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THE PHILOSOPHY OF TIME: DOES PHYSICS HAVE THE LAST WORD?

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Good evening, ladies and gentlemen, fellow time-torn creatures, fellow transients, it is a privilege to be giving one of the Gresham College Lectures. I am going to say one or two things this evening about the nature of time. More precisely, I am going to talk about some themes in a particular book on Time, *Of Time and Lamentation: Reflections on Transience* whose handsome cover you can see on my presentation [please refer to slides under 'extra lecture materials']. More precisely still, I am going to discuss just a few themes from the book.

Let me say something about the genesis of the book and the wider background of ideas behind it. It goes back a long way – to my school days when I was both irritated and intrigued by the conversations of those of my fellows who had televisions. Alas, our family did not. There was much talk at school of Herman Bondi's famous series of popularising lectures $E = mc^2$. These were on cosmology, on general relativity, and time travel and so on. Behind them was the assumption that physics had the last word on time, however counter-intuitive and paradoxical its conclusions. If you want to know the time, ask a policeman as the song went; but if you wanted to know what time is, ask a physicist. I knew this was not right but I could not say in what respect.

When I started writing philosophy seriously, I focussed on the philosophy of language, of mind and of consciousness. I also devoted or wasted a decade or two on combating various philosophical illnesses such as Neuromania – the idea that you are your brain – and Darwinitis – the notion that human beings are essentially evolved organisms and that persons are to be understood in biological terms.

Towards the end of the 90s – the 1990's not the 1890s – it became apparent to me that what I was most opposed to was naturalism, the idea that humans are essentially pieces of nature, and both subject to and explained by the laws of nature; and that the way forward for human self-understanding was to see ourselves through the lens of the natural sciences. This was seen – mistakenly in my view - as liberating, because it was thought to be the only, alternative to supernaturalism – an essentially religious account of the origin of humankind, of our nature and of our place in scheme of things. It has seemed to me, however, that there was a task for humanism, and more generally secular thought, to develop an image of ourselves that was in thrall neither to theological stories nor to scientism – the idea that natural science has the last word on what we are.

I pursued this goal primarily by means of philosophically informed descriptions and meditations of items such as the human head, and the hand of the metamorphoses of hunger in our lives, of gestures such a pointing and of our lives seen through the rear mirror of death, from the standpoint of our corpse. These were indirect ways of reminding ourselves how our ordinary, daily life was utterly different from that of even our nearest primate kin. It was a celebration of what Karl Marx in his early writings – before he discovered Communism - spoke of as our 'species being'.

The main target hitherto of my anti-scientism – not to be confused with being anti-science which would be absurd - was the misuse of biological science to create a distorted and impoverished image of ourselves. I was, however, conscious that behind biology there lay a bigger beast: physics. Physics is, of course, wonderful: it can lay claim to be our greatest cognitive achievement and the wall-to-wall landscape of artefacts that makes our



lives safer, longer, more comfortable, and more fun should command our gratitude as well as our awe. But the increasingly loud claim that we are heading towards a theory that explained everything in the universe including ourselves is worrying. The view that physics was going to provide the final answers has been expressed most clearly by Nobel Prize winning physicist Steven Weinberg:

The explanatory arrow points downwards from societies to people, to organs, to cells, to biochemistry, to chemistry, and ultimately to physics. Societies are explained by, people, people by organs, organs by cells, cells by biochemistry, biochemistry by chemistry, and chemistry by physics.

The consequences of believing this were also set out by Weinberg:

The more we know of the universe, the more meaningless it appears.

This is not only unappealing but also, I believe, untrue.

For this reason, I re-directed my attention from biologism to this mode of scientism that draws its authority from physics. In particular, I focussed on the physics of something central to human life; namely, time. And so I arrive back at *Of Time and Lamentation*. Well, not quite. The book is in three parts: Part 1 is 'Killing Time', Part 2 'Human Time' and Part 3 'Finding Time'.

In the first part, 'Killing Time' I examine what physics does to time and indeed to our understanding of the nature of the world. I focus in particular on the reduction of time, in physics, to something called 'little t'. Little t is a pure quantity and it is one of four dimensions, the others being the three dimensions of space. The discussion of time as little t – which should be seen for what it is, namely a mathematical abstraction – is jumping off point for a wider investigation of what I call the exsanguination of the world in scientism, that sees the sum total of things as a system of magnitudes. This has no place for actual experience, values, meaning or purpose. It not only excludes humanity from something central to our lives – namely time – but it also empties space as well by reducing places to decimal places. And finally in this section I discuss the relationship between mathematics and reality, a hotly contested topic and something which could be the theme of a whole talk. In passing I deal with tasty questions such as how did we come to think of time as a space-like fourth dimension, is there such a thing as the passage or flow of time, does time have a direction and is an arrow of time, is time travel possible, are the paradoxes of relativity theory real, and what is meant when we say that clocks tell the time?

The chapter on clocks addresses the question of how we know one clock is more accurate than another. If we appeal to a third clock to settle the matter, where does that clock get its authority from? The answer is less obvious and more interesting than the question might suggest. The authority of clocks has two main sources. Firstly, there is the level synchrony between different types of clocks. Atomic clocks remain in more precise synchrony than pendulum clocks. But secondly and more importantly, the discovery of laws enables periodicities to be predicted independently of direct measurements. The laws themselves have a predictive precision that goes beyond any actual measurement. For example, the law of gravity was verified to an accuracy of 4% by Newton and has recently been verified to be accurate to less than 1/10,000 %. Time measures are embedded in, and hence validated by, fundamental laws of mechanics. So comparing clocks is not like buying 2 copies of the *Guardian* to see whether the news is true. What, however, it does underline is that time in physics is time reduced to a pure quantity – time as 'little t' as a number of units – as part of a world reduced to a system of magnitudes. I shall return to this.

In Part 2, human time is centre stage. At the heart of human time is something that physics cannot accommodate: namely, tensed time – the past, the present and the future. Einstein – here not played by Geoffrey Rush – famously argued that tensed time – the time of past, present, and future – was not real. He even wrote to this effect to the widow of his oldest friend Michele Besso to cheer her up:



Now Besso has departed from this strange world a little ahead of me. That means nothing. People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion.

Albert Einstein

Later in his life he admitted that this worried him, as reported by the philosopher Rudolf Carnap:

Once, Einstein said that the problem of Now worried him. He explained that the experience of the Now means something special for man, something essentially different from the past and the future but that this difference does not and cannot occur within physics.

That this experience cannot be grasped by science seemed to him a matter for painful but inevitable resignation.

He could have been spared this worry had he just accepted that there are aspects of time – fundamental aspects of time – that lie beyond the reach of science and, indeed, are irrelevant to what science is concerned about, though they are central to our human experience. In short that physics does *not* have the last word on time though it has many important and useful things to say about it.

And so, after a defence of the reality of tensed time - against most physicists (and also to their undying shame quite a few philosophers) - I examine each of the tenses. I begin with the present which proves to be immensely rich and in some respects paradoxical: it is at once elusive and inescapable: you can't get hold of it and you can't get away from it. Its elusiveness was highlighted by St. Augustine.

[The present] is a point of time so small that it cannot be divided into even most minute particles of moments...Such a time must fly so rapidly that it has no duration and no extension.

St Augustine

There is a long and I hope enjoyable discussion of 'now' - of the present teeming moment that escaped Einstein and indeed St. Augustine. It has depths and widths and multiplicities that have nothing to do with the durationless temporal points of little 't' to which physics reduces time and Augustine reduces the present. Exploring the nature of 'now' also offers a wonderful way of illuminating the teeming complexity of our supposedly ordinary consciousness. No wonder Piglet told Pooh that today was his favourite day. Here, here Winnie.

And so to the past. My exploration of the past starts off with the wonderfully poignant line from the late mediaeval French poet Francois Villon's *Ballade de dames du temps jadis* when he wonders what happened to the ladies of negotiable affections – sex-workers I think we call them nowadays - with whom he spent much of his mis-spent youth: *mais ou sont les neiges d'antan* : where are the snows of yesteryear? The past is deeply mysterious because it is the presence of that which is, by definition, no longer present. It also has many layers – from the earlier stage of a process that is still going on like the present talk, to the past of yesterday, of our childhood, of historical time, geological, and astronomical time. Thus there are the different pasts of immediate recall, of distant memory and of facts, private, public, and historical pasts. The primary curator of the past – human memory – proves to be entirely mysterious and none of the existing models offered by neuroscientists do anything to diminish or even address its mystery. I introduce readers to the concept of the double intentionality or aboutness of memory. Memories are about (or of) experiences that are of (or about) events in states of the world. In this chapter, I also take the opportunity to combat presentism, a view held by many philosophers that only what is present exists or is real and the past and future entities are not real. Presentism is a perfectly harmless 'ism' – nobody was murdered in its name. However, it produces all sorts of unnecessary difficulties; notably, when we try to explain why some statements about the past are true – such as Socrates was a Greek – and others are not – such as Socrates was Welsh. If there is nothing corresponding to Socrates how can we say 'Socrates is Greek and not Welsh'. The presence of the past lies in its consequences, including records of it. Those consequences are traced to their origin in the past by human consciousnesses and that past is thus



resurrected. No such resurrection is possible in the physical world. The physical world at a particular time is the sum total of the physical world at that time. There is no basis for digging up the past and making it live. Its effects are there in the present; only in humans are those long-completed causes also present as objects of memory and record.

The next stop is the future. Among the questions that I address in the chapter, two are paramount. The first is, how can tomorrow be present today? Or in what sense is the future real? The second is one that has exercised philosophers since the ancient Greeks: whether what is going to happen in the future is predetermined and already fixed (or not). There are familiar fatalistic arguments arising out of the fact that the laws of nature seem (by definition) unbreakable. Everything, surely, must unfold along the tramlines they set down. At the heart of our freedom is our capacity to turn time upside down. We turn time round on itself. We reach for causes to bring about effects. The present is shaped by possibilities which we envisage happening in the future. We make this envisaged future drive the present. At the heart of our freedom is the ability to envisage possibility – and possibilities lie outside the scope of physics which, of course, describes actuality. Our freedom lies in our ability to stand outside of the time at which our material bodies are located: we project ourselves into an explicit future (which may be individual or shared) that draws on and equally explicit past (which likewise might be individual or shared). It is this *tensed* time that we have which accounts for our otherwise inexplicable capacity to act freely and to be truly the origin of at least some of our actions and hence responsible for them. The world according to physics has no space for tensed time – the past, the present, and the future – and so it cannot explain, indeed seems to disprove, our freedom. But, as Einstein admitted, this not a proof that we are not free but that physics is incomplete as an account of what there is.

The other form of fatalism was originally suggested by Aristotle when he argued as follows. Either a sea battle will take place tomorrow or it will not take place tomorrow: one of these must be true. If it is true then it must be true today. So the whether there is or is not a sea battle is foreordained. There is clearly something wrong with the argument but tracking it down takes us to all sorts of places and there are fiendishly complicated and delicious fun to be had on the way. One for our discussion I hope.

The fourth and final stop is eternity which proves, even to a secular humanist such as myself, an extraordinarily rich idea. It is possibly the most profound idea that humanity has ever had with the exception of the idea of God, who is of course eternity's star inhabitant.

In Part 1 I rescued from the jaws of physics and in Part 2 restored human time to its rightful, that is to central, place. In Part 3 'Finding Time', I address the question '(What) Is Time?', examine the relationship between time and causation – which has been called the 'cement of the universe' – and finally demonstrate the connection between time – in particular, tensed time – and human freedom.

In '(What) Is Time?' I endeavour to clarify what time is, the nature of the beast, though I suffer an honourable failure to arrive at a non-circular definition of time – as I will explore with you shortly. I also investigate the stuff of time – moments and instants. I look at the relationship between time and change and examine whether there can be change without time or time without change. And I oversee a battle royal between those who say that human time is primary and others hand the palm to clock or astronomical time. The answer to the question is extraordinarily complicated and best represented by this figure – the ouroboros that swallows itself.

The final two chapters are devoted to examining the relationship between time, causation, and human freedom. In the first part of the book, I dismissed the idea that time had a direction – that there was an arrow of time. The most commonly cited source of the supposed directionality of time at least among philosophers is the relationship between cause and effect: causes must occur before their effects and this ordering forms the basis of the arrow of time and it is this that underpins the difference between before and after. The idea of a cause, however, proves to be very elusive and I hunt it down over many pages and then feed it to the hounds. The quest also creates the basis of a new perspective from which it is possible to see how we humans – who turn events into handles to cause other events – are truly free. That, then is gallop through some of the territory covered in *Of Time and Lamentation*. You are, of course, entitled to more than a prospectus for a book and so



before you ask for your money back, I would like to pick up one or two themes of the book with you. They are: ‘What is time?’, ‘Time as the fourth dimension’, ‘The seductive myth of time travel’ and the idea of ‘the flow of time’.

So let us begin at the beginning. What is time? We recognise that time is intrinsically complex: there is temporal location – when did such and such an event happen? – temporal order – in what order did events take place – and temporal duration – how long did such and such an event take? And then, as I have already emphasised, there is tensed time – namely past, present, and future. So how shall we define time? Here’s a few goes.

Definition 1

Time is our perception of the sequence of events.

This doesn’t work. The sequence of events, implies the *temporal* sequence of events. So the definition boils down to ‘Time is our perception of time’ or ‘Our perception of temporal order’. This doesn’t seem to get us very far. Worse still, it is deeply contentious because it implies that there would be no time in the absence of perception of sequence of events. From this we would conclude that there is no time prior to the emergence of conscious beings. But we know that conscious beings are rather latecomers in the history of the universe. Prior to conscious beings there was the Big Bang, the formation of the planets, including the earth, the emergence of life and, finally, the development of conscious life. This is not merely a speculative empirical order of events. It is *logically necessary* that the Big Bang should occur before the emergence of conscious life. So let’s try something else.

Definition 2

Time is what stops everything happening at once.

This, perhaps jokey, definition of time is also circular. ‘At once’ means ‘at the same time’. Another, connected, but less jokey definition is

Definition 3

Time allows change without contradiction

If I say that Raymond Tallis is in Stockport and Raymond Tallis in London that seems like a contradiction unless I add that Raymond Tallis is in Stockport at one time and in London at another. This makes time permissive of change. There are problems with this. The most important is that the permissiveness of time is dangerously close to the notion that time has causal powers.

Indeed, many philosophers have argued in favour of this idea that time is defined by the direction of causation. The eminent philosopher of time Hugh Mellor, for example, has stated that:

Definition 4

Time is the causal dimension of space-time

There are many reasons for rejecting this idea. The most important are that if time were a cause in its own right a) every change would have two causes – time plus the preceding event that brought it about, the cause in the usual sense; and b) time, being homogeneous, would not favour one event rather than another, and hence could not have a part to play in the occurrence of any particular event, in directing the unfolding of things. What is more, causes must always precede their effects, so we must assume that time is in place before we can have causal sequences. So let’s try again. Another slightly jokey definition is



Definition 5

Time is what happens when nothing else does

It is what is left when events are drained from the world. This is wrong because it assumes: a) that time can be separated from change; b) that it is a kind of substance; or, worst of all, c) that time itself is a kind of happening or process. We can examine these assumptions in discussion if you like but I would put it to you that they are ill-founded.

Definition 6

Time is the Direction of Becoming – of the overall changes in the universe.

There have been numerous attempts to equate time with certain universal characteristics evident in the way the world unfolds. These are the so-called arrows of time that I referred to earlier. It is noted that the passage from earlier to later is associated with

- a) Increasing entropy – the world gets more disordered untidy with increasing time. This is illustrated by the example of dropping an egg. If you filmed an egg falling to the ground and smashing into pieces, you could tell whether the film was being played backwards or forwards. Messes happen, the world gets increasingly untidy; messes do not unhappen, they do not tidy themselves up.
- b) The difference between memory and anticipation – we can recall the past but only guess at the future
- c) Increasing information – as the universe gets older, there is more to be known about it.

Each of these only serves to illustrate the circularity in the characterisation of time. The observation that the universe is more disordered at later time than at an earlier time presupposes that we already have in place the notions of later and earlier. Millions of words spent on time's arrow could have been saved had that obvious fact been noted.

It will be clear to you by now that time seems to resist being reduced to anything else. I mention all these failed attempts to capture the essence of time to persuade you that any attempt to define time in non-temporal terms, in a non-circular way, will be doomed. This is expressed by the philosopher Quentin Smith:

Time is neither causation, motion, physicality, mentality, nor anything else. Time is time. Time is a series of items related by *primitive* and *irreducible* relations of earlier, later and simultaneous.

It may not be possible to define time – other than by saying in all sorts of elaborate ways that time is time. You may think that that was not a conclusion worth waiting for or paying good money to hear. But to reaffirm that time cannot be reduced to, or translated into, anything else is a way of affirming its irreducible reality. This is something that many physicists and some philosophers have difficulty with. Indeed, some of them think that they can do without time in developing a theory of everything because time boils down to something else. Arguing that time is irreducible to other things and cannot be dispensed with in any theory of the universe that is worth having is itself a conclusion worth having. However, it leaves a lot of work to be done, some of it characterised by the philosopher Craig Callendar :

In philosophy, time has always been an especially challenging topic. At root, the problem is the quintessential difficulty that so often motivates philosophical discussion: the problem of disentangling the nature of the entity from the features that we happen to attribute to it.

Craig Callendar

So even if we cannot say what time is – other than it is irreducibly itself – there is serious work to be done in saying what it is not and scraping off the metaphorical accretions that have gathered round our idea of time. The



most potent of these metaphors for time is to describe it as a dimension; more specifically the one you will be familiar with: time as *the fourth dimension*. This will bring us squarely back to physics and its failure to do justice to time.

Seeing time as the fourth dimension is central to the physics of time. The first three dimensions belong to space. The spatial dimensions are up-down, side-to-side, and front-to-back – x, y, and z. Time then becomes ‘little t’. This exposes it to all sorts of indignities, that real stretches of time would not tolerate. It can be multiplied by itself; placed under space to get velocity; and even multiplied by the speed of light. Imagine multiplying a night with a crying baby by itself, putting a Bargain Break Weekend in Bruges under some spatial distance, or multiplying the duration of a medical career by the square root of -1.

Time as the fourth dimension is like D’Artagnan added to the three musketeers. By joining the club in which it is outnumbered by spatial dimensions, it becomes spatialised. It is also represented spatially in graphs. Here it is as the horizontal axis. And then, of course, the traditional ways of representing time tended to be spatial: sands moving in a timer, shadows moving over the dial of the sundial, fingers moving over the face of the clock.

It is a fundamental mistake to spatialise time because there are profound differences between space and time. These are some of the differences that have often been invoked: space does not flow while time does; space does not have a direction – it is after all the sum total of the *possibility* of directions while time does; space has three dimensions and time only one; and, finally, we can travel in space but not in time. In fact, two of these disanalogies are invalid – fake news. Time does not flow any more than space does and I’ll talk about that presently. And we have already disposed of the idea that time has a direction – the arrow of time.

What of the other two differences? I have already mentioned that space has three dimensions and time has or is only one. Equally clear is that it is possible to travel in space but it is not possible to travel in time. I can travel from Stockport to London when I fancy and I can choose my ‘here’. I cannot travel to 2019 or choose my ‘now’. I have no choice over my ‘now’ being this evening 10th April 2018. I can go to any here but not to any now. However, the spatial representation of time seems to have had the effect of licencing the idea that time travel is possible. So where does the myth of time travel come from and why is it so seductive?

There is a famous defence of this idea in a passage with which many of you will be familiar from H.G. Wells

“Clearly”, the Time Traveller proceeded, “any real body must have extension in *four* directions: it must have Length, Breadth, Thickness, and – Duration... There are really four dimensions, three, which we call the three planes of Space, and a fourth, Time... *There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it*”.

There are, of course, entirely respectable modes of time travel. There is a sense in which everything is travelling in time. This room is today in Tuesday 10th April and tomorrow Wednesday 11th April. Strictly, this is mere movement in time rather than travelling in time. Travelling is something voluntary and I cannot stop this kind of time travel. Less banal is the mental time travel afforded by memory, particularly episodic memories of past experiences or factual memories of the historical past. I can, as the saying goes, cast my mind back at will to today’s delightful journey down to London. And I can be transported back to the Battle of Hastings by a racy account of what happened. Forward travel in time is more contentious. I can anticipate what will happen next week but, since it has no obligation to happen, however eager my anticipation, my time travel into the future may turn out to be an internal affair of my consciousness.

The time travel I am thinking of, and which has launched a thousand space-ships, has been defined by the philosopher David Lewis:

[Time travel] involves a discrepancy between personal time and the world’s time...The separation in time between departure and arrival does not equal the duration of the [time traveller’s] journey.



Forward time travel would be (say) getting to next Wednesday when, so far as the rest of the world is concerned, it is still Tuesday. And all backward movement is genuine time travel since the world is going forward. Travelling to last Wednesday or 1066 would amount to occupying a personal time that was at odds with the world's time.

So why is time travel, so beloved of science fiction writers? Fundamentally, it is because of something I have already referred to: a false analogy between space and time that deludes us into thinking that a) since time and space are both dimensions and b) since we can travel in space, we must be able to travel in time. If I can go back and forth along a spatial line, why can't I go back and forth along a temporal line? The answer is that time is not a line, though is usually represented as such in natural science. But I owe you more of an explanation of the impossibility of time travel than that.

In the book I divide my critique of the very idea of time travel into three parts: the troubled journey; the difficult arrival; and finally, the necessary impotence of the time traveller on arrival. For simplicity, I will confine myself to travel into the past. Travel into the future has even more problems.

First, the troubled journey. Time travel requires the complete separation of movement in time from movement in space in a manner that is at odds with the mandatory four-dimensionality of movement as it is understood in common sense as well as in classical physics. The time traveller has to engage in a one-dimensional movement of a four-dimensional person, reducing a journey to the equivalent of a pure line or even a pure length – essentially to the mathematical representation of one of its dimensions.

That may seem tricky but it is only the beginning of the contradictions built into time travel. The most important is the time traveller's need to break with, and then to reassume, causal connections with the rest of the universe. She has, so long as she is travelling, to be causally insulated from the rest of the universe, as her movement is in the opposite direction to causation, which goes from prior cause to subsequent effect. In short causal connectedness is required to be picked up and put down at will and this without the assistance of causation. A part of the universe – the time traveller, her vehicle and any companions or luggage she brings with her – has to break ranks with the rest of the universe, without this impacting on anything else that is not there for the ride.

What about arrival at a target? The difficulties experienced by the time traveller in the departure hall and *en route* are as nothing to those that attend trying to arrive a particular target date, and I spell them out in some detail in the book but I will spare you them now.

On Arrival

Let us assume instead that our time traveller is able to land at a particular time. Unfortunately, this will be landing nowhere-in-particular, no particular point in space, and in an infinitely thin time-slice. What happens when she leaves the time ship. There are obvious limitations on what she could be permitted to do and this is connected to the best-known objection to time travel.

Suppose she returns to the day when her parents first met. She distracts one of them. As a result, they do not catch sight of one another, their relationship never happens. Consequently, our time-traveller is not born, so she cannot undertake the journey we are talking about. This is an example of how, by interfering with her past, she has removed the very condition necessary for her journey to the past: namely, that she should exist. There are clearly things that she must be prevented from doing. Since, however, every event has the capacity to deflect the subsequent course of the universe, howsoever slightly (remember the so-called butterfly effect), there appears to be no way of defining and vetoing those events that should be forbidden on the grounds that they will interfere with the time traveller being born or even with the life that led up to her wanting to become a time traveller. To be entirely safe, she should be forbidden to act at all, because there cannot be bespoke, local tinkering. For the idea that there might be such local interventions that stay local flies in the face of the fact of the connectedness of the world.



But even a limited Visa or Causation Permit, restricting all interference with the way things are at the destination, would not be enough to ward off problems. The very fact of her arrival – in virtue of eating, walking, breathing or even looking - must alter what happens at her destination. Not only is she bound to impotence and must forego the hope of (say) righting past wrongs (a common motive for fictional time travellers): she must be forbidden to do all the ordinary things which are necessary for survival. The causal chains set running by her lightest footfall would already be beyond her capacity to cancel: footprints and eye prints are equally inadmissible. In short, the time traveller is forbidden from doing anything on her arrival that would constitute actual arriving.

So much for time travel. Its ubiquity in the genre is one of the many reasons why I can't stand science fiction. But that is another story. So we cannot travel in time except in the rather ordinary sense of passing from Tuesday to Wednesday in a 24 hour period. But does time travel? What are we to make of the idea that time flows?

This seems a common sense observation – of course time flows. Sometimes it rushes by – when you are having a great time – and some times it crawls, when you are bored, in pain, or impatient for something. But except metaphorically, the idea of time flowing is nonsense. If time really flowed we would be justified in asking what it flowed in? Clearly not space. Moments do not travel for example from Stockport to London. So does time flow in time – or in some second-order or hypertime – something to which we can give no meaning? Clearly not. And, anyway, if it did flow, how fast would it flow? One second per second? This manifestly makes no sense because you cannot have something happening at *a certain rate* if time is on both the numerator and the denominator.

The point is that if time really were a dimension like length, it would not flow any more than length flows in space. We think of time flowing only because we import into our idea of time, our sense of the dynamism of the world, the endless flight of events, and the movements that comprise them. Colloquially, we talk about the days passing, about Christmas coming nearer, and about the years flashing by. What pass and what flash by are events – and our lives.

There are other images of the dynamism of time. Philosophers entertain the idea of the present being like a moving spotlight, lighting up a succession of moments, making them be 'now'. The philosopher CD Broad likened the passage of time to a policeman on patrol walking down a row of houses illuminating them in succession with his bull's eye torch. And there is the notion that time is 'a growing block' as the sum total of days and the events they have witnessed getting larger. They are all flawed, for reasons I discuss in the book. We think of time as dynamic only because we project the restlessness of the universe over time into the restlessness of time which is then seen as carrying events from the future to the present and then into an ever-receding past.

My focus has been on the way physics, if taken to be a full account of everything, would misrepresent time. In fact, it has been pointed out by some philosophers of physics that at a fundamental level, physics can do without time. Time is not fundamental. This is certainly true of certain interpretations of quantum mechanics. As Lee Smolin has pointed out:

The whole history of physics has been a history of diminishing the nature of time and diminishing the role of time.

This is not only bad for time but bad for physics:

Cosmology is presently in a crisis and the essence of this crisis is in the understanding of the nature of time

Lee Smolin, *The Age of Uncertainty*, 2017

On this I am most certainly not qualified to comment. But the problem goes beyond physics.



Herman Weyl famously declared that in the four-dimensional manifold of the Einstein universe

The objective world simply *is*, it does not *happen*. Only to the gaze of my consciousness, crawling upward along the lifeline of my body, does a section of this world come to life as a fleeting image in space which continually changes in time.

You can see now why I have been so keen to rescue time from the jaws of physics.

Well, these are a few randomly chosen topics of the many that are discussed in a book that was a decade or more in the making. There is much more I could say but as Humphrey Lyttleton used to say, I can hear the tortoise of time exploding in the microwave of eternity.

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