What Bergson Should Have Said to Einstein[1]

Let me begin by repeating (changing only the name) a paragraph from a recent paper by David Chalmers.

> I should say that I am not a historian or a serious scholar of Bergson. These are merely some speculative remarks not well-grounded in scholarly attention to Bergson's texts. But I think the speculative question is interesting. I'm going to sketch one speculative answer. I'm going to be interested to hear from people who know much more about Bergson than I do about whether this speculation has any remote plausibility. If the historical speculation has none, as may well be possible, I think there is still a very interesting philosophical project in the neighborhood which is itself worthy of attention.[2]

My speculative remarks concern the famous debate between Henri Bergson and Albert Einstein that took place in Paris on 6 April 1922. This encounter has recently received a book-length treatment,[3] but little of the substance of the debate was actually reported in it. Einstein and Bergson disagreed, unsurprisingly, as to whether time is better understood through scientific or philosophical examination.[4] But in regard specifically to Bergson's views concerning time in the special theory of relativity, we

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[1] This paper was delivered at the Reasssessing Bergson conference held in Cambridge, England on 11-12 September 2019. I am grateful to the co-organizers of the conference (Theo Borgvin-Weiss, Florian Fischer, Sam Sokolsky-Tifft, and Zoe Wallker) for inviting me to this meeting. The conference proceedings are intended to be published as the contents of issue 1 of a new journal, *Bergsoniana*, sponsored by the Société des amis de Bergson. While my paper has been in press, it has come to my attention (4 June 2020) that a second paper arguing that Bergson should have embraced local passage in relativistic spacetimes, "What Bergson should have said about special relativity" by Peter Kügler, was published in *Synthese* (May, 2020). It was received by that journal 11 December 2019.

[2] See "Carnap's Second *Aufbau* and David Lewis's *Aufbau*" by David Chalmers at philarchive.org. In this *tour de force* Chalmers speculates on the nature of a book that Carnap indicated that he intended to write but never did write—a physicalist version of his (phenomenalist) *Aufbau*—and the nature of a book by David Lewis that Lewis did not even indicate an intention to write.

[3] *The Physicist and the Philosopher* by Jimena Canales (Princeton University Press, 2015). I will refer to this book below as P&P.

[4] Indeed, Canales cites this debate as one of the sources of the increasing gulf between scientific and humanistic treatments of time in the 20th century.

have the evidence of a book he wrote on that topic at the time of the debate, *Duration and Simultaneity*.[5] My remarks in this paper primarily concern claims of Bergson in that book, claims that deal specifically with time in STR (the Special Theory of Relativity), and I will leave it to others, should they wish, to tease out their implications for some of Bergson's more general theses concerning time.

STR is well-known for showing that certain quantities or relations (length, mass, simultaneity) that were regarded as frame-invariant or absolute in pre-relativistic physics are actually frame-dependent or relative. One standard and striking illustration of these novel and unintuitive ideas is the so-called "twin paradox."[6] One way of presenting the "paradox" is to imagine a pair of identical twins. One travels to a distant galaxy on a rocket ship at very high speed and then returns to earth at the same high speed. The other remains on earth. STR implies that the travelling twin on their return will have aged less than the stay-at-home twin.

Bergson did not accept this conclusion. In fact, he argued that

(1) The clock paradox is false. The sort of behaviour described in the clock paradox will not in fact occur using clocks in our world.

(2) The clock paradox results from a misunderstanding of STR. Therefore one can deny that the behavior described in the clock paradox would actually occur while accepting all of STR (that is, all the valid mathematical/physical core of STR) itself.

I think that any fair-minded reader of D&S will agree that Bergson argued for (1) and (2) above. Let me give just one bit of textual evidence (from the third Appendix to the second edition) that supports both claims.

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[5] *Duration and Simultaneity* (first published in French in 1922 as *Durée et Simultanéité*). A second edition was published in 1923 with three important appendices added. The English version that I use here was published by The Bobbs-Merrill Company, Inc. in The Library of Liberal Arts (1965). The translator is Leon Jacobson. I will refer to this book below as D&S.

[6] I prefer to refer to it by the more generic term *the clock paradox*. Of course, it is not a paradox at all; it is just one of the many counter-intuitive implications of STR. For an illuminating, at-the-time-comprehensive discussion of failed responses to the clock paradox see *Time and the Space Traveller* by L. Marder (University of Pennsylvania Pres, 1971). For a sophisticated modern philosophical account of the "paradox" see chapters 5 and 6 of Richard Arthur's *The Reality of Time Flow* (Springer, 2019).

In short, there is nothing to change in the mathematical expression of the theory of relativity. But physics would render a service to philosophy by giving up certain ways of speaking which lead the philosopher into error, and which risk fooling the physicist himself regarding the metaphysical implications of his views. For example, we are told above that "if two identical, synchronized clocks are at the same spot in the system of reference, if we shift one very rapidly and then bring it back again next to the other at the end of time t (the time of the system), it will lag behind the other by $t - \int_0^t a\,dt$." In reality, we should say that the moving clock exhibits this slowing at the precise instant at which it touches, still moving, the motionless system and *is about to re-enter it*. But immediately upon re-entering, it points to the same time as the other…. (D&S,185)

Unfortunately, claims (1) and (2) are incorrect. In 1971 an experiment was done that directly tested the clock "paradox". It was reported in a two-part paper. I will simply quote the abstracts to the two parts.

During October 1971, four cesium beam atomic clocks were flown on regularly scheduled commercial jet flights around the world twice, once eastward and once westward, to test Einstein's theory of relativity with macroscopic clocks. From the actual flight paths of each trip, the theory predicts that the flying clocks, compared with reference clocks at the U.S. Naval Observatory, should have lost 40 ± 23 nanoseconds during the eastward trip, and should have gained 275 ± 21 nanoseconds during the westward trip. The observed time differences are presented in the report that follows this one.[7]

Four cesium beam clocks flown around the world on commercial jet flights during October 1971, once eastward and once westward, recorded directionally dependent time differences which are in good agreement with predictions of conventional relativity theory. Relative to the atomic time scale of the U.S. Naval Observatory, the flying clocks lost 59 ± 10 nanoseconds

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[7] Hafele, J. C. and R. Keating, "Around-the-World Atomic Clocks: Predicted Relativistic Time Gains," *Science*, New Series **177** No. 4044, 14 July 1972: 166-168.

during the eastward trip and gained 273 ± 7 nanoseconds during the westward trip, where the errors are the corresponding standard deviations. These results provide an unambiguous empirical resolution of the famous clock "paradox" with macroscopic clocks.[8]

   So thesis (1) above is false. As for (2), it is important to see not just that it is false, but also how central it is to STR that it is false. To that end, let me show you two illustrations from a remarkable popular book about relativity, Robert Geroch's *General Relativity from A to B*. First, we will look at Figure 34 on page 75 of that book.[9]
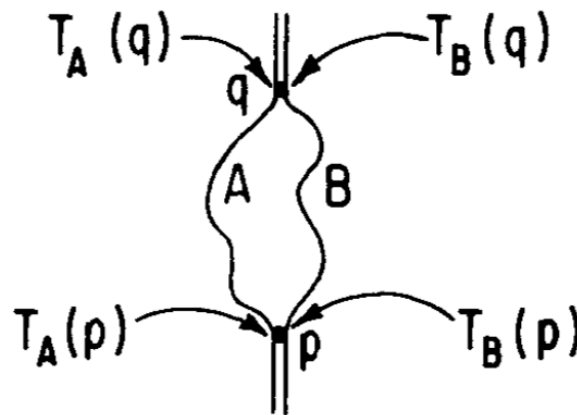

Fig. 34
Space-time diagram of an experiment involving two clocks, *A* and *B*. The clocks separate at event *p*, and return together at event *q*. Is the elapsed time according to *A* between *p* and *q* the same as that according to *B*?

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[8] Hafele, J. C. and R. Keating, "Around-the-World Atomic Clocks: Observed Relativistic Time Gains," *Science*, New Series **177** No. 4044, 14 July 1972:168-170

[9] The University of Chicago Press, 1978.

Then we turn to Fig. 35:

$$t = T_A(q) - T_A(p)$$
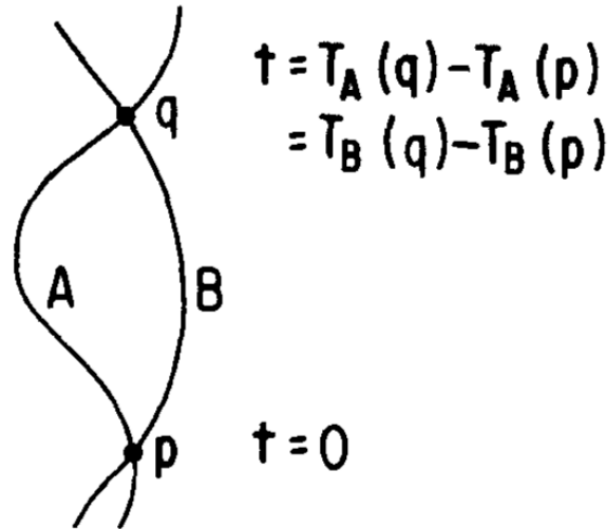$$= T_B(q) - T_B(p)$$

$$t = 0$$

Fig. 35

Under the supposition that the answer to the question of figure 34 is yes, we obtain a universal time in space-time. The measured elapsed time from p to q must be the same no matter what clock measures this time, and so, assigning to p time $t = 0$, a unique time is assigned event q.

Event q is just an arbitrarily chosen point in spacetime. So therefore any event in spacetime (if we answer *yes* to the question posed by Geroch) can be assigned a unique time, once we assign t=0 to p. And therefore we can collect all events assigned the same time into surfaces, thus obtaining the "universal time" that Geroch mentions. The resulting spacetime structure is what Geroch calls *Galilean spacetime*. It is the spacetime perhaps best adapted to be the setting of Newton's mechanics, but it has

too much structure (the unique same-time surfaces) to be Minkowski spacetime, the spacetime of STR. A *yes* answer to Geroch's question is inconsistent with STR.[10]

So we must respond to Geroch's question with *no* (in STR). A convenient way to express this response is to say that in STR *time is path-dependent*. The path-dependence of time is, then, central to STR. The clock paradox is merely one specific manifestation of the path-dependence of time.

According to Canales, Bergson paid dearly for this mistake. He enjoyed rock-star celebrity in 1922 but died in obscurity.

> By the time Bergson died on January 3, 1941, the event was particularly shocking because the world had already fallen into the habit of thinking of him as dead. His debate with Einstein precipitated the vertiginous downward fall. (P&P, 31)

What I wish to say here, tentatively, is that it need not have been so. Bergson did not play his philosophical hand as well as he could have in the debate with Einstein (and in *Duration and Simultaneity*). It might well have been better for him personally and for the course of philosophy in the twentieth century if he had. I will now try to make this case, but I would like to lay it out in a slightly round-about manner.

First, I think that any fair-minded reader of D&S would have to conclude that Bergson made a serious and sustained effort to understand STR. The theory was accepted by the community of theoretical or mathematical physicists surprising rapidly, but it was nevertheless a complex and counter-intuitive theory that still has the power to startle anyone who studies it. In the century since its advent, its central ideas have been clearly distinguished and the arguments for or derivations of the odd relativistic effects

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[10] Milič Čapek in *Bergson and Modern Physics: A Reinterpretation and Re-evaluation* (Reidel, 1971) claims that "Bergson was right as long as we remain within the framework of the special theory of relativity." (p. 246) The common mistake that the general theory of relativity is required to remove the apparent paradoxical nature of the clock "paradox" is effectively dealt with in the book by Marder referred to above.

have been simplified and polished.[11] It's much easier for us now to see what is essential to STR than it would have been for Bergson then.

    It is not shocking, then, that he took an essential idea of STR for an optional philosophical gloss. He doubtless had salient reasons for (erroneously) convincing himself of this view; but I also think that he had sufficient respect for experiment to believe that, had it been possible to do an experiment like the Hafele and Keating experiment in, say, 1920, he would have accepted the result. Two real clocks make round-the-world trips in *each* direction. Neither of them is imaginary. I do not know what exactly led Bergson to reject the twin thought-experiment, to reject that idea (as I would like to put it now) that there could be real time along two trajectories in (Minkowski) spacetime between a pair of events like *p* and *q* in Figure 34 above, even though the times measured along the world lines were not the same. (That is, even though $T_A(q) - T_A(p) \neq T_B(q) - T_B(p)$.) But I do think—or at least I would like to conjecture—that had he seen the evidence against (1) above, he would have changed his mind.

    By the 1970s the state of knowledge had changed considerably from that of 1923. The question to ponder is not, I submit, *whether* Bergson would have changed his mind about the clock paradox, but *how* would he have have changed it? I will hazard one conjecture, but I am aware that many others are possible.

    Consider the aphorism that appears on page 65 of D&S: "[T]ime is succession." Let us ask ourselves what Bergson could say if he had been asked (or had asked himself): a succession of what? Most philosophers of time—and probably most non-philosophers as well—would after some thought suppose that time is a succession of sets or collections of simultaneous instantaneous events spanning the universe. (There might be some hesitation as to whether the events are instantaneous or have some small duration, but that choice makes no difference to my story in this paper.) These

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[11] For an elegant popular introduction to all the standard STR phenomena, see N. David Mermin's *Space and Time in Special Relativity* (Waveland Press, 1968). Mermin discusses the clock paradox on pages 187-194 in a version involving three inertial observers (and so no acceleration). It is remarkably instructive to calculate in detail the example from the perspective of *each* of the three clocks or "observers".

sets of events occur one after another. That is, they occur successively. This succession is the unfolding or happening or history of the universe.[12]

   This answer would not be available to Bergson. A global or universe-wide set of simultaneous events is what he would call—if I understand him correctly—a snapshot of the universe. The idea that time is the succession of such snapshots is precisely the cinematographic conception of time that he castigated in *Creative Evolution*. He might, of course, reconsider that old view of his, but a reconsideration in light of STR makes it less, rather than more, plausible. In STR, at any given spatio-temporal location there is no special (or "metaphysically privileged"[13]) snapshot. There are only an infinite number of equally non-special snapshots. This multiplicity does not provide an attractive foundation on which to build a metaphysics of time.

   I believe there is a better choice for Bergson. Consider the two paths followed by two clocks connecting events *p* and *q* in figures 34 and 35. Each path is a set of events that occur successively. Each path could be the path of a space traveller.[14] Instead of trying to confine real or lived time to just one such path,[15] allow real or lived time, at least potentially, along each path. Embracing the twins rather than rejecting them is surely a step in the right direction, a recognition of what STR says and the weight of evidence in its favour.

   But of course this step raises new questions. What of triplets? There is no reason to stop at two, it seems. Each of their three paths in spacetime would be sets of events that occur successively. To put this point another way, suppose there were three distinct timelike curves connecting points *p* and *q* in Geroch's figures. Then there would be in general three distinct (proper) times along each such world line, each potentially equally "real" or lived or genuine. But once this line of thought is started,

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[12] Bergson speaks of "the singleness of an impersonal time. Such is the hypothesis of common sense." (D&S, 47) He goes on to imply that Einstein supports this hypothesis.

[13] A notion that is often invoked but rarely explained.

[14] Allowing for the fact that, if the space traveller is human, some paths have accelerations that humans cannot survive.

[15] "The real is that which is measured by a real physicist, and the imaginary, that which is represented in the mind of the real physicist as measured by imaginary physicists." (D&S, 79)

one should see that there is no natural finite end to it. There is no non-arbitrary upper bound on the number of timelike curves connecting p and q (or any other pair of points in spacetime) with associated proper times.

Why not, then, trade the constricted or anemic conception of lived time that we find in *D&S* (lived time on one timelike curve, ghostly time on the others) for a robust conception of genuine time flourishing equally on *all* timelike world lines?[16] Of course, this need not presuppose or entail that all timelike worldlines are the paths in spacetime of conscious "observers" or clocks. It would entail or presuppose that all such worldlines are *potentially* the paths of such "observers" or clocks. On this view, Minkowski spacetime would teem with times.[17]

I have to say 'times' because, as noted above, time is path dependent and there is a non-denumerable infinity of paths connecting any two timelike separated points like p and q in the two figures above. Although this plurality of times may seem philosophically puzzling, *any* account of time (or at least any that I am acquainted with) brings some philosophical puzzles in its train. But there is also a great philosophical advantage as well. This point of view is a necessary corrective to the mistake, often made by physicists as well as philosophers and historians,[18] that the spacetime of STR is somehow "static" or a "block universe." Here, for instance, is the opinion of one eminent philosopher, Sir Karl Popper:

> And a deterministic system such as the field theory of Einstein might even be described as a four-dimensional version of Parmenides' unchanging three-dimensional universe. For in a sense no change occurs in Einstein's four-dimensional block-universe. Everything is there just as it is, in its four-dimensional *locus*; change becomes a kind of 'apparent' change; it is 'only' the observer who as it were glides along his world-line and becomes

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[16] This picture is fleshed out and defended in "Neither Presentism nor Eternalism" by the physicist Carlo Rovelli, in *Foundations of Physics* 49 (2019): 1325-1335.

[17] And Bergson did write "We believe that a philosophy in which duration is considered real and even active can quite readily admit Minkowski's and Einstein's space-time…" (D&S, 63)

[18] Canales writes that "Einstein's theory… on its own… describes a universe where our sense of time passing by us was an illusion." (*P&P*, 275)

successively conscious of the different *loci* along this world-line; that is, of his spatio-temporal surroundings . . .[19]

This sort of (confused, I suggest) idea is no doubt one that lies behind (or beneath) disputes about time that continue to this day. As Canales says, near the end of her book,

As the [20th] century drew to a close, the "time of the universe" and "lived time" appeared as irreconcilable as science and philosophy in ways that exceeded the discussion that took place that day. (P&P, 348)

But this source of division (and confustion) could have been scotched by Bergson. Had Bergson accepted the result of the clock paradox, he could have *correctly* pointed out to Einstein that Minkowski spacetime, far from being a static or so-called "block universe", is chock-a-block (as it were) with temporal dynamism.[20] For all I know, by the way, he could have been the first to point this out, thus gaining (from my point of view at least) a far more significant place in the history of philosophy and physics of time than he has today.

Students of Bergson may suspect that he could not have changed his views regarding STR in the way I have suggested without altering other, very fundamental views, as well. They may be right. My reflections above concern the behaviour of clocks—more specifically, the behaviour of ideal clocks on timelike world lines. For Bergson, such behaviour is only indirectly indicative of anything at all about time itself. Here's a typical remark in this vein:

It is therefore the simultaneity between two instants of two motions outside of us that enables us to measure time; but it is the simultaneity of these

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[19] *Conjectures and Refutations* (Basic Books, New York and London, 1962), p. 80.

[20] Čapek writes that Bergson "failed to see that the relativistic space-time, correctly interpreted, far from implying the elimination of becoming, reintroduces it into the physical world." (*Bergson and Modern Physics*, 252) Either Bergson failed to see this correct interpretation, or he thought that it had philosophical costs that he was reluctant to pay, as I suggest below.

moments with moments pricked by them along our inner duration that
makes this measurement one of time. (D&S, 54)

The root idea here is, I believe, that time, real time, is accessible to our
consciousness whereas the quantity measured by clocks is some sort of derivative
quantity or secondary shadow of genuine duration. I think this view is deeply mistaken,
but it will not be possible to argue that point in any detail within the confines of this
talk. The best I can do in this short compass, I think, is to quote a perceptive statement
of a view more like the one I favour by Ernst Cassirer:

> For Newton it was certain that the absolute and mathematical time, which
> by its nature flowed uniformly, was the "true" time of which all empirically
> given temporal determination can offer us only a more or less imperfect
> copy; for Bergson, this "true" time of Newton is a conceptual fiction and
> abstraction, a barrier, which intervenes between our apprehension and the
> original meaning and import of reality. But it is forgotten that what is here
> called absolute reality, *duree reelle,* is itself no absolute but only signifies a
> standpoint of consciousness opposed to that of mathematics and physics.
> In the one case, we seek to gain a unitary and exact measure for all
> objective process, in the other we are concerned in retaining this process
> itself in its pure qualitative character, in its concrete fullness and subjective
> inwardness and "contentuality." The two standpoints can be understood in
> their meaning and necessity; neither suffices to include the actual whole of
> being in the idealistic sense of "being for us." The symbols that the
> mathematician and physicist take as a basis in their view of the outer and
> the psychologist in his view of the inner, must both be understood as
> *symbols.* Until this has come about the true philosophical view, the view of
> the *whole,* is not reached, but a partial experience is hypostasized into the
> whole.[21]

A recurring theme in Canales's book is that the disagreement between Bergson and
Einstein regarding time is one of the sources of the twentieth-century rift between
continental and analytic (or humanistic and science/logic inspired) philosophical

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[21] This quote appears on pages 454-455 of the Supplement to Cassirer's *Substance and Function*,
"Einstein's Theory of Relativity considered from the Epistemological Standpoint," which first appeared in
German in 1921. I quote from the English translation by William C. Swabey and Marie C. Swabey, which
was first published by the Open Court Publishing Co. in 1923 and which was reprinted by Dover
Publications in 1953.

schools. I am not enough of a historian to have an informed opinion on this matter.[22] But insofar as she is correct, then I suggest that that source of the rift was spurious. Bergson could have replaced his tortured denials of the clock paradox with a recognition that succession along timelike worldlines is dynamic and, at least potentially, lived. I contend that neither humanists nor scientists need dissent.

Čapek ends his chapter on Bergson and Einstein by noting that "it is clear that to separate what is living from what is dead in Bergson's interpretation of relativity theory is a complex task." My minimal hope is to convince the reader at least that Bergson's denial of the clock paradox is a dead element of his thought. My maximal hope is that reflection upon the clock paradox and STR will lead those who are sympathetic to Bergson's ideas to look more sceptically on his privileging one side of a deeply complex phenomenon (time only as psychological time) to a balanced appreciation of the whole (time as experienced and *the same time* as measured by clocks).

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[22] For a different, but possibly complementary, account, see Michael Friedman's *A Parting of the Ways* (Open Court, 2000).