

Palle Yourgrau

## WHEN TIME TURNED INTO SPACE

### Abstract

*It has become a commonplace among intellectuals to speak of space-time instead of space and time. It is taken as a sign of scientific literacy. This seemingly harmless custom masks an alarming tendency in which thinking, today – especially about such abstract concepts as space and time – is being increasingly palmed off onto what is spoken of in hushed tones as Science, with a capital “S”. It is increasingly forgotten that science itself is knee deep in philosophical assumptions and presuppositions, and that the deliverances of science – including mathematical science – are in need of philosophical interpretation, and at times, correction. In the case of space-time, the question is whether the age-old dialectic of time vs. space, so fruitful for the development of western thought, is now, with the advent of relativity, in danger of disappearing, just as time itself has seemingly disappeared into relativistic space-time. We must ask ourselves: have the new dogmas of the new Church of Science simply replaced the old dogmas of the old Church?*

“We cannot obtain for ourselves a representation of time, which is not [itself] an object of outer intuition [whose form is space], except under the image of a line [i.e. an object of outer intuition, space], which we draw [... W]e [thus] endeavor *to make up for this want* [of an image or shape of time] by *analogies* [...]”

I. KANT, *Critique of Pure Reason*

Whatever became of time? Marcel Proust may have been searching for times lost, but it is time itself that has long since disappeared. It happened in 1905. While the rest of the world was sleeping, a Swiss patent clerk turned time into space. To be more precise, it happened when Hermann Minkowski teamed up with Albert Einstein to create four-dimensional Einstein-Minkowski space-time. As Minkowski famously declared, “henceforth, space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.”<sup>1</sup> It was a self-fulfilling prophecy. Time has, just as Minkowski predicted, faded away into a

---

<sup>1</sup> H. MINKOWSKI, *The Union of Space and Time*, in M. CAPEK (ed.), *The Concepts of Space and Time: Their Structure and Development*, D. Reidel Publishing Company, Dordrecht 1976, p. 339.

mere shadow. Today, over a century later, it has become fashionable to speak of space-time, instead of space and time. Every school child does it<sup>2</sup>. To speak otherwise is to put oneself in the company of the Flat Earth Society. A reference to space-time is taken as a sign that one is scientifically educated, that one has heard the sound of Einstein's violin. Immanuel Kant's clear, categorical distinction between the two forms of intuition, space vs. time, has been relegated to the unscientific past, to be replaced by a single geometrical (i.e. spatial) idea known as space-time<sup>3</sup>. Even philosophers, who should know better, have not escaped this trend. The philosopher of science Hilary Putnam has written, explicitly, that after relativity, "*there is no more philosophy of time*, there is only the question of determining the correct *geometry* of space-time"<sup>4</sup>.

Now, it should go without saying, though, unfortunately, I need to say it, that this is an alarming development, a kind of tragedy (or perhaps, comedy), for since the dawn of western civilization, time has struggled to keep pace with space. "[We] do not know what to do about time," wrote Abraham Heschel in *The Sabbath*<sup>5</sup>, "except to make it subservient to space." Since Plato – who, with his hero, Parmenides, held time in great suspicion, finding a conflict between the idea of time and the idea of being – everything western thought has touched has, in a strange twist of Midas, turned into space. Indeed, according to tradition, Plato, who in *The Republic* had taken great pains to remove time

---

<sup>2</sup> Indeed, as the mystical French philosopher Simone Weil has written, "[the restricted theory of relativity] is a very simple theory, so long as one does not try to understand it." (S. WEIL, *Reflections on Quantum Theory*, in EAD., *On Science, Necessity, and the Love of God*, ed. and transl. Richard Rees, Oxford University Press, London 1968, p. 49).

<sup>3</sup> As Nandor L. Balazs asserts, "Minkowski recast the special theory of relativity in a form which had a decisive influence in the geometrization of physics." (Quoted by John Stachel [see below]). Einstein himself, however, in *Comment on Meyerson's 'La deduction relativiste'* (in M. CAPEK (ed.), *The Concepts of Space and Time*), pp. 366-367, denied that relativity theory spatializes time, as pointed out by Stachel (J. STACHEL, *Einstein, Albert*, in *Complete Dictionary of Scientific Biography* (2008), [http://www.encyclopedia.com/topic/Albert\\_Einstein.aspx](http://www.encyclopedia.com/topic/Albert_Einstein.aspx)). Stachel fails to note that Einstein's discussion is itself in need of scrutiny. Meyerson "rightly insists," says Einstein, "on the error of many expositions of Relativity which refer to the 'spatialization of time'. Time and space are fused in one and the same *continuum*, but this continuum is not isotropic, and the element of spatial distance and the element of duration remain *distinct in nature*, distinct even in the formula giving the square of the world interval of two infinitely near events." (Second emphasis added). It is hard to see, however, how exactly, in relativity, spatial distance and duration are "distinct in nature". They are distinguished, to be sure, in the formula for the interval, as Einstein insists, but this is in effect a *geometrical* distinction, not a representation of a *categorical* difference, à la Kant, of two different natures. In the formula of the Pythagorean theorem, for example, the hypotenuse is *distinguished* from the other two sides: the square of the hypotenuse is equal to *the sums of the squares* of the other two sides. Does this indicate that the hypotenuse is of a "distinct nature" from the other two sides?

Simone Weil sizes up the situation perfectly: "In these equations [of relativity] the letter representing time and each of those representing the three co-ordinates of space are found to figure symmetrically. The translation of these equations into common speech has produced those paradoxes – time as a fourth [spatial] dimension – which have procured for Einstein a somewhat cheap reputation." (S. WEIL, *Reflections on Quantum Theory*, pp. 49-50; brackets added).

<sup>4</sup> H. PUTNAM, *Time and Physical Geometry*, in ID., *Mathematics, Matter and Method: Philosophical Papers*, Vol. 1, Cambridge University Press, Cambridge, 1979, p. 205. (Emphasis added).

<sup>5</sup> Farrar Straus Giroux, New York NY 2005.

from geometry<sup>6</sup>, put his cards on the table by inscribing over the entrance to his Academy, “Let no one ignorant of geometry enter here.” It was left to Einstein, however, whose own motto might well have been, “everything is something else”<sup>7</sup>, to deal the final blow<sup>8</sup>. A blow to philosophy<sup>9</sup>, as such, it turns out, as much as to time.

For space-time, *pace* Minkowski, is not something that is neither space nor time; it is in fact a new kind of *space*. It represents a generalization of the concept of space, not, as some have argued, a generalization of the concept of time<sup>10</sup>. What distinguishes a spatial

<sup>6</sup> As Socrates says, “[...] if geometry compels the soul to study being, it’s appropriate, but if it compels us to study becoming, it’s inappropriate. [...] Now [...] this science is entirely the opposite of what is said about it in the accounts of its practitioners. [...] Their accounts refer to doing things [...] They talk of ‘squaring’, ‘applying’, ‘adding’, and the like, whereas the entire subject is pursued for the sake of [pure] knowledge [of being].” (PLATO, *The Republic*, 527 a – b, transl. G.M.A. Grube, Hackett Publishing Company, Indianapolis/Cambridge 1992, brackets added). Einstein, in his *Comment on Meyerson’s ‘La deduction relativiste’*, p. 366, expressed the exact opposite view, claiming that “[e]ven before the theory of relativity, there was no justification for considering geometry, as opposed to physics, an *a priori* science. Those who adopted this point of view were forgetting that geometry is the science of the possibilities of the displacement of solids.” Ironically, however, with the construction of space-time – a (tenseless) four-dimensional space (see below) – Einstein ended up realizing Plato’s dream of a geometry free from time. It is an example, perhaps, of what Hegel called “the cunning of History”.

<sup>7</sup> Not only did Einstein with the invention of spacetime turn time into space, he turned energy into mass ( $e = mc^2$ ) and gravity into space-time curvature (geometry, yet again). Just as it can be contested, however, whether he really succeeded in turning time into space, it needs to be examined whether he succeeded in turning energy into mass (or vice versa). It is far from obvious whether his most famous equation demonstrates that “energy” and “mass” are just two terms for the same thing, as shown by Marc Lange in *The Most Famous Equation*, in “The Journal of Philosophy”, 98 (5/2001). Yet, as Lange points out, the noted physicist/philosopher Max Jammer asked, rhetorically, “[a]re therefore not ‘mass’ and ‘energy’ merely synonyms for the same physical reality, which [...] may perhaps be termed ‘massenergy’?” In response, Lange poses his own rhetorical question: “[g]iven that mass is a real property (since it is Lorentz invariant) [i.e. the same in every inertial frame] whereas energy is not, how can mass and energy be the same thing (‘mass-energy’) [...]?” (p. 227, brackets added).

<sup>8</sup> That Einstein was in effect bringing to completion a project begun by Parmenides emerges clearly from a conversation that the philosopher of science Karl Popper had with Einstein: “I tried to persuade him,” writes Popper, “to give up his determinism, which amounts to the view that the world is a four-dimensional Parmenidean block universe in which change is a human illusion or very nearly so. (He agreed that this had been his view, and while discussing it I called him ‘Parmenides’).” (K. POPPER, *The Open Universe: An Argument for Indeterminism*, Rowman and Littlefield, Totowa 1982, Note 2).

<sup>9</sup> Indeed, it can be argued that the world-historical but now little noted debate in 1922 at the *Société française de philosophie* in Paris about the nature of time between the physicist Einstein and the philosopher Henri Bergson, which the physicist – dismissive of philosophy – was thought to have won, marked the ascendancy of physics over philosophy in the quest for pure reason, which continues to this day. Bergson’s objections, however, were not without consequence. Einstein did not receive the Nobel Prize for his work on relativity. “Most discussion [of Einstein’s work],” said the President of the Nobel Prize Committee, “centers on his theory of relativity. This pertains to epistemology and has therefore been the subject of lively debate in philosophical circles. It will be no secret that the famous philosopher Bergson in Paris has challenged this theory [...]”. The historian of science Jimena Canales is writing a book, from which this quotation is taken, *The Time that Einstein Lost*, shining new light on this long forgotten debate.

<sup>10</sup> Milic Capek, for example, suggests that space-time represents not a spatialization of time but rather a temporalization of space. See *The Inclusion of Becoming in the Physical World*, in ID. (ed.), *The Concepts of*

from a temporal manifold is that positions in a space have no ontological significance. *Where* you are in space does not tell us *whether* you are. The reverse is true of time. Socrates belongs only to the past. Hence, he no longer is. By contrast, when, in *The Wizard of Oz*, Dorothy realized she was no longer in Kansas, this told her where she was [or wasn't], not whether she was. Thus, the very idea of time – in the intuitive sense, in which “the now” flows, sweeping things into and out of existence – is disappearing. And, sadly, this is but one aspect of a general phenomenon in which one's deepest philosophical intuitions and insights are being abandoned in light of what are considered definitive statements delivered by Science, with a capital “S”<sup>11</sup>.

The age-old dialectic of the intuitive and the formal, the very life-blood of true science, is being extinguished<sup>12</sup>. We need our philosophical intuitions to “police” our

---

*Space and Time.* Now, one can generalize the concept of space, for example, from “flat” to “curved”, and thus novel geometries represent novel spaces. But if, as Kurt Gödel argued, in his new world models for (general) relativity there exist closed temporal curves representing time-travel, then such geometrical structures rule out the possibility that there is such a thing as time, in the intuitive sense, in those relativistically-consistent worlds. For if we can revisit the past, it follows that it never really *passed*. (Gödel has an additional, much maligned, “modal” argument, that if time is *possibly* ideal in such world models, it follows that it is also ideal in the *actual* world. I have argued that this argument is much more forceful than is usually thought. For references, see below).

The fact that the possibility of time travel would spell the end of time – and that certain geometries represent not a generalization of time, but its elimination – is often missed, because a time *circle* is confused with a time *cycle*. A cycle is a temporal process that is repeated, that goes around, over and over, *n* times. A circle, by contrast, is a closed geometrical curve, in which nothing “goes around”. It is a spatial, not a temporal concept. A genuine time traveler would not bounce around from the present back to the past, and back again to the present, *over and over again*. Science fiction writers, for example, for “Star Trek”, and also Alan Lightman, in his popular *Einstein's Dreams* (Vintage, New York NY 2004) deceive their audiences about this sobering fact, since they conflate time *circles* with time *cycles*. Thus Lightman, a trained physicist who should know better, writes in *Einstein's Dreams*, p. 8: “Suppose time is a circle, bending back on itself. The world repeats itself, endlessly, precisely. For the most part, people do not know they will live their lives over. [...] Politicians do not know that they will shout from the same lectern an infinite number of times in the cycles of time.” What Lightman describes here is obviously a *cycle* of times, not a time *circle*.

<sup>11</sup> As Simone Weil wrote: “Respectable scientists like de Broglie himself accept wave mechanics because it confers coherence and unity upon the experimental findings of contemporary science, and in spite of the astonishing changes it implies in connection with ideas of causality, time, and space, but it is *because* of these changes that it wins favor with the public. The great popular success of Einstein was the same thing. The public drinks in and swallows eagerly everything that tends to dispossess the intelligence in favour of some technique. It can hardly wait to abdicate from intelligence and reason [...]” (S. WEIL, *Wave Mechanics*, in EAD., *On Science, Necessity, and the Love of God*, p. 75; emphasis added).

<sup>12</sup> If I may be permitted to wax Hegelian for a moment, I would like to say that human thought progresses through a dialectic between each of a series of opposing categories – space vs. time, the discrete vs. the continuous, number vs. line, straight vs. curved, etc. – and that from time to time great advances are made in partial “reductions” of the one to the other (as in Georg Cantor's “arithmetization of the continuum”). The crucial term, here, however (as Karl Popper used to emphasize, in a related context), is “partial”. To believe that one can eliminate one side of such an opposition in favor of the other is to succumb to a dangerous illusion. The illusion goes back to classical science. “[...] C]lassical science,” wrote Simone Weil, “claimed to resolve the contradictions, or rather the correlations of contraries, which are integral to the human condition [...] For example, the continuous and the discontinuous are given to us; we think both in terms of space and of number [...whereas c]lassical science wanted to suppress the discontinuous [... O]ne cannot reasonably hope

formalisms, to keep them honest, just as we need formal theories to correct, extend, and systematize our intuitions. As the logician John Myhill wrote (speaking of the extreme formalism of mathematical logic): “Ultimately, formalism in its private aspect is an expression of fear. But fear can lend us wings and armor, and formalism can penetrate where intuition falters, leading her to places where she can again come into her own.” Just this, however, the extreme and thoughtless deference to the deliverances of Science – as in the glib gestures of the educated to space-time, in place of space and time – is inhibiting. In short, intellectually speaking, we’re selling out, no less than people used to sell out to the Church, when its pronouncements conflicted with the deliverances of their own insights, when people chose to believe the one true Church rather than to trust their own “lying eyes”. We must ask ourselves: have the old dogmas of the old Church been replaced by the new dogmas of the new Church of Science? It is no longer religion, it seems, but rather Science (including mathematical science<sup>13</sup>) that threatens our intellectual integrity. As Simone Weil wrote in *The Need for Roots*<sup>14</sup>, “so far as the prestige of science is concerned, there are no such people nowadays as unbelievers. That places on [...] philosophers, [...] to the extent to which [they] write about science, a responsibility equal to that which priests had in the thirteenth century.”<sup>15</sup>

That the priests of the new “Church of Science” are not just un-philosophical but downright anti-philosophical emerges clearly from an interview with Neil deGrasse Tyson<sup>16</sup>, the popular host of the newly re-invented TV series, “Cosmos”. “Philosophy was my major,” says one of his interviewers. Tyson’s response: “That can really mess you up.” When that same interviewer attempts to mitigate his contempt, Tyson talks him out of it. “The philosophers,” says Tyson, “believe they’re actually asking deep questions about nature. The scientists say: what are you doing?” The scientist, he avers, “knows when the question of what is the sound of one hand clapping is a pointless delay in your progress.” It seems rather to be Tyson who is attending to the sound of one hand clapping, the one hand of Science, which claps alone, spurning the hand of philosophy.

However did we get from Einstein’s profound investigations into the nature of space and time to this cartoonish dismissal of philosophy<sup>17</sup>? We need to know not only whether Einstein was right that time can be turned into space but what it *means* if he’s right<sup>18</sup>. As we’ve seen, and as his friend, the great logician Kurt Gödel, argued long ago

---

[however] that a world in which contraries are correlated can be explained by suppressing one of every two contradictory terms [...]” (S. WEIL, *Reflections on Quantum Theory*, pp. 59-60; brackets added).

<sup>13</sup> As I argue in a lecture, *On the Pernicious Influence of Mathematics: Some Advice From Gödel and Rota*, delivered in 2011 at Boston College to the Clavius Group of Catholic Mathematicians. The lecture is now available on youtube.

<sup>14</sup> Trans. A. Wills, Ark Paperbacks, London 1987, p. 229.

<sup>15</sup> For further discussion, see P. YOURGRAU, *Simone Weil*, Reaktion Books, London 2011.

<sup>16</sup> See <http://www.nerdist.com/pepisode/nerdist-podcast-neil-degrasse-tyson-returns-again/>. The trouble begins twenty minutes into the discussion.

<sup>17</sup> Though Einstein’s hands are far from clean, he would doubtless be shocked to see the final fruits of his ambivalence about philosophy.

<sup>18</sup> Assuming, that is, the standard interpretation of relativity, the one advanced by Einstein, which rests, as is well known, on a kind of verificationist philosophy, which can be questioned. As Gödel put it in an essay on Einstein and Kant, unpublished during his lifetime, “[...] in perfect conformity with Kant, the observational results by themselves really do not force us to abandon Newtonian time and space as

in his neglected writings on Einstein<sup>19</sup>, it means that time in the intuitive sense – “what everyone understood by time before Einstein”, as Gödel put it – is an illusion. To say merely that time is “generalized” in relativity theory, or “relativized”, is, in Gödel’s words, a euphemism. Einstein, in other words, did not *illuminate* time. He *eliminated* it. What does that mean? It means that if Einstein is right, all moments of time exist equally, all motion, all change, is unreal or ideal<sup>20</sup>, the privileged “now” is an illusion, that, as Einstein himself put it, “‘now’ loses for the spatially extended world its objective meaning.”<sup>21</sup> Or as he wrote to the widow of his friend, Michele Besso, “in quitting this strange world [Michele] has once again preceded me by a little. That doesn’t mean anything. For those of us who believe in physics, this separation between past, present, and future is only an illusion, however tenuous.” For those of us who believe in physics, then, by Einstein’s lights, we’re still eating breakfast this morning, and already having

---

objective realities, but only the observational results together with certain general principles, e.g. the principle that two states of affairs which cannot be distinguished by observation are also objectively equal.” The philosophical assumptions, however, of Hendrik Lorentz (of the Lorentz transformations, one of the foundations of Einstein’s relativity) differed from Einstein’s, and as J.S. Bell (of Bell’s inequality fame, from quantum mechanics) has said, “[t]he facts of physics do not oblige us to accept the one philosophy rather than the other.” (J.S. BELL, *How to Teach Special Relativity*, in ID., *Speakable and Unspeakable in Quantum Mechanics*, Cambridge University Press, Cambridge 1988, p. 77).

<sup>19</sup> I have tried to remedy this neglect. See P. YOURGRAU, *Gödel Meets Einstein: Time Travel in the Gödel Universe*, Open Court, Chicago and La Salle IL 1999 and ID., *A World Without Time: The Forgotten Legacy of Gödel and Einstein*, Basic Books, New York NY 2005. In his review of the latter (“Notices of the American Mathematical Society”, 54 (7/2007), pp. 861-868), the distinguished Einstein scholar John Stachel objects violently to the very idea of trying to remedy this neglect. (For my reply to Stachel, only a brief *Letter to the Editor*, in “Notices of the American Mathematical Society”, 54 (10/2007), p. 1281, was permitted).

In effect, for Stachel, the moral of the story is: when it comes to physics: Einstein good, Gödel bad. In Stachel’s words, Gödel’s construction of his surprising new world models for general relativity – the “Gödel universes – is “an example of that fetishism of mathematics, to which some Platonists are so prone.” (p. 868). To mention just one problem with Stachel’s view, however: Einstein himself rejected it. Gödel’s close friend at the Institute for Advanced Study, Oskar Morgenstern, said that Einstein told him that Gödel’s contributions to the theory of relativity were the most important since the appearance of his own. See G. MOORE, *Kurt Gödel*, in L.H. ADAMS-F.H. LAVES (eds.), *Dictionary of Scientific Biography*, Vol. 17, Supplement II, Charles Scribner’s Sons, New York NY 1990, 348-357.

<sup>20</sup> This seemingly obvious point somehow eludes W.V. Quine, the dominant figure in American philosophy for many years, who writes in *Quiddities: An Intermittently Philosophical Dictionary* (The Belknap Press of Harvard University Press, Cambridge MA 1987) that in four-dimensional space-time, motion and change are preserved: “When time is thus viewed, an enduring solid is seen as spreading out in four dimensions [...] Change is not thereby repudiated in favor of an eternal static reality, as some have supposed. [...] To speak of a body as changing is to say that its later stages differ from its earlier stages.” (W.V. QUINE, *Space-Time*, in ID., *Quiddities*, p. 197). By this criterion, however, the series of natural numbers is ever changing, since in its “earlier stages” numbers are consistently smaller than in its “later stages”.

<sup>21</sup> A. EINSTEIN, *Relativity: The Special and General Theory*, Crown Publishers, New York NY 1961, p. 149. As Gödel put it: “each observer has his own set of ‘nows’, and none of these various systems of layers can claim the prerogative of representing the objective lapse of time.” (K. GÖDEL, *A Remark About the Relationship between Relativity Theory and Idealistic Philosophy*, in P.A. SCHILPP (ed.), *Albert Einstein: Philosopher Scientist*, Open Court, La Salle IL 1949, p. 558).

dinner tonight<sup>22</sup>. And the “I”, in turn, we each refer to, is not, appearances to the contrary, something that persists as it evolves over time<sup>23</sup>. Rather, what you naively thought of as yourself, as “I”, consists of an infinity of infinitesimally thin three-dimensional slices stacked up, like pieces of salami, in the fourth dimension of space-time. Got it? I doubt it. Not only is this an idea difficult to believe in – not to say, to live with – it’s difficult to understand how we could have even managed to entertain the illusion that we are each a single persistent being moving through time, and that the present moment, the “now”, is privileged – i.e. how we can, as Plato used to say, “save the phenomena”. The world, for example, though round, looks flat, when you go for a walk. “Appearances are saved”, however, when it’s pointed out that at the tiny dimensions of a human being in comparison with the greatness of the earth, the world is indeed, relatively speaking, flat. Nothing similar appears to be in the offing to explain why the present moment in your life appears privileged, when in fact it isn’t, nor why time seems to pass, when it doesn’t.

Now of course, time in the intuitive sense has a geometry, that of a one dimensional straight line ever increasing in length, as noted in our epigraph from Kant, which continues, “[...] under the image of a line, which we draw, and [...] by this mode of depicting it alone could we know the singleness of its dimension.” But to *provide a geometry* for a domain is distinct from introducing a *geometrization*, i.e. a reduction of a manifold to purely geometrical, spatial elements. Thus Erwin Schrödinger developed a non-Euclidean geometry for “color space”<sup>24</sup>, but in no sense was this put forward as a *geometrization* of color, i.e. a reduction of colors to locations in a geometrical space. By contrast, as we’ve seen, four-dimensional Einstein-Minkowski space-time is put forward as a geometrization of space and time, the consequences of which, philosophically speaking, we have been urging, are dramatic and alarming (even if – indeed, especially if – true). A defender of Einstein, Gödel sees a confirmation in relativity not of empiricist philosophers but of idealists like Parmenides and McTaggart<sup>25</sup>.

---

<sup>22</sup> Which is not to say that on this view, my eating breakfast is *simultaneous* with my having dinner. (That would cause indigestion). Rather, the idea is that in Einstein’s reading of relativity, the two meals are equally real, equally existent; no ontological privilege attends any one time, hence any one event, over any other. Being present becomes a purely relative, local affair. No time is “really”, exclusively now, just as no place is “really”, exclusively here. Paris is here, if you happen to live in Paris, and 1905 is now, if you happen to live in 1905.

<sup>23</sup> As Einstein says, “[i]t appears therefore more natural to think of physical reality as a four-dimensional existence, instead of, as hitherto, the *evolution* [over time] of a three dimensional existence. This rigid four-dimensional space of the special theory of relativity is to some extent a four-dimensional analogue of H.A. Lorentz’s rigid three-dimensional aether.” (A. EINSTEIN, *Relativity: The Special and General Theory*, pp. 150-151, emphasis in the original, brackets added).

<sup>24</sup> See W. MOORE, *Schrödinger: Life and Thought*, Cambridge University Press, Cambridge 1989, pp. 120-129.

<sup>25</sup> Paradoxically – given what we’ve said so far about Kant – Gödel also cites Kant as being confirmed by relativity. What we’ve neglected to mention, however, is that Kant, too, is an idealist, albeit a “transcendental” one. Gödel has in mind passages like the following, from *Critique of Pure Reason*: “Alterations are real and [...]these] are possible only in time. [T]ime is also therefore something real [...] Thus empirical reality has to be allowed to time [...] It is only its absolute reality that has to be denied [...] It does not inhere in the objects, but merely in the subject which intuits them.” (I. KANT, *Critique of Pure Reason*, transl. Norman Kemp Smith, St. Martin’s Press, New York NY 1965, p. 79). Gödel’s

One should be wary, then, of the current fashion of referring blithely to space-time, unaware of the philosophical baggage that one has thereby taken it upon oneself to carry. Anyone who is not shocked by quantum mechanics, said Niels Bohr – one of the fathers of that mysterious science – has not understood it. Too few, sadly, realize that much the same is true of relativity. Too few realize, as well, that just as the tension between relativity and quantum mechanics signals a problem yet to be solved, the conflict between our intuitions of time and the deliverances of relativity also represents a problem that needs to be resolved. (Indeed, the two problems may in the end turn out to be closely related)<sup>26</sup>. What needs to be resisted, above all, is the idea that philosophy itself has somehow been superseded by physics. The two disciplines, after all, are complementary; they're not in competition. And time is precisely one of the subjects where the two most stand in need of each other. Today, *à la recherche du temps perdu* has a special meaning for us all. We neglect it at our peril.

---

discussion of Kant's empirical realism but transcendental idealism with regard to time, in relation to relativity, is extremely subtle, something that is rarely appreciated. It is certainly not appreciated by Charles Parsons in *Gödel and Philosophical Idealism*, in "Philosophia Mathematica", 18 (2/2010). For a contrasting view, see P. YOURGRAU, *From Kant to Star Trek*, in ID., *Gödel Meets Einstein*, pp. 115-122.

<sup>26</sup> Indeed, Popper has written, in regard to the experimental results of Alain Aspect et al. concerning Bell's theorem, that "[...] should the result of these experiments [...] be accepted, and interpreted as establishing physical action at a distance (with infinite velocity), then these experiments would have to be regarded as the first crucial experiments between Lorentz's and Einstein's interpretations of the formalism of special relativity." (K. POPPER, *A Critical Note on the Greatest Days of Quantum Theory*, in A.O. BARUT et al. (eds.), *Quantum, Space, and Time: The Quest Continues*, Cambridge University Press, Cambridge 1984, p. 54). Anticipating the objection that such "physical action at a distance" cannot function as a "signal", Popper adds that, "even if signals cannot be transmitted with infinite velocity, the mere idea of infinite velocity requires the existence of a Lorentzian-Newtonian absolute space and absolute time, although, as Newton anticipated, it may not be possible in this case to identify the inertial system that is absolutely at rest." (*ibidem*, p. 54). For a similar point of view, see D.Z. ALBERT-R. GALCHEN, *Was Einstein Wrong? A Quantum Threat to Special Relativity*, in "Scientific American", March, 2009.