The Time Flow Manifesto

Chapter 6.
Philosophical Issues.

DRAFT

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Chapter 6. Philosophical Issues.

'Philosophy' today has come to mean the *academic ideological disputes* between various grandiose 'meta-philosophies', rather than the content or explanation of the real problems and issues. I illustrate typical expressions of the conventional 'scientific anti-realist' philosophy of time here, and show how far it has infiltrated the scientific world view.

Physical Time: symmetry, irreversibility and physical directionality.

In the first part of this study, it was first shown that fundamental physics as we know it *entails a deeply embedded intrinsic directionality of time,* and is not time symmetric or reversible at all at the micro-physical level. It was shown that the irreversibility of quantum mechanics *entails a law-like cause and explanation of thermodynamics and physical time directionality in our universe*. In particular, the *time reversal of our universe* is not physically possible in any sense, as commonly claimed. 'Contingent boundary conditions' on the early universe are *not* required to derive the thermodynamic time asymmetry or explain the irreversibility of ordinary processes. This resolves long-standing problems about physical time asymmetry, reversibility and retrodiction, but it means the *mechanistic* theory served up as 'the scientific view of time' is fraught with analytic errors, explanatory failures, and metaphysical dogmas.

The initial error.

If this is right, then we must wonder: how did the 'conventional scientific-philosophical account' manage to get the analysis of time symmetry so wrong? It is not hard to see how in retrospect. It started from an initial error derived from false analogies between classical and quantum mechanics. The pioneers of the subject got one fundamental principle wrong early in the interpretation of quantum theory: the criterion for the time symmetry of *probabilistic* theories – applied to quantum mechanics. Quantum mechanics (more or less) satisfies their chosen principle, but it is not the real criterion for time symmetry.

This is only one principle – but reasoning is cumulative, and if a fundamental principle is wrong, reasoning down the chain of consequences is liable to be wrong as well. If we climb the wrong branch of a tree, we find ourselves stranded at a dead-end, and we can never reach the top. To rejoin with the trunk, we have to climb back down from the tree branch, and start again. The initial false principle led to the false inference that quantum mechanics is time symmetric, and that real physical processes are consequently reversible. Then instead of correcting their mistakes when they had a chance, some fifty years ago - when Watanabe (1955) first pointed out the situation - the physicists ignored it, and the philosophers continued to build a theory on it.

Once a false view of these two foundational questions became established by the 1960's – the twin fallacies that quantum mechanics is time symmetric and physical processes governed by thermodynamics are reversible – numerous secondary writers published accounts of this, science textbooks referred to it as a standard scientific result, philosophers published justifications and explanations and extended ramblings, and the ideology took on a momentum that was too big to stop. By 1980's it was practically unacceptable to question it.

Since this initial error in the conventional account is the starting point for all these problems, I restate it here. The conventional accounts of time symmetry of quantum mechanics hold that a *probabilistic theory* is time symmetric (equivalently, reversible; time reversal invariant; TRI) if it satisfies the rule that:

[*] $$prob(s_2(t+\Delta t)|s_1(t)) = prob(Ts_1(t+\Delta t)|Ts_2(t))$$

But this is a false mirror: the real criterion for probabilistic time symmetry is:

[CPTS] $$prob(s_2(t+\Delta t)|s_1(t)) = prob(Ts_2(t-\Delta t)|Ts_1(t))$$

Or in other words, the true reflection of the term: *$prob(s_2(t+\Delta t)|s_1(t))$ with respect to time is the term: $prob(Ts_2(t- \Delta t)|Ts_1(t))$, and not the term: $prob(Ts_1(t+\Delta t)|Ts_2(t))$,* as assumed throughout the literature. There is no doubt about this: it is mathematically proven, and Chapter 1 shows how easy it is to demonstrate that [*] is *irrelevant* to time symmetry. The principle [*] is logically independent of the [CPTS] and time symmetry. Quantum mechanics (more or less) satisfies [*], but it completely fails the [CPTS] and time symmetry.

The most remarkable thing is that generations of specialist philosophers, still working in research programs to the present day, have failed to notice this. In fact, Watanabe, the best writer on the time symmetry of quantum physics in the C20th, and a pioneer of the analysis of time symmetry in quantum electrodynamics, did notice, and made strenuous efforts to bring it to attention; but his work has been misinterpreted, ignored and buried - initially under false objections by a few writers in the 1960's. Leading writers on the subject today rarely make any reference to Watanabe, only to other secondary commentators.

The need for proof of the criterion for probabilistic time symmetry.

The fact that so many specialists in the field have failed to notice this error *for themselves* reflects something quite remarkable and disturbing: *no one in the main-stream tradition has thought to try to <u>prove</u> that the conventional criterion is correct.* If anyone competent in probability theory tried to prove their criterion, they should quickly realise it is wrong. Note that [*] is only a *criterion* applied to probabilistic theories, to try to capture the meaning of time symmetry. Time symmetry, or invariance under time reversal, is *defined by* the fundamental transformation that maps: *$T: t \rightarrow -t$. I.e. it exchanges the directions of time. But it has almost never* occurred to anyone in C20th physics or philosophy (besides Watanabe) that a proof is needed to show that the criterion *correctly captures time symmetry*. This reflects two troubling attitudes among physicists.

The first attitude is that *the conventional criterion is intuitively obvious*. Given the conclusion is wrong, this shows a fatal failure of intellectual vision. It reflects a more general intellectual laziness of modern physicists when it comes to giving *conceptual proofs and analyses of concepts that goes beyond mere equation-solving.* This is not an isolated example: this intellectual laziness is rife. Physicists are very careful when working within a prescribed calculus in applied mathematics (differential equations, tensor calculus, etc), and deriving solutions to fixed equations. But when it comes to interpreting concepts and giving proofs of conceptual reasoning – as we have to do in philosophical logic or mathematical logic – they suddenly get very casual. They expect the pure mathematicians to do the detailed foundational work for them.

We see this gung-ho attitude throughout the twentieth century debates about foundations of quantum mechanics. The concerns of 'intuitive scientific realists' like Planck, Lorentz, Einstein, Schrodinger, Bohm, Dirac – who worked to find precise interpretations of concepts - are casually dismissed by most physicists – *"Just stick the boundary conditions into the equations and get the measurement predictions out"* became the modern physicist's credo. *"Einstein just wasn't as sophisticated at maths as us, he was an old-fashioned realist and didn't realise that empirical results are the only thing that counts. Forget these guys, we know far more than they did."*

Unfortunately when physicists come to comment on conceptual issues, this attitude leads them into a vastly over-inflated sense of confidence, and they often jump to the first conclusions that make intuitive sense, instead of carefully formulating the concepts in a manner that exposes arguments to real requirements of proof and evidence. In reality, an education in modern physics *simply does not provide the intellectual tools to deal with conceptual analysis,* any more than it provides the tools to deal with political analysis or anthropological analysis or literary analysis. The failure is reflected by inadequacies the *formal calculus of physics itself.* It is shown in a later technical chapter that *the ordinary calculus is inadequate to formally derive results about time symmetry (or other symmetries).* A framework of *intensional logic* is required to formalise a language for empirical theories. Without it, critical proofs have to be conducted in an informal meta-language (natural language). The concept of *intensional logic* is unknown in physics. Mathematical languages are *extensional,* because they only need to deal with analytic truths, not empirical truths.

More generally, scientific conceptual reasoning involves *counterfactual reasoning* and *abductive reasoning (inference to the best explanation).* But no adequate *counterfactual or abductive logic* has ever been formalised. The idea that conceptual analysis can be done solely using the formal languages of conventional applied mathematics is based on ignorance about the foundations of logic itself.

The reactionary defence of quantum time symmetry.

The second attitude is a reactionary view that *the choice of the orthodox criterion is just a convention for defining time symmetry.* What about the fact that it fails to capture the symmetry transformation: ***T**: t → -t? "Well it is simply an alternative definition of time symmetry, and <u>the one that works for quantum mechanics</u>.*" This attitude is the most common source of continuing denial that any error has been made in the conventional criterion. It is a classic example of neo-positivist reasoning. Neo-positivism is characterised by its own special principles of reasoning, providing a set of defensive manoeuvres for circumventing criticism. This response goes like this:

(A) First, prior to any controversy, it is claimed that the conventional criterion for time symmetry is unchallengeable, having been objectively proven in physics, and anyone disputing it is considered an ignorant crank.

(B) Attempts to publish critical proofs are initially rejected as cranky, but with persistence, some reviewers are persuaded that there is a case to be answered.

(C) When it finally sinks in that there is indeed a serious problem with the conventional analysis, it claimed that it all depends on 'defining the meaning of time symmetry', and angry defences of the conventional results are given on pragmatist grounds, without addressing the problem directly.

(D) The correct definition of time symmetry is consistently circumvented. On this view, there is no objective analysis of time symmetry: the neo-positivists are intent on *choosing a definition of time symmetry in the best way they can to render theories 'reversible' and maintain their doctrines.*

This is disingenuous to say the least. A physicist who could not correctly identify *space reflection symmetry* would not be considered competent. Why should incompetence to correctly identify *time reversal symmetry* be any different? A physicist who taught that *space reflection symmetry* is defined by a transformation other than: ***R**: **r** → **-r** and claimed that this is merely a 'conventional definition' would* be ridiculed. Yet this is precisely the response when the neo-positivists are confronted with their own error in defining time reversal symmetry. Instead of accepting that time symmetry is objectively defined as invariance under the transformation: ***T:** t → -t,* they go to extraordinary lengths to try to construct alternative definitions and arguments to retain their conventional account. Of course, they only do this *when they discover their account is in error*. If their account was correct in the first place, they would simply insist that time reversal is defined by the time reversal transformation.

There is no doubt that the intended meaning of *time reversal* is uniquely defined by the transformation: *t → -t. All the physicists assume this before they recognise there* might be a problem. And most importantly, all the critical consequences drawn by the philosophers from the claim that fundamental physics is reversible or time symmetric uniquely depend on this meaning. These include all the conventional dogmas: that *physics reflects no intrinsic differences between the two directions of time,* that *physical processes could equally well all run backwards in time,* and that *there is no law-like explanation of directionality of ordinary physical processes.* These all depend on the claim of *invariance under the time reversal transformation: t → -t.* These consequences do not follow from the symmetry claimed to represent the 'reversibility of quantum mechanics'.

The false interpretation of time reversal in the literature.

This initial mistake, i.e. the false interpretation of probabilistic time reversal symmetry, is rife throughout the literature. The false principle [*] seems to have been first applied in quantum mechanics by Lewis [1931], coming from a background in chemistry. For typical statements from the main-stream literature:

In specialist texts on the physics of time symmetry:

"The probability *w* [that a system at time t1 in a state |ψ> is found at time t_2 in a state |ϕ>] will be $w = \langle\psi|U(t_2,t_1)|\phi\rangle$. *Now consider the reverse probability,* w_{rev}, that a system at time t1 in a state $K|\phi>$ is found at time t_2 in a state $K|\psi>$. This will be $w_{rev} = <\psi K^{\dagger}|U(tl2,t_1)|K\phi>$. *... whence the principle of microreversibility* $w = w_{rev}$ ... Symbolically [this] may be written prob(|ψ>∅|ϕ>) = prob(*K*|ϕ>∅*K/ψ>) which should be compared with the classic principle [$s_1 \varnothing s_2$ / $Ts_2 \varnothing$ Ts_1]."* (Davies, 1974, p.157).

In quantum mechanics textbooks:

"A system is said to exhibit symmetry under time reversal if, at least in principle, its time development may be reversed and all physical processes run backwards, with initial and final states interchanged. Symmetry between the two directions of motion in time implies that to every state Ψ there corresponds a time-reversed state ΘΨ and that the transformation Θ preserves the values of all probabilities, thus leaving invariant the absolute value of any scalar product between the two states." Merzbacher, 1982, p.406-407

In specialist papers on the philosophy of time symmetry:

The laws L governing physical system {S} are said to be invariant under time reversal, or equivalently, the temporal processes of {S} are said to be nomically reversible if and only if (a) for any nomically possible states s_i and s_f of $S \in \{S\}$, Ts_i and Ts_f are also possible states of S and (b) if the laws L imply that whenever $S \in \{S\}$ is in state s_i it is state s_f after and interval of τ, then they also imply that whenever S is in state Ts_f it is in state Ts_i after an interval τ. ... If the equations of motion contain a stochastic term, then the present characterisation would have to be modified. The most obvious extension would be to require that the transition probability from s_i to s_f equal the transition probability from Ts_f to Ts_i. (Earman, 1969, p.281).

"A theory is TRI [time reversal invariant] just in case given a lawful sequence of states of a system from an initial state S_i to final state S_f with chance equal to r, the sequence from the temporally reflected final state S_f^T to the temporally reflected initial state S_i^T, also has chance equal to r, i.e, $P(S_i \rightarrow S_f) = P(S_f^T \rightarrow S_i^T)$." (Callender, 2002, "Is time handed in a quantum world", < http://philsci-archive.pitt.edu/id/eprint/612>)

In introductions to the philosophy of physics:

If the laws of nature are time-reversal invariant, then for any process that occurs in the world, the process that consists in starting with the time reversed final state of the original evolution and ending up with the time-reversed initial state of the original process is equally compossible with the laws of nature... Remember, of course, that in quantum-theoretic context, it is the transition probabilities between reversed states which must equal the probabilities of the unreversed states taken in opposite temporal order for the laws to be time-reversal invariant. The physics of time reversal invariance, then, is quite simple. (Sklarr, 1974, p. 368).

It is interesting that there is *no explicit acknowledgement that the criterion [*] is false, and* leading writers now avoid formally stating what time symmetry means for probabilistic theories. Miller (2009) cites Holster (2003) with the observation that:

> "There is not universal consensus on the meaning of time-symmetry either in classical physics or in quantum physics (for recent discussions and references to the literature, see [Malament, 2004] and [Holster, 2003] respectively). The orthodox position is that a system is time symmetric if it satisfies motion reversal invariance [Wigner 1959, Sachs 1987] and that is the meaning which will be adopted in the following."

Which is to say, Miller simply chooses to adopt the 'orthodox meaning of time reversal', without bothering with the question of whether it is correct or not. The more defensive reaction however is to continue with attempts to try to prove the time symmetry of quantum mechanics, as illustrated by Roberts (2012), a recent graduate student of Earman, who starts his PhD dissertation with:

> "This dissertation is about the sense in which the laws of quantum theory distinguish between the past and the future. I begin with an account of what it means for quantum theory to make such a distinction, by providing a novel derivation of the meaning of time reversal."
>
> "The philosophy of physics often engages in [the] problem of clarifying the meaning of a central term appearing in the foundation of a theory. One resilient example for both physicists and philosophers is the term, "time reversal." Unlike a transformation like rotation or translation in space, there is no apparent physical act that would exchange the past and the future. … Although Malament's (2004) example has spawned considerable discussion among philosophers, nobody has yet pursued the question of how this kind of question can be answered in a theory like quantum mechanics. That is the problem that I aim to solve in Chapter 2." (Roberts, 2012).

The claim to "provide a novel derivation of the meaning of time reversal" should immediately set off alarm bells. Remarkably, Roberts never defines time reversal in terms of *the time reversal transformation T:* $t \rightarrow -t$ *throughout the entire PhD thesis!* (The same is true of all the recent technical papers by the neo-positivists that claim to 'define' time reversal in quantum mechanics: *they no longer define it as the* $t \rightarrow -t$ *transformation*.) Roberts goes on to develop 'novel definitions of the meaning of time reversal in quantum mechanics' (*yikes*!) with the intention of *proving quantum mechanics is reversible.* He follows the lead of his mentor, Earman (2002), of seeing the problem as *redefining time reversal to defend the claim that quantum theory is time symmetric*. His claim that ‘no one has yet pursued the question of how this kind of question can be answered in a theory like quantum mechanics’ shows a remarkable ignorance of work in the field. But remarkably, too, Roberts *never states any definition or condition for the time reversal of probabilistic laws* – and never considers quantum mechanics as a probabilistic theory! – despite the fact that this is what exposes the striking time-asymmetric feature of the theory.

Ramifications of the initial error in the explanation of time directed processes.

The ramifications of this initial error are huge. Using the mistaken criterion for probabilistic time symmetry, quantum mechanics, along with ‘all other theories of physics’, are claimed to be time symmetric. (Note the criterion must be applied to *thermodynamics* as well as *quantum mechanics*.) The impact of this error on the subsequent interpretation is rife throughout the primary and secondary literature, e.g.

> "We must dismiss the suggestion that the asymmetry lies in the laws of physics. The laws of classical dynamics and electromagnetism, as well as quantum mechanics, are all expressed in time symmetric differential equations. In other words, if f(t) is a solution to these equations, so is f(-t)... " (Smart, 'Time', in *The Encyclopaedia of Philosophy,* Vol 8, p.126.)

> "How is it possible to account for the difference between past and future when an examination of the laws of physics reveals only the symmetry of time? Scarcely any topic in fundamental physics can avoid running up against this problem at some stage; and yet after more than a century of speculation, occupying the attention of some of the world's greatest physicists, the question seems far from answered. ... A casual inspection of the literature creates the impression of great confusion and misunderstanding surrounding the topic." (P.C.W. Davies, 1974, p.1.)

> "These three examples indicate what is, with one exception [K-mesons], a remarkable fundamental fact of nature: *all known laws of physics are invariant under time reversal.* ...Although we are forced to conclude that the laws of physics do not themselves provide a time asymmetry, it is one of the most fundamental aspects of our experience that, as a *matter of fact,* the world is asymmetric in time. This is sometimes expressed by saying that the temporal asymmetry is 'fact-like' rather than 'law-like'... This means that symmetric behaviour is observed as a result of the natural selection of certain types of special *boundary conditions* in preference to others." (P.C.W. Davies 1975, p.26-27).

> "The laws of science do not distinguish between the past and the future. " (Hawking 1988, p.144).

> "It is, however, remarkable that the laws of physics have all been found to be quite symmetrical with respect to the sense of time. " (Gold, 1962, p. 403).

> "Both the thermodynamic and the non-thermodynamic species of irreversibility which we shall find to obtain are *de facto* or nomologically contingent in character." (Grunbaum, 1972, p. 219).

> "This essay is a philosophical evaluation of the findings of Wald and Penrose in which they claim to have supported an arrow (or the irreversibility) of time in quantum gravity. ... My conclusion is that the arrow of time found in quantum gravity is at best de facto (nonlawlike)." (Liu, 1993, p.619).

> "Certainly, our fundamental physical theories do not incorporate a time bias. Even the notoriously irreversible phenomena of thermodynamics - processes of entropy increase which are typically associated with time's arrow - can, as we shall see in the next chapter, be reconciled with the isotropy of time. True, there is a difficulty with quantum mechanics. On some interpretations, *measurement* is treated as a basic irreversible phenomenon. However, the problems of how to make sense of the formal theory are themselves still so gigantic and intractable that no implications may yet be drawn from quantum mechanics regarding the anisotropy of time. " (Horwich, 1987, p.55)

> "The *arrow of time* expresses the fact that in the world about us the past is distinctly different from the future. Milk spills but doesn't unspill; eggs splatter but do not unsplatter; waves break but do not unbreak; we always grow older, never younger. These processes all move in one direction in time - they are called "time-irreversible" and define the arrow of time. It is therefore very surprising that the relevant fundamental laws of nature make no such distinction between the past and the future. This in turn leads to a great puzzle - if the laws of nature permit all processes to be run backwards in time, why don't we observe them doing so?" (Joel L. Lebowitz (2008), Scholarpedia, 3(4):3448. URL: <http://www.scholarpedia.org/article/Time's_arrow_and_Boltzmann's_entropy>)

It can be seen that there is little reserve in the literature about stating the universal validity of time symmetry in physics. Horwich is admittedly self-contradictory - stating first that "fundamental theories do not incorporate a time bias", and then claiming that quantum mechanics cannot even be analysed – but he is wrong: quantum mechanics is *irreversible*, whatever interpretation is taken of quantum measurement. It is irreversible *because its probabilistic laws are irreversible.* Quantum probabilities are a defining feature of the theory. Even if a deeper theory is discovered that explains these probability laws, e.g. by deterministic underlying variables, *the probabilistic laws of quantum mechanics will still be irreversible.*

The reactionary view of thermodynamic reversibility.

Not all writers are unaware of this problem, but want to maintain the *status quo* of the conventional theory. Callender performs some awkward contortions to suppress the possibility that the time asymmetry of quantum mechanics might explain the physical directionality reflected in thermodynamics. Like Roberts and Earman, he does this by focussing on the *deterministic evolution of the quantum mechanical wave function* (which is claimed to be reversible, but is effectively unobservable), and ignoring the heart of the empirical theory, viz. its probabilistic laws. His article in *The Stanford Encyclopedia of Philosophy* tells us:

> "Thermodynamics is the science that describes much of the time-asymmetric behavior found in the world. This entry's first task, consequently, is to show how thermodynamics treats temporally 'directed' behavior. It then concentrates on the following two questions. (1) What is the origin of the thermodynamic asymmetry in time? In a world possibly governed by time-symmetric laws, how should we understand the time-asymmetric laws of thermodynamics? (2) Does the thermodynamic time asymmetry explain the other temporal asymmetries?" …
>
> "To the best of our knowledge, our world is fundamentally quantum mechanical, not classical mechanical. Does this change the situation? … Modulo some philosophical concerns about the meaning of time reversal (Albert 2000, Callender 2000, Earman 2002), the equation governing the unitary evolution of the quantum state is time reversal invariant. For interpretations that add something to quantum mechanics, this typically means that the resulting theory is time reversal invariant too (since it would be odd or even inconsistent to have one part of the theory invariant and the other part not). Since the resulting theory is time reversal invariant, it is possible to generate the problem of the direction of time just as we did with classical mechanics." Callender, Craig, "Thermodynamic Asymmetry in Time", *The Stanford Encyclopedia of Philosophy (Fall 2011 Edition)*, Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2011/entries/time-thermo/>.

The fundamental problem referred to here is that since the laws of classical mechanics are time symmetric, it is impossible to derive the time asymmetry of classical thermodynamics from the underlying laws alone – as Boltzmann and Loschmidt understood in C19th, and the Ehrenfests made clear in the early C20th. Something extra must be added to get classical thermodynamics. This is widely interpreted as an extra 'fact-like' condition (or boundary condition in the past). If quantum mechanics is time symmetric as well, we have the same problem in quantum thermodynamics.

This is the conventional dogma for more than 50 years, but unfortunately for this account, quantum mechanics is *not time symmetric,* and it is shown in Chapter 3 that *the probabilistic asymmetry of quantum mechanics is exactly what is required to explain why quantum thermodynamics is time asymmetric*.

To avoid this conclusion, you must conceal the time asymmetry of quantum mechanics. The main tactic is to focus on the deterministic part of quantum mechanics (where there is a separate confusion about time reversal of quantum mechanical states as well) and avoid discussion of its irreducibly probabilistic laws. Consequently we have ‘time asymmetry denial programs’ at prominent institutions.

I would urge the serious researcher to *understand and acknowledge what ordinary quantum mechanics says about time first*, before going off on a wild goose-chase to establish a new ‘deterministic time symmetric’ theory.

The current dominance of the mechanistic ideology.

The continuing dominance of the static theory of time in main-stream science is perfectly represented by the recent *Scientific American Special Issue*, “A Matter of Time”, (2012). Scientific American publishes these super-prestigious ‘special issues’ to present the current ‘state-of-the-art’ of various sciences through summary articles by prominent authorities in the field. The editors tell us that “This special issue of Scientific American summarizes what science has discovered about how time permeate and guides both our physical world and our inner selves”. Remarkably for a science journal, it has extensive contributions on the ‘philosophy of time’, by Davies, Callender and Musser, three leading neo-positivists. I examine their views on time flow and time symmetry. It should be noted that Callender and Musser spend much of their articles cheer-leading speculative programs to *remove time from physics altogether*, and make no effort to explain background concepts or issues. The notion that this material ‘*summarizes what science has discovered about ... time’* is as misleading as the material itself.

Davies' contribution, with which the volume grandly opens, is dedicated to attacking realism about time flow, and repeating his view that it can only be explained as a 'subjective' phenomena, through a reductionist materialist account based on the bloc universe. This is the central doctrine of the static theory of time.

> "Nothing in known physics corresponds to the flow of time. … The most straightforward conclusion is that both past and future are fixed. For this reason, physicists prefer to think of time as laid out in its entirety – a timescape, analogous to a landscape – with all past and future events located there together. Completely absent from this description of nature is anything that singles out a privileged, special moment as the present … Indeed, physicists insist that time doesn't flow at all; it merely is. Some philosophers argue that the very notion of the passage of time is nonsensical… The time of the physicists does not pass or flow. … The concept of flux, after all, refers to motion. It makes sense to talk about the movement of a physical object, such as an arrow through space, by gauging how its location varies with time. But what meaning can be attached to the movement of time itself? …posing the simple question 'How fast does time pass?' exposes the absurdity of the very idea [of the passage off time]. … Although we find it convenient to refer to time's passage in everyday affairs, the notion imparts no new information that cannot be conveyed without it." P.10.
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> "Objectively, past, present and future must be equally real. All of eternity is laid out in a four-dimensional block composed of time and the three spatial dimensions". P.11.
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> "The arrow of time denotes an asymmetry of the world in time, not an asymmetry or flux of time. … talk of the past or the future is as meaningless as referring to the up or the down". P.11.
>
> "Given that most physical and philosophical analyses of time fail to uncover any sign of a temporal flow, we are left with something of a mystery. … Nothing other than a conscious observer registers the flow of time. … Therefore it appears that the flow of time is subjective, not objective. … This illusion cries out for explanation, and that explanation is to be sought in psychology, neurophysiology, and maybe linguistics or culture." P.13. (Davies, 2012, "That Mysterious Flow").

Davies wrote a useful monograph on "The Physics of Time Asymmetry" some 40 years ago (Davies, 1973), and he has repeated the same views ever since. While his first book espouses many of the neo-positivist errors described here, it still contains a good exposition of basic physics, and remains a useful text. But Davies has never published any philosophy. He is an interesting science journalist, but has no idea of technical philosophy. The fact that Scientific American presents this neo-positivistic mush as *state-of-the-art philosophical reasoning about time for scientists,* without any balancing views, shows how naïve physicists are about philosophy.

The second authority is Callender, equally preoccupied with attacking any suggestion of time asymmetry or time flow, and supporting the same static theory:

> "As you read this sentence, you probably think that this moment – right now – is what is happening. … Yet as natural as this way of thinking is, you will not find it reflected in science. The equations of physics do not tell us which events are occurring right now – they are like a map without the 'you are here' symbol. The present moment does not exist in them, and therefore neither does the flow of time." P.15.
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> "Bolztmann […] reasoned that, because Newton's laws work equally well going backward or forward in time, time has no built-in arrow. Instead he proposed that the distinction between past and future is not intrinsic to time but arises from asymmetries in how the matter in the universe is organised. Although physicists still debate the details of this proposal, Boltzmann convincingly plucked away one feature of Newtonian time." P.16.
>
> "Although time may not exist at a fundamental level, it may arise at higher levels – just as a table feels solid even though it is a swarm of particles composed mainly of empty space. Solidity is a collective, or emergent, property of the particles. Time, too, could be an emergent property of whatever the basic ingredients of the world are." P.16. (Callender, 2012, "*Is time an illusion?"*).

According to Callender, science has steadily 'plucked away' all the classical features of time, especially those that give it any directional structure, including *time flow* and *time asymmetry*. The argument against time asymmetry from classical physics remains 'convincing' to him today, although physicists 'still debate the details' - with no mention that the argument has dramatically changed with quantum mechanics. His main speculation is that time itself has some kind of materialist reduction, similar to the mechanical reduction of 'solidity'. But the nature of this 'reduction' is left absolutely vague, and is completely speculative. Time is a fundamental variable in the equations of physics, and is essential in the dimensional analysis and logical construction of physical quantities. Solidity is a phenomenal property of objects perceived through the senses. How are they comparable? All we are given is a metaphor. Callender's presentation of Bolzmann is also inaccurate and anachronistic. Callender, like Davies, is most passionate in his opposition to time flow:

> “Tensers [realists about the distinction between past, present and future] are wasting their time trying to find an image of the tensed theory in physics. Specific physical theories will be more or less hostile to tenses, but in general they will be against tenses so long as there is no clear need for them. … From this perspective, physics – and science itself—will always be against tenses because scientific methodology is always against superfluous pomp.” (Callender, “Finding 'Real' Time in Quantum Mechanics”, 2007. Published in Einstein, Relativity and Absolute Simultaneity. (Eds) W.L. Craig and Q. Smith. Routledge, 2007.

Again I find it incredible that *Scientific American* presents such pompous and speculative opinion as *state-of-the-art philosophical reasoning about time for scientists!* Following Callender, we have Musser, with “A hole at the heart of physics” and “Could time end?”, recycling the same conventional doctrines.

> “The laws of physics contain a time variable, but it fails to capture key aspects of time as we live it – notably, the distinction between past and future.” p.22.

> “A second example of philosopher’s contributions concerns the arrow of time – the asymmetry of past and future. Many people assume that the arrow is explained by the second law of thermodynamics, which states that entropy … increases with time. Yet no one can really explain the second law. The leading explanation, put forward by … Boltzmann, is probabilistic. … This reasoning, however, is symmetric in time… thus the second law is not so much a fundamental truth as historical happenstance, perhaps related to events early in the big bang. Philosopher Huw Price of the University of Sydney argues that almost every attempt to explain time asymmetry suffers from circular reasoning – some hidden presumption of time asymmetry. This fallacy also distorts how physicists interpret quantum mechanics. Price’s work is an example of how philosophers can serve … as the ‘intellectual conscience of the practising physicists’. Trained in logical rigor, they are experts at tracking down subtle biases.” P. 23.

Forgive me if I shudder at the last declaration. The suggestion that Price serves as ‘the intellectual conscience of physicists’, or is ‘trained in logical rigor’ is ludicrous. Price is the archetypal verbose *anti-realist* philosopher, has written copious quantities of verbiage about time and semantics without ever giving an equation or a proof or a correct formal definition of anything, and he thinks *time flow* and *self* are both explained as *‘grammatical illusions’*:

> “But this illusion [time flow] rests in turn on a deeper one; that of a single persisting self, self identifying over time. I think that Jenann Ismael is correct about the origin of this deeper illusion, in treating it as what she calls a ‘grammatical illusion’, resting on an indexical ‘abuse of notation’ … The

> impression of a single thing [the self] reencountered across cycles of self presentation is a grammatical illusion."

This is the kind of pseudo-explanation we expect from an armchair philosopher. Why study physics or cognitive psychology to understand time or the self, when we can explain it all as a 'grammatical illusion', without ever recording an empirical observation or writing an equation? The last 'philosopher of time' of such monumental tedium was Gale, who wrote a long book recording various English language uses of tenses, and called it the philosophy of time.

But as far as serious claims go, again we have from Musser the assumption that *fundamental physics is symmetric in time,* and the inverted fallacy that physicists who *have* recognised the time asymmetry of quantum mechanics therefore have a distorted interpretation of quantum mechanics! And again, where in any of this is there any clear statement of the implicit claim that *quantum mechanics is time symmetric,* or any *definition of what time symmetry means?*

In his second article in the volume, "Could time end?", Musser reiterates:

> "Physicists have recognised from the mid-19th century that the arrow [of time] is a property not of time per se but of matter. Time is inherently bi-directional; the arrow we perceive is simply the natural degeneration of matter from order to chaos" (Musser, 2012, p.109).

The same message is repeated in the interview of Carrol by Matson, "What keeps time moving forward?"

> "But then, when you act like a good scientists or philosopher and try to make sense of it, this puzzle arises: the fundamental laws of physics treat the past and the future as being exactly the same, whereas the world does not." (Carrol, p. 92). "The answer to why the past is different from the future … is intimately connected with the whole universe – with what happened at the big bang, with the special condition in our universe when it started" (Carrol, p.92). "I wanted to draw attention to this connection between the arrow of time and cosmology". (Carrol, p.92). "What we would think of as 'how time works', the fact that the past is set in stone while the future can still be altered – is all because of entropy." (p.92).

This is far from novel – it is a reiteration of the conventional doctrine that became popular decades ago - that *the fundamental laws of physics are time symmetric,* and *the cause of physical time asymmetry is the fact-like boundary condition of low entropy in the early universe.* No real progress has been made in this explanation by the conventional 'philosophy of physics' research programs for decades. The same essential explanation and same essential problems have barely changed since the current cosmological paradigm was established (i.e. the expanding universe theory). The last three decades of 'research' in conventional philosophy of physics has really failed to come up with *any new significant explanations or resolutions of anything.*

Musser's then recites a classic positivist fallacy of reasoning, apparently showing that time might 'disappear' in a heat-death of the universe in a long-term future:

> "You might suppose that duration will continue to make sense in the abstract, even if nothing could measure it. But researchers question whether a quantity that cannot be measured even in principle really exists. To them, the inability to build a clock is a sign that time itself has been stripped of one of its defining features. 'If time is what is measured on a clock and there are no clocks, then there is no time', says philosopher of physics Henrik Zinkernagel". (Musser, P.110.)

The fact that Musser recites this positivistic principle with approval shows how far out of touch he is with modern philosophy and logic. If philosophy of science *has* made progress on any single methodological point in the last century, it is to discard the false positivist principle that *physical reality is defined by the possibility of measurement or observation.* This fallacy remains popular among physicists, it is true, passed down by word of mouth through generations of physics lectures; but it was discarded decades ago by serious philosophers of science and logic.

I conclude here with another quote from Davies:

> "Some researchers, notably the late Nobel laureate chemist Ilya Prigogine, have contended that the subtle physics of irreversible processes make the flow of time an objective aspect of the world. But I and others argue that it is some sort of illusion. After all we do not observe the passage of time. What we actually observe is that later states of the world differ from earlier states that we still remember. … Nothing other than a conscious observer registers the flow of time… Therefore is appears that the flow of time is subjective, not objective." (Davies, 2012, p.13).

Davies here refers to one of the great C20th philosopher-scientists to study the directionality of time scientifically, and in novel detail, Ilya Prigogine - but Prigogine is paid mere lip service. After noting that Prigogine was a realist about time flow, he is ignored: none of his views are explained, and Davies' own opinions are justified as the serious scientific view of today, with this logical gem: *"But I and others argue that it is some sort of illusion. After all we do not observe the passage of time… Nothing other than a conscious observer registers the flow of time… Therefore is appears that the flow of time is subjective, not objective."* Isn't *registering the flow of time* the same as *observing the passage of time?* And we register *all sensory knowledge consciously,* including sight and sound and touch, without making the things see and hear and touch 'subjective'. Davies' argumentation about this just drifts away into dreamland. But *how can this kind of opinionated rambling represent the leading 20th Century scientific philosophy of time?*

The fleeting mention of Prigogine is the *only* mention I can find by Davies, Callender and Musser in the whole Scientific American Special Issue on Time *of any C20th writer with an alternative to their view*. This is another characteristic of the neo-positivists in their attacks on alternative views: *they rarely cite arguments by their critics, or quote arguments against their own views.* This is what moves neo-positivists from scientists to propagandists. The focus on *propagandising their own selective view of science* is central to the neo-positivism, and stems from doctrines and attitudes entrenched in the concepts they use to analyse science – including the fallacious 'demarcation' of 'sciences' from 'pseudo-sciences', and the evangelisation of positivism through prestigious American schools of philosophy of science.

This 2012 *Special Issue on Time* is a low point in the entire history of *Scientific American.* It tells us very little about the scientific view of time in physics. The journal has allowed itself to be taken over as the mouth-piece for a philosophical program, presenting an unbalanced jumble of speculative opinion as 'scientific philosophy' and 'scientific orthodoxy'. Scientists who warn against academic philosophers have a good point. I do think *philosophy* itself is vital to science: but how do we distinguish *real philosophers* from programmatic dogmatists?

Metaphysical Time: time flow realism.

Neo-positivism, materialism, and the static theory of time.

I refer to the conventional view as *the static theory of time,* and it is closely aligned to a *neo-positivist philosophy.* The essence is that: (A) physical time is symmetric, (B) physical time is just a dimension of static space-time, and (C) the only legitimate knowledge of time is derived from physics. Neo-positivism is a much broader and much murkier ideology. Certainly not all adherents of the static theory of time are neo-positivists. But neo-positivists are the core support for the static theory, and its most dogmatic expressions are generated from the broader neo-positivist vision.

What I call *neo-positivism* is a bundle of related doctrines, typified by a *materialist metaphysics and nominalist ontology*, an *anti-realist approach to conceptual analysis,* a *positivist-instrumentalist-pragmatist semantics,* a *mechanistic-reductionist program of explanation,* an *empiricist-inductivist epistemology.* The sociological conditioning is to display a *scientistic attitude,* with scientific authority treated as the ultimate source of knowledge. Its broader ramifications include *nihilism* and *atheism*. Captivation by the philosophical vision of neo-positivism is the biggest impediment to a serious approach to the subject of time.

Neo-positivism involves a bundle of doctrines, ranging across *metaphysics, ontology, methodology, epistemology, semantics, sociology and ethics.* Like *neo-conservatism* politically, it has some continuity with classical versions of *positivism* proper (logical positivism, logical empiricism, C19th positivism), but in recent decades it has focused on a different mixture of doctrines, which are by not consistent or coherent as a whole, although I wouldn't hold that against anyone. The driving characteristic of modern neo-positivism is really *scientific materialism,* which is intermittently *realist* about the existence of physical entities (including unobservable entities like quarks, black hole singularities, etc), but generally anti-realist about anything else. The big tension in *positivism* is between the impulse to *scientific materialism* and *epistemological subjectivism*. Pressed to its logical conclusion, positivism leads to a radically *subjectivist or idealist metaphysics,* and it is thoroughly anti-realist about scientific theories and physical entities. But this radical anti-realism is unacceptable to scientists, although anti-realism is entertained as it suits in special cases – notably in QM.

Neo-positivism today is largely dedicated to a *reductionist materialist metaphysics*, and to the claim that *the empirical scientific method is the (only) means to obtaining real knowledge of the material world.* Its doctrines about meaning, knowledge and methodology, although derived from positivist epistemology, are pragmatically adapted to whatever best justifies scientific materialism at the time. Materialism holds that the only real things are *actual physical objects or events or processes.* Nominalism chimes in with the view that only 'particulars' exist, and there are no 'abstract objects', such as properties or universals, laws of nature, etc, independent of particular objects. Neo-positivism is devoted to the assumption that *everything real reduces to elementary physical processes,* and concludes that *any meaningful concept must be explicated in such terms*. This drives a materialist, mechanistic, reductionist program in philosophy. All 'abstract' concepts of experience or common language – including *consciousness*, *perception, phenomenal properties (colour, texture, etc), time flow*, *ethical value*, *personal identity, God, emotion, love, beauty, thought, intelligence, etc* – are regarded as meaningful only insofar as they can be reinterpreted as descriptions of physical processes. How do we know what physical processes or entities are real? *"Through (materialist) sciences of course."* Materialist physics is meant to tell us *what is real,* and materialist neuro-psychology is meant to explain *how we perceive* and materialist behavioural psychology or linguistics is meant to explain *how we communicate,* and so on.

There are consequently two key motivations that come into play in the neo-positivist account of time. The first is to *explain away the phenomena features of time, as evident through experience, by giving a reductionist explanation, based on a materialist account of perception and consciousness itself.* The second is to *provide a metaphysical view of time that supports scientific materialism.*

For examples of the first motivation, we have seen Davies' view above that: "Therefore it appears that the flow of time is subjective, not objective. … This illusion cries out for explanation, and that explanation is to be sought in psychology, neurophysiology, and maybe linguistics or culture." And similarly Callender: "Although time may not exist at a fundamental level, it may arise at higher levels – just as a table feels solid even though it is a swarm of particles composed mainly of empty space. Solidity is a collective, or emergent, property of the particles. Time, too, could be an emergent property of whatever the basic ingredients of the world are." I.e. we simply *explain away our perceptions of time,* without inferring any objective properties of time from our experience. (If anyone wonders how we then explain away *conscious experience* in turn, the answer for the neo-positivists is of course it has a materialist reduction: consciousness apparently is also an illusion. We must wonder if it is a real illusion, or just the illusion of an illusion.)

But this is hardly satisfactory given that time is taken as one of the *fundamental variables in fundamental physics (along with space, mass, charge),* as well as being *a fundamental organising principle for experience itself* – not just a secondary property of material objects, like solidity. We must still deal with the physical reality of time somewhere in our account. The second motivation is to describe the physical reality of time in a way that supports materialism. Neo-positivists want all of reality to be described as *a single, actual, physical or material object, with all its parts set out transparently, in fixed relations to each other.* The paradigm for this vision is the blue-print for a physical machine at an instant of time, with its mechanical parts transparently related in space. We expect from this image that *the machine is defined completely by the diagram of its mechanical parts.* There seems to be nothing left out of the picture – most importantly for the neo-positivist, there are no 'abstract entities' or 'spiritual entities' that we do not see. (Which is why 'invisible' entities like force-fields, properties, space, laws of nature, thoughts, or souls have caused consternation for materialists).

Time of course is the fundamental problem for this view – for it is not simply another mechanical entity in the diagram of a machine. It is like an 'invisible' dynamic principle, bound up with change and causation and laws of nature – threatening the simple *mechanistic vision of reality.* Where is *time* in the engineering blue-print? The static view of time dispenses with this difficulty: time is treated simply as just another relation between material events, like spatial relations. We make a *space-time* diagram, and spatialise or *materialise* temporal relations.

This static theory of time is then really a very simple theory of *existence*. Philosophers have wondered for what existence is, why things exist at all, why existence is prone to change, whether there are transcendent forms of existence beyond the physical, how conscious existence relates to physical existence, and so on. The neo-positivists dismiss all such questions: "*the world simply exists, with all the facts of its history laid out changelessly for all time, as it actually is. It is all reducible to fundamental physical events, there is no change, no transcendent realm, no reason, no cause, no soul, no consciousness, no abstract entity, no purpose, no value.*" And this vision, we are assured, is proven by modern science.

To keep this metaphysical view afloat, neo-positivism lashes together a raft of auxiliary philosophical doctrines, about methodology, semantics, explanation and epistemology. These are largely just rationalisations to support their primary doctrines. The mechanistic vision of metaphysics is reflected in analogous mechanistic visions of everything else, including scientific method, scientific progress, logic, evidence, truth and semantics. Most typical is an anti-realist paradigm of *reductionist semantic explanation*, which is an extension of *reductionist material explanation.* E.g. in science, the phenomenal substance 'water' reduces to a molecular substance 'H_2O'. The phenomenal property of 'hardness' reduces to a molecular property amounting to 'impenetrability of surfaces'. So far that sounds reasonable – as long as we are talking about *explaining properties of a physical substance in terms of properties of its constituent physical parts*. But in the attempt to create a 'scientific philosophy', the positivists extended this reductionist paradigm to semantics and meaning: *the meanings of phenomenal concepts must therefore reduce to the meanings of atomistic concepts.* And to maintain *empiricism,* they added prescriptions that semantic reductions of 'real (scientific) concepts' must be based on reductions to fundamental 'observables' or 'atomic empirical facts'. This kind of conceptual reductionist program goes back to Hume – who famously challenged the concept of causation itself, because he could not find the causal relation between events reflected in the causal relation between their 'ideas'.

It needs to be emphasised that there is a crucial role for *operational and instrumental definitions of measurements in physics.* This was brought to the forefront of C20th

methodology by Einstein in the Special Theory of Relativity (defining the frame of reference *for an observer)*, and later in quantum mechanics. I will express this in a principle that we need to construct *objectivised models of measurement.* This means that instead of simply starting with observations, intuitively interpreted, and inferring physical models from them, we start with physical models, and infer the observations they imply. This is absolutely necessary in modern physics because *observation becomes theoretically dependant.* It becomes a theoretical exercise to identify what is happening in the experimental process of observation. Consequently, we need to provide careful theories of what observations are from within our theoretical models – which are effectively provided by *operational definitions of measurement.* Neo-positivism however tries to turn this into a general theory of *operational definitions of meaning,* leading to various *anti-realist semantic theories.* But this is a serious delusion: they are two completely separate things. *Measurements* are not *meanings* any more than physical objects are meanings.

This is where neo-positivism turns into a theoretical fantasy. *Realist semantics* (or *formal semantics*) is much simpler and direct. When people talk about things (properties, perceptions, abstract objects, whatever) we analyse the meaning *as if they intended to talk about the things they mention.* If they talk about *water* then they mean *water.* If they talk about *seeing red* then they mean *seeing red.* If they talk about time, or causation, or probability, or numbers, or good, or God, or whatever else – that is what they intend to refer to. In realist semantics or logic, we model meanings literally as they are intended. We do not reinterpret or prescribe the *objects of reference* in terms of some favoured scientific ontology, or some reduction to operational definitions of scientific measurement.

Anti-realist semantics is always intent on *re-modelling meanings in terms of something else.* If we talk about *water* but science shows water is really H_2O – why then *the philosopher must show that by 'water' we really talk about H_2O!* If we talk about consciousness but our philosophy holds that consciousness is just physical brain activity – why then *the philosopher must show that by consciousness we really mean physical brain states!* There are all kinds of failed programs to this effect in philosophy – including variations of *verificationism, instrumentalism, operationalism,* and *pragmatism*. These failed theories of meaning and logic come to the fore when the neo-positivists start defending their metaphysical views, and preaching the nonsensicality of traditional metaphysical discussions. We see this constantly in attempts to prove that time flow is metaphysically incoherent or impossible or meaningless.

The effect of this is seen not just in scientific metaphysics of course, but in neo-positivist attacks on traditional metaphysics generally. For the best example, a primary question for each of us personally is whether we have a personal identity that survives physical death, and the answer deeply affects the meaning of life. The answer makes a huge difference to how we behave and feel. Belief in Buddhist *reincarnation*, Judeo-Christian *eschatology*, Animist *spiritualism,* or materialist *annihilation* imply different attitudes and behaviours, hopes and values, in this life. It is a traditional task of philosophy to explore the implications of these – and our conception of time is basic to these questions. Neo-positivists are intent on trivialising these questions - dismissing them as pseudo-scientific questions, 'deflating' them as 'semantic confusions' - rather than exploring their significance. Their solution is to deny that we have a personal identity or even a consciousness at all! The *static theory of time* supports this trivialisation of our normal attitudes towards time and existence, by removing the existential significance of past, present and future, and prescribing a mechanistic ontology in which there is nothing to identify with 'personal identity' or 'consciousness'.

My view is that the questions about personal identity, consciousness and temporal existence remain wide open in philosophy and science, and neo-positivism – which is more or less to say, the main central tradition of Anglo-American philosophy of science in the last fifty years - has been a barren approach, and a hindrance to real philosophy.

Time flow in the metaphysics of physics.

The question whether to adopt a *static ontology* or a *time flow ontology* is the most fundamental metaphysical question in modern physics. It is intimately related to the concepts of *existence, causality* and *truth* that form the heart of naturalistic metaphysics. It is argued here that at the very least this must be maintained *as an open question in science and philosophy*. As illustrated above, leading academics have focussed for decades on attacking the concept of time flow, dismissing it as wrong, incoherent, and irrelevant to any future development of physics. Neo-positivists want to dismiss the very question of time flow once and for all from science, and hear no more about it. They would use this 'scientific result' as leverage to dismiss time flow from philosophy and metaphysics altogether. They want to *prescribe a doctrine about time* that sets the boundaries on acceptable ideas and discussions.

This doctrinal approach should be rejected in any case. The problems are too complex to be decided by the kind of simplistic arguments put forward in the literature today. The attacks on time flow are almost all based on fallacies and rhetoric. One is the fallacy of time symmetry, and the failure to recognise that physical processes have a fundamental time directionality rooted in the laws of nature. The popular 'metaphysical' arguments against time flow reflect fallacies of conceptual analysis, and these are important to recognise in philosophy generally. Given these failures of analysis, it is impossible to believe that the conventional doctrines can represent any kind of mature theory of time.

The debate cannot be conducted within the assumptions of neo-positivism itself – we must widen the conceptual view *to allow realist metaphysics to be discussed.* Chapter 4 illustrated another approach to metaphysics, presenting the *space of possible worlds* as a fundamental tool for representing questions and issues and theories. This is illustrated by summarising how a variety of metaphysical issues can be explicated in this representation. These are issues that have no realistic *representation* within the strictures of neo-positivism. The primary issue treated in detail is the representation of time flow, but a wider context is vital, and a realist treatment of concepts such as *actuality, nomic necessity (laws of nature), higher-order propositions, symmetries, consciousness, causation,* and *many worlds interpretations of quantum mechanics* are illustrated, as well as *past, present and future*.

Most importantly for physics, it is shown here that the two main choices – static versus time flow ontology - lead to quite different methods for developing empirical theories of physics. This is because they lead directly to two quite different prescriptions for *the representational space of physics or physical models.* The assumption of time flow reveals a class of new realist models that has been overlooked in mainstream physics – just like string theory reveals new models that were overlooked in mainstream physics for a long time. Until these models are properly explored and evaluated, it is impossible to verify whether they are successful. Realism about time flow is supported here in a positive way by showing the kind of alternative theory it leads to.

This raises the ongoing question for the future development of physics, rather than just for the current interpretation of theories. Most physicists will insist that *our current theories of physics are the true theories,* and rule out any alternative development. For these types of academics, the question of alternative theories is not an object of interest, it is an object of fear. They are welcome to their views but *they do not represent the scientific enterprise* - unless you want to redefine science as a kind of doctrinal bureaucracy. The interest here is in the scientific enterprise, and from this perspective, the current theories of physics are not considered finished or complete or consistent or even *understood* yet.

Time Flow Physics: the theory of the future.

We finally turn to the implications that time flow would have for physics proper if it was reintroduced into modern physics.

The fundamental dogma of modern physics.

It is no coincidence that this study begins in Part One with a critical reassessment of a cluster of false doctrines about *time symmetry*. These doctrines go deep into the psyche of the modern physics. They do not just reflect false assumptions – they reflect poor analysis, and failure to arrive at reliable and meaningful interpretations of current physics. They reflect metaphysical doctrines dressed up as 'scientific results' – and simultaneously a set of analytical methods that conceal and deny the real metaphysical dimension of scientific thought. These fundamental errors made in understanding the conventional physics of time need to be corrected before moving on to new conceptions. Any new development in physics today must start with basic, well-proven, main-stream physics. The material from real physics is very extensive and generally accurate in empirical detail, and it provides the primary material we have to work with as theorists or philosophers. If we misunderstand the meaning of this material, then new theoretical developments will be built on sand.

The serious problems confronting physics today are traced back to the fact that *our understanding of the general theories of physics has failed.* To move forward, we need to examine the failures of these theories – and this means the failures in our understanding of them. While more observational data is always nice, this will not solve the problems we are now confronted with. We are confronted with *conceptual failure.* The broad framework in which modern physics is prescribed today has two major foundations, quantum theory and relativity theory. But these have proved to be incompatible, inconsistent with each other, conceptually incomplete, and empirically anomalous in many areas.

Most famously in recent years, cosmology has thrown up ‘dark energy’ and ‘dark matter’ - but these mysterious anomalies are just the tip of the iceberg: modern physics is fraught with numerous conceptual and empirical inconsistencies and anomalies. The outcome has been a flourish of new theorising over the last decades. The world of physics is suddenly full of weird and wonderful things – multiple universes connected by worm-holes, time running backwards, many-world branching models of quantum reality, holographic universes, strings in higher-order space-time dimensions, cyclic big-bangs, singularities with infinite energy density, dark matter and dark energy, fractal generation of new universes from singularities. These are now all serious theoretical ideas (and I should add that they are interesting and creative ideas, and their inventors should be appreciated even if they turn out to be completely wrong). Yet there is barely any direct observational evidence to confirm any of them! How did the conservative and positivistic culture of physics allow this menagerie of strange metaphysical speculations to evolve?

If we look more closely however we see that these ideas are not just wild speculation – far from it. They are very *prescribed speculation.* They are prescribed by the need to conform to the two framework theories: quantum mechanics and the General

Theory of Relativity (GTR). In fact, most of the weirdest results are simply derived from mathematical extrapolations of GTR into extreme or infinite solutions, on the naïve assumption that GTR is *absolutely true (even when we put infinite quantities into it).* For example, ordinary physicists a few decades ago would hardly tolerate speculation about 'time travel' through 'worm-holes' joining different universes together through 'black holes' – but they take it seriously now, because they are told that this is *the inevitable consequence of applying GTR to regions of space with extreme energy densities and infinite quantities.* The implication of questioning such speculation is to doubt the universal truth of GTR – but such is the passion with which this theory is held, it is more acceptable to take its most bizarre physical implications as *facts,* than to question whether the theory is being taken beyond its realm of validity.

Relativistic black holes are now taken as *facts of physics* – even though normal causality breaks down within them, and they require infinite physical quantities, and no one has ever observed anything to confirm that the detailed physical properties of real 'black holes' conform to the theoretical properties described in GTR. Black holes are taken as *facts* purely because the ultimate truth of GTR is assumed, and consequently its mathematical extrapolation into the realm of infinite quantities and singularities is taken for granted. A similar point can be made about dark matter and dark energy: they are inferred by *mathematical physicists forcing a theoretical model on the universe;* yet they have never been independently or directly observed. Indeed, despite much searching, physicists cannot identify any known types of particles or matter or energy to play the role of dark matter or dark energy. And yet these substances are blithely assumed as *facts of physics.* To me this is where physics becomes *metaphysics,* in the negative sense so criticised by physicists themselves: a theoretical dogma that cannot be independently confirmed by evidence.

The primary metaphysical dogmas of modern physics however are not black holes or dark matter or dark energy, but *the belief that certain symmetries are universal, and reflect the ultimate construction of nature itself.* As such, these symmetries have no deeper explanation, they are taken as axiomatic, considered irrefutable, and provide the foundational assumptions on which all theorising is based. This is opposed to the normal 'empiricist' interpretation of science, where laws represent inductive generalisations, that might one day be found to be only approximate, or have a deeper explanation in terms of a more fundamental mechanism.

Two symmetries are considered particularly problematic here. The first is *time reversal symmetry*, as we have seen. The second is *Lorentz symmetry*, the darling of relativity theory. This is prescribed within physics by the demand to write covariant relativistic formulations of fundamental equations in tensor calculus. This symmetry is thought to reflect the fundamental properties of space-time itself - just as the Euclidean metric and the classical Galilean symmetry was thought to reflect fundamental properties of space and time in the era of classical physics. Belief in the absolute nature of Lorentz symmetry is *the* fundamental dogma of modern physics. Physicists believe that in this symmetry they have found *the absolute truth about space-time* – not just a fallible 'empirical law'.

But of course the classical (Galilean) symmetries, also regarded as universal truths in the C19th, notoriously proved to be wrong, and were eventually explained as just a special limiting case of Lorentz symmetry. How do we know the same fate does not lie in store for relativistic mechanics and the Lorentz symmetry? Most physicists would probably say that this symmetry has been so carefully tested by experiment, that it is known with practical certainty, and we can stop questioning it. But that is a delusionary reason. The fact that there are so many anomalies in physics today, so many inconsistencies between quantum theory and general relativity, and no unified theory, shows that *there is something seriously and fundamentally wrong with our current theories*. There is something wrong at a deep level. The notion that we can confirm the absolute truth of the Lorentz symmetry *on the basis of specific isolated experiments* is a mistake. Newtonian gravity was not overthrown and replaced by GTR because of specific empirical anomalies, but because the Newtonian theory as a whole did not cohere with the rest of physics. After the Special Theory of Relativity, Einstein knew that Newtonian gravity *ultimately could not be the right theory,* despite being very well confirmed by the experimental evidence at the time, because it does not fit the relativistic framework. We have to treat general theories holistically, not as piecemeal propositions. And we cannot test theories purely on their own – we need alternative theories to *compare against,* so we know what kind of anomalies and what scale of anomalous effects to look for. Physicists needed GTR to compare Newtonian gravity against, to have an idea of where it could go wrong, and how much it could go wrong by.

The most striking (claimed) implication of relativity theory is also its most bizarre: the denial of time flow, based on the denial that there is any physical relation of absolute simultaneity. If relativity theory is *not fundamental,* then this denial is most likely to be wrong. The most direct way to check the robustness of the current theory is consequently to *add the postulate of time flow back into physics directly, and see if a viable theory results*. This is the starting point for what I have called *time flow physics.*

If the physicists are right, no plausible alternative empirical theory should be possible. If they are wrong, we should find a plausible new type of theory is possible after all. Time Flow Physics is a challenge to the assumption that Lorentz symmetry is the *universal symmetry of nature*, as Einstein and Minkowski interpreted it, because if there is an absolute frame of simultaneity then the definition of this frame is not Lorentz invariant. Now this confronts the deepest metaphysical doctrine of modern physics. Physicists often complain about being pestered by cranks in physics, and will invariably tell you that *the cranks always claim they have disproved Einstein.* Conversely, any challenge to Einstein's relativity theory is now likely to be scorned as signifying a 'crank theory'. Yet the scientific method is *supposed to challenge such assumptions* – in theory.

Any successful challenge to relativity theory must be quite subtle, however. For example, the most popular 'proof' of relativity theory is the prediction that the speed of light is a maximum speed of propagation. This has been carefully tested. Its confirmation is taken as a proof of the theory as a whole. But an alternative theory does not have to contradict this principle - this is only one part of relativity theory. The alternative theory proposed here also predicts that *the speed of light is universal*.

On this subject, recent experiments to check the speed of neutrinos, by a highly respected team of physicists (the OPERA group) are illuminating. This caused a big controversy in 2011, and drew hostility from leading physicists, because the results indicated that neutrinos travelled faster than light, and this would certainly contradict relativity theory if it was true. This result was ultimately explained by experimental error however, and withdraw. It must be stressed that *this kind of experimental error is perfectly normal in science. It happens all the time.* The real failure rate of novel experiments in physics would shock people. What is really illuminating is how this drew such hostility from other physicists. It threatened their deepest metaphysical doctrine: *relativity theory and Lorentz symmetry*. The suggestion that this could be wrong is extremely threatening to physicists. Conversely, now it is corrected, physicists can be more dogmatic than ever that relativity theory is universal, but this does not follow either.

I add that the experiment to check the speed of neutrinos was a well-conceived and proper investigation at the leading edge of experimental physics. It was the fact that the OPERA group reported a result that *contradicted the orthodox metaphysics of physics* that caused such a controversy. But what are you supposed to do if your results are anomalous? In theory, you are supposed to report them, and get someone else to try to check them for errors, and try to reproduce them independently - and this is exactly what the OPERA team did. But perhaps today this is naïve: in practice, physicists have to suppress such results on pain of being tarred and feathered.

However I make no apologies for challenging the orthodox interpretation of physics. I am not an academic, and I have no vested interest in anyone else's dogmas.

Time flow physics.

The most direct way to explore a theory that challenges the Lorentz symmetry is therefore simply to propose that *there is a physical relation of absolute simultaneity,* as defined by 'the present moment' in time flow metaphysics, and *see if any theory of physics makes sense on this assumption.* I have shown how a coherent theory with this assumption can be developed. The most surprising thing is that it leads directly to a *multi-dimensional spatial model*. It is argued here that time flow allows a class of physical models that are (a) highly *realistic*, but (b) not *representable* in the static view. Time flow should remain a central *concept* of physics at least, because it allows the representation of a wider class of realistic physical models than can otherwise be conceived.

In fact a time flow theory provides a real *contrast of* explanations and insights into many problems in conventional physics and cosmology – even if this turns out to be empirically wrong, it should be evaluated. The bottom line is that *if time flow is real*, then the current theories can *never* succeed in explaining the key phenomena of cosmology, gravity and particle physics. If we don't look at alternative explanations, how will we ever know? Theories in science are not bad or worthless or cranky simply because they are *wrong*. Almost all the best theories we have ever had in physics have been wrong.

This new theory has a simple ontology with very powerful symmetries. Symmetries remain the key feature, driving the conception of the model, and determining the form of equations within tight constraints. However the symmetries are not the same as those physicists currently expect and demand and prescribe as physical symmetries for future theoretical developments. There are two profound differences in symmetries, both to do with time. The first is a failure of *time reversal symmetry,* which physicists currently claim to be a deep and guiding principle of physics. The second is the replacement of ordinary *covariance,* or Lorentz symmetry, with something more fundamental.

This will sound shocking to main-stream physicists: *how could you make a realistic theory without such symmetries?* And yet of course there has to be some shocking difference for it to be a new theory at all! And there are two very good explanations for the failure of these symmetries. (A) Time reversal symmetry actually *does not hold for current theories of physics either!* The notion that it is a real symmetry of physics, or a real symmetry of time, is a myth. This is what is shown in Part 1. So in fact, the new theory does not differ from our current theories in this respect – but the explicit recognition that it is time asymmetric has a powerful effect in conceptualising the theory. (B) Ordinary *covariance* or Lorentz symmetry is replaced with a more powerful symmetry, that generates the appearance of a covariant theory in the normal realm of phenomena – just like Lorentz symmetry approximates to classical Galilean symmetry at low velocity and energy, or the curved space-time of General Relativity approximates to the flat space-time of Special Relativity at low gravity. But Lorentz symmetry is ultimately *not fundamental, it is generated from the mechanical symmetries of a more fundamental multi-dimensional model of space.*

This is the point where the new theory really departs from current expectations – it falls outside the ability of current physicists to *represent,* because they have chosen to *prescribe the representational space for theories of physics.* This is effectively done by prescribing a *covariant tensorial formulation for the equations of physics*. This choice of representation really prescribes *a metaphysical belief in a certain symmetry.* This prescription occurs precisely through the rejection of *time flow* in modern physics, and the adoption of the *static space-time manifold*. But before tackling this, we need to clarify the more mundane issues about time symmetry and directionality in the ordinary physics of time.

These footnotes have only incomplete references. References provided in the book version.