunately I have found a way back into feeling a fascination about science, though I can assure you that I will not be contributing anything of any significance to loop quantum gravity theory.

I have totted up daily the pros and cons of confronting my ignorance, and I am pretty sure the advantages outweigh the disadvantages. Sure, it means I now live in a meaningless universe, by the looks of things, but existential philosophy was eager to tell me that, before astrophysics ever got involved. If you want to feel frighteningly alone in the universe, sit on a railway-station platform in midwinter, waiting for a train that increasingly looks as if it will never come, and read Jean-Paul Sartre: 'Every existing thing is born without reason, prolongs itself out of weakness, and dies by chance.' And then he doubles down on that with: 'It is meaningless that we are born, it is meaningless that we die.'* These are the sorts of aphorisms that would lose you your job in the fortune-cookie factory.

Professor Brian Cox is very fond of the words of John Updike: 'Astronomy is what we have now instead of theology. The terrors are less, but the comforts are nil.' But does this mean there are no comforts or consolations from science, bar perhaps the temporary consolation of medical ingenuity, spaceships and instant-whip desserts?

Sometimes it can be hard to start the day with a spring in your step when you have been made aware that you are merely a perturbation in the universe's wave function. The last few centuries have seen our uniqueness being whittled away – we are no longer at the centre of the universe, no longer a special creature separate from those grubby, ball-licking, poop-flinging animals. Like all of the rest of them, we are just a quantum fluctuation, although a quantum fluctuation that combs its hair and plays Scrabble.

Physicists usually seem the least bothered by such a demotion. I think it is because they see things either at an atomic level or wave-function level, and find the recycling of these patterns and subatomic particles satisfying enough. Biologists seem a little more concerned, perhaps because they observe things at a more molecular level and

smell the organic decay. Chemists generally don't have time for either position, as they are too occupied with wondering why people don't talk about chemistry enough. Chemistry is the middle child. First there was physics, the older sibling; finally there was biology, the spoilt child; and in between, chemistry came into the universe: essential, but often overlooked.

The physicists seem to have got so used to the indifference of the universe that they forget it might be news to other people, and they forget the need to break it to us gently. This can lead to nihilistic flourishes at public lectures and debates, which can be deeply disturbing. They bandy about our inconsequentiality and expect us to sit obediently, taking it all in. We are *just* a bunch of atoms. *Everything* is just a bunch of atoms – Chartres Cathedral, the Grand Canyon, a blue whale, Jupiter. Cancel your travel plans; you can simply stare at all the atoms that you have at home; they may well form something magnificent one day, so enjoy them while they take the shape of your desk-tidy or pan-scourer. It is like returning from a world tour and dismissing the Great Wall of China as 'just a load of bricks'.

Our experience and sensations are all down to nothing but firing neurons. You are merely calcium ions, firing away. Even our selfhood may be an illusion, as is our autonomy. We're on a humdrum planet. We're in a corner of the galaxy that is unexciting. Our galaxy is mediocre.

You can see why scientists don't always make the best motivational speakers, and why first dates can be tricky, because not everyone wants to know the number of bacteria living on the surface of their skin, before the starter. Yet again, though, it is the philosophers who most firmly bop us on the nose. The philosopher Bertrand Russell wrote, 'The universe has crawled by slow stages to a somewhat pitiful result on this earth and is going to crawl by still more pitiful stages to a condition of universal death.'[2]

Some may see such statements as cosmological honesty, but, like a work colleague who says, 'A lot of people in the office think you smell of Camembert stuck in a burnt-out clutch, and that your new haircut makes you look like Mao Tse-tung – just thought you should know',* such plain speaking can be upsetting and a source of despair

and depression, even if it might be true. 'I speak as I find, and I find the universe to be indifferent, and destined to end leaving no trace of human creativity or indeed any knowledge, love or beauty at all. And how was your day at the office?' If that has been your only experience of engaging with science, then I can see why many people decide not to return to it, but in my view that is in fact why it is worth sticking with. First may come disillusion, but then comes reenchantment. Some discoveries hit harder than others, but if you can get through that existential pain barrier, there are things on the other side (I am not one for running marathons, so I work out at the library instead).

With our loss of exceptionalism, there is also a gain of connection, and these connections can be found across scientific disciplines. You are not alone up on your Olympian heights; you are joined up to everything, and the loneliness of uniqueness is replaced with a new cosmological camaraderie. A scientist's pessimistic realism is often the most coherent and quotable way of accessing their work, but after the humdrum, after the 'cold and indifferent', comes a big BUT…

I believe that within much of what can seem to be negative or pessimistic about our universe, there are many possible theories that can propel us, that drive us to find our own meaning and consolations – and hopefully that is what this book is about. You don't have to depart from reality to find happiness and purpose. There are meanings in all this fragility; there is wonder and delight in all these doubts. Detaching yourself from certainty does not mean you must feel lost and bereft. The problem with ultimate truths and utter certainties is that they can get in the way of your adventures in ideas and can possibly block paths altogether. Accepting that the inevitability of life must be attached to the inevitability of death should sharpen the senses and the need to experience. The realization that to love is also to commit to loss is what magnifies that love.

Facing the realities of what scientific endeavour can tell us about the universe, and ourselves, can seem like facing up to the loss of things we have relied upon or held dear, but with the losses come gains that outweigh them, even if they are not always immediately apparent. I think the realization that there is no grand meaning to us – that we are not born with meaning stamped on us, but must strive for

meaning, in all its tentativeness and potential fragility – makes it far more vital.

And yet for all these grand philosophical ideas about meaning, returning to actual engagement with science and scientists can be a bumpy road. Sometimes, many years after last burning your fringe on a Bunsen burner, reopening a science book can be a disappointing and frustrating experience. You start to read a book about quantum theory because, bizarrely, someone said it would help you understand how things may be alive and dead all at once, which sounds amazing; and you'd also really like to understand that Christopher Nolan film you have watched three times now. Dismayingly, though, as you plough through the book, it gets more and more complex, you fail to understand superpositions and entanglement, nothing seems to relate to what you really wanted to know; and you end up throwing your arms up in the air and presuming that you're stupid and, once again, simply do not have the brain required. Sometimes the voice in my head shouting, 'YOU DON'T UNDERSTAND THIS!' is so loud that I can't even hear the sentences I am reading.

At times the words on the page can seem to have a life of their own, independent of the reader. I have often found myself rattling my skull, desperate to work out where all the information that I have just read has gone. Was each sentence like a neutrino, passing through my eyes and skull without ever interacting with my brain?* Even if it does begin to make an impression, some of what you start to understand is aggressively counter-intuitive. Cosmological common sense seems to be in limited supply. For instance, it took me a very long time to get my head around the idea that there are 200 billion stars in our own galaxy alone.* Every time I said it out loud, I presumed I would be openly mocked.

Then I found out that many astronomers believed there were more galaxies in the universe than there were stars in our galaxy. Then I was told that the size of the universe could be infinite, which means there is someone else across the universe who has just read 'the size of the universe could be infinite, which means there is someone else across the universe who has just read "the size of the universe is infinite"' – and they have a head and life exactly like mine, or I have

one exactly like them: different atoms, same life. That goes for you, too. And you.

That there is nothing special about me means that there are an infinite number of *me*'s. There are an infinite number of *you*'s, too. Then I read that we have to say '*our* universe', because we are probably one of many universes. I bump into a quantum physicist who is keen to tell me about 'many-worlds interpretation', where everything that can happen does happen and, at the point of each potential event dividing, more worlds are created to allow all possible outcomes to occur. Now you have a multiverse of many worlds.

Another cosmologist butts in and tells me about the 'holographic principle' of black-hole thermodynamics, which suggests that all physical objects – including ourselves – are actually two-dimensional projections from somewhere else. On top of all that, I am still trying to get my head around the idea that my head, and everything else in the vast known universe, used to fit on the end of something smaller than the prick of a pin. Actually, even smaller than that – a sort of nothing-whatsoever size. Everything I have ever imagined was contained in something of infinite density, but no mass.

How could that be? I find it hard to close a suitcase if I try to put a spare pair of shoes in it, let alone a spare plant, hat stand or galaxy. It can all seem like the fevered imagination of a speed-pepped science-fiction author fearful of missing his deadline for *Astounding Stories*. You can see why people might shy away from science – never mind the numbers. It feels utterly absurd.

But if the universe was easy to understand, it would be a very boring place. When you see the professional public scientists broadcasting, they often seem sure, certain and infinitely polymathic. This is why some of the most important moments to watch out for may be when you see the scientists perplexed. When faced with a question to which the scientist's reply is 'I don't know', we can feel immensely relieved, but sometimes this can be followed by excitement. 'Now you ask, let's see if we can work it out!'

I remember standing with a physicist in front of an audience of 4,000, trying to work out how a Slinky moves downstairs. We came up with interesting answers, both of which were wrong, but even getting to the point of error was fun, and hopefully many people went

home from that event, found their old Slinky and started their own research work. It hasn't just been Slinkies, though; it's been thinking about the edge of the universe, about the possibility that we are the only intelligent life in the universe (and that may well not be intelligent enough) and about the Sun swelling into a red giant. Sometimes such pondering is playful, and sometimes the air of doom becomes sweltering. And that's really been my inspiration for this book.

When I first started re-engaging with scientific ideas, it was easy to get lost. It still is. It is a big universe and there are many ideas and theories about it, but the anxiety of not knowing where I am is not as jagged and forbidding as it once was. Scientific progress and development can fill people with confusion and fear, and it can challenge their most deeply held beliefs and connections, but I have lived to tell the tale and to want to learn even more stories. My mind has been repeatedly blown by the images and ideas offered by scientific thought and enquiry, and I am glad. I am getting used to doubt, and I am inspired by the seemingly inexplicable. I don't need a quick fix any more. A little knowledge is only a dangerous thing if you think it is enough knowledge.

Brian Cox once wrote, 'A little existentialism never did anyone any harm.' But when I asked him about this, he admitted that he didn't think he had ever experienced any existentialism; he simply imagined it might be useful for people who did. I am the anxious one in our partnership. Our temperaments are a cliché of art versus science. I am the fraught, antsy bag of nerves, while he coolly wanders towards the certainty of his own demise, safe in the knowledge that his atoms will survive, even if he doesn't. Brian wouldn't rail against the dying of the light; he would simply capture the light in an equation.

I believe that almost any loss that comes from the scientific adventure carries with it great gains, too – not merely pragmatic, but also enchanting and transcendent ones. Whatever idea seems to rob you usually contains a reward as well.

I wrote much of this book during the first lockdown of the Covid-19 pandemic. A positive outcome of the pandemic for me, in this regard, was that a number of people who would never usually have

been available were kicking their heels at home, so bored that they talked to me. When I look at the wish list that I drew up at the beginning of 2020, the only person I failed to talk to was the film director David Cronenberg and, to be honest, it wasn't so much that I needed to talk to him for the book; I just love *The Fly*[*] and I thought I could add a few paragraphs to the chapter on biology, dealing with the current genetic understanding of human–fly hybrids, which can be the outcome of drunken use of a teleport. As I talked to all the different contributors to this book, I have found the picture of the universe around me changing frequently. I think one of the purposes of bold human endeavours – whether scientific, philosophical or artistic – is to change how we see what we see, and possibly change ourselves with that.

Changing your mind is not always easy. These days, particularly across politics and on social media, it is easy to find people who would rather be aggressively certain than tentatively contrite or in doubt. Many seem to believe that it is better to be solidly wrong than wavering towards being better informed. But a common theme with the many people I spoke to was the need for inquisitive humility rather than righteous brutality, if we are to progress. And with that humility comes the need to interrogate yourself as much as you interrogate other people and to ask, 'Why do I believe what I believe? What foundations am I standing on? And why do I favour them?'

We need to know who we are, in order to find out who we can be; to refute pointless barbarism and squabbles and build a world on common ground and collective understanding. I also believe that the more we confront the meaninglessness of the universe, the greater our ability to create our own meaning. I have tried to deal with the areas of understanding that have robbed us of our more comforting myths, but this has not robbed us of stories. The universe is still made of stories, and they have the comfort that they may well be true, too.

So I hope this book can do that for you. I hope you find something in it to enrich your picture of the world, or that you find some new enchantment on what might have seemed to be barren land. From my very first interview with the astronaut Chris Hadfield, a human who has watched the world turn beneath him, to my last interview with Carla MacKinnon, an artist whose experience of sleep paralysis

means she has felt night-hags squatting on her chest, the shared underlying message of so many people has been that the more we explore and the more we learn, the better our questions become, the greater the adventure and the more connected we are, whether it is to supernovae or to octopuses. Life becomes easier to live when you start to understand it, when you don't ignore the questions, when you don't try and paper over your confusions, but open up to them.

By becoming acquainted with scientific curiosity, by learning and understanding from it, I believe we can be re-humanized rather than dehumanized. Perhaps we can be as beguiled by reality as we can be beguiled by myth, and can find room for both.

> I am extremely timid, sensitive, impressionable, and with a great sense of mortality, lazy. Yet inside me there is another self completely unmoved by all of this, full of power and light.
>
> CECIL COLLINS

> Not explaining science seems to me perverse. When you're in love, you want to tell the world.
>
> CARL SAGAN