Are Probabilism and Special Relativity Compatible?

Author(s): Nicholas Maxwell
Source: *Philosophy of Science*, Vol. 55, No. 4 (Dec., 1988), pp. 640-645
Published by: The University of Chicago Press on behalf of the Philosophy of Science Association
Stable URL: http://www.jstor.org/stable/187533
Accessed: 15/03/2011 09:47

DISCUSSION:

ARE PROBABILISM AND SPECIAL RELATIVITY COMPATIBLE?*

NICHOLAS MAXWELL†

Department of the History and Philosophy of Science
University College, London, U.K.

Are probabilism and special relativity compatible? Dieks argues that they are. But the possible universe he specifies, designed to exemplify both probabilism and special relativity, either incorporates a universal "now" (and is thus incompatible with special relativity), or amounts to a many world universe (which I have discussed, and rejected as too ad hoc to be taken seriously), or fails to have any one definite overall Minkowskian-type space-time structure (and thus differs drastically from special relativity as ordinarily understood). Probabilism and special relativity appear to be incompatible after all. What is at issue is not whether "the flow of time" can be reconciled with special relativity, but rather whether explicitly probabilistic versions of quantum theory should be rejected because of incompatibility with special relativity.

A key feature of the fully micro-realistic propensiton version of quantum theory which I have expounded and defended elsewhere (Maxwell 1976; 1982; 1984, chap. 9; 1985; and especially 1988) is that it postulates the existence of fundamentally probabilistic events in nature, to be associated with instantaneous wave packet collapses conceived of as real physical processes. It is at once clear that propensiton quantum theory (PQT) cannot be compatible with special relativity (SR). Even if a "relativistic" version of PQT postulates that, as long as no probabilistic event occurs, the physical states of quantum systems evolve in accordance with a relativistic dynamical equation (such as the so-called Klein-Gordon equation), nevertheless, the moment a probabilistic event *does* occur, SR is violated. On the face of it, this renders PQT highly suspect.

In an earlier article, however, I argued that probabilism in general is incompatible with SR (Maxwell 1985). *Any* fundamentally probabilistic physical theory must be incompatible with SR. If this is correct, then the fact that the specific fundamentally probabilistic theory of PQT is incompatible with SR in the way indicated above cannot be taken to count against the theory (Maxwell 1985, sections 7 and 8). In this way, the truth or falsity of the thesis "Probabilism and SR are incompatible" has

*Received March 1987.

†I wish to thank Robert Seymour for helpful discussion.

Philosophy of Science, 55 (1988) pp. 640–645.

a crucial bearing on the viability, the acceptability, of PQT, and other versions of quantum theory which postulate instantaneous wave packet collapse as a real physical process.

After my article was published, Michael Redhead drew my attention to a paper by C. W. Rietdijk published nearly twenty years earlier (1966; see also Rietdijk 1976), in which Rietdijk argues that SR and probabilism are incompatible. Curiously enough, Rietdijk's aim is in a sense the opposite of mine. Whereas my aim is to establish that, granted probabilism, SR must be rejected, Rietdijk's aim is to establish that, granted SR, probabilism must be rejected. Rietdijk's arguments, if I have understood them properly, are not the same as mine. Nevertheless, Rietdijk deserves the credit for first discovering that SR and probabilism are incompatible.

But is this discovery genuine? Is the incompatibility thesis correct? Dieks (1988) argues that it is not. He considers a probabilistic universe made up of a number of (inertial) worldlines—particles to which origins of inertial reference frames can be assigned. As far as each particle is concerned, its own past is ontologically closed and definite (there is but one past), but its future is ontologically open and indefinite: there are objectively, in reality, many alternative possible futures. It is Dieks' view that this combines ontological probabilism and SR, there being no "universal instant of the universe".

Dieks recognizes clearly that the crucial question, which must be answered if this universe is to exemplify (in a compatible way) both ontological probabilism and SR, is the following. Given that event E_1, associated with particle 1, is here and now, if event E_2, associated with particle 2, is outside both the past and future lightcones of E_1, is E_2 ontologically definite, indefinite, or what? Dieks claims that the following answers the question in a way I fail to consider:

> My answer simply is that the specification of the ontological definiteness of E_1 does not determine the ontological status of E_2; E_2 may be ontologically definite *or* indefinite. In other terms, the subset of space-time diagrams in which E_1 is ontologically definite contains diagrams in which E_2 is definite as well as diagrams in which E_2 is indefinite. This answer is completely consistent with special relativity; Maxwell's worries about the combination of relativity and probabilism appear to be misplaced. (Dieks 1988, p. 459)

On the face of it, what is being asserted here is the following:

(A_1): From the standpoint of E_1, any E_2 (with space-like separation) really is *either* ontologically definite *or* ontologically indefinite, even though this cannot be determined or known at E_1. From the standpoint of E_1, as we (in thought) move up those parts of the worldlines of all other particles that have space-like separation from E_1, so, in each case a point on each worldline is reached where the ontologically definite becomes ontologically indefinite—even though this point cannot be determined at E_1. This point is, in each case, the "now" associated with each worldline.

But this answer only works because it *does* provide a universal, unambiguous way of dividing off the ontologically indefinite future from the ontologically definite past by means of an "universal instant of the universe". Given E_1 then, according to (A_1), all "nows" of all other particles exist unambiguously, even though they cannot be determined at E_1. Consider the (discontinuous) nearly space-like hypersurface made up of all "nows" on worldlines contemporary with E_1, together with past lightcones of these "nows" projected into the past until they intersect. According to Dieks himself, this hypersurface unambiguously and universally divides off the ontologically definite past from the ontologically indefinite future: this is the unambiguous, universal "now" of the Dieks universe to which E_1 belongs. The existence of such an universal "now" is incompatible with SR interpreted "realistically" (see Maxwell 1985, p. 24). Thus my worries about the combination of relativity and probabilism do *not* appear to be misplaced!

It is just possible that Dieks wishes to defend not (A_1) but rather: (A_2): From the standpoint of E_1, as long as E_2 has space-like separation it is invariably objectively, in reality, ontologically indefinite (and vice versa).

The difference between (A_1) and (A_2) is this. (A_1) asserts that, from the standpoint of E_1, E_2 really, objectively, is *either* ontologically definite *or* ontologically indefinite, even though which is the case cannot be known at E_1 (it is epistemologically indefinite). (A_2) asserts, on the other hand, that from the standpoint of E_1, E_2 is *always* really, objectively ontologically indefinite whether this is known or not.

I do not think Dieks wishes to defend (A_2). But in any case it does not, in my view, help much with Dieks' case. It is discussed explicitly in my paper (1985, fourth point, pp. 27–28). Formally, (A_2) renders ontological probabilism and realistically interpreted SR compatible, but at the price of postulating a multitude of actually existing alternative universes. Any such view is too grotesquely ad hoc to deserve being taken seriously.

A third interpretation of Dieks' argument is possible. Dieks may simply be denying that there is, in his universe, any kind of definite spatiotemporal relation whatsoever between any two events, E_1 and E_2, that (would ordinarily be said to) have a space-like separation. At E_1 there are space-time *diagrams* in which E_2 figures (and vice versa), but there is no real, definite spatiotemporal relation between E_1 and E_2 in actuality. It is as if E_1 and E_2 exist in different universes, spatially unrelated, which can subsequently become parts of *one* universe, *one* space, if both E_1 and E_2 come to lie in the past lightcone of some event E_3.

The problem with Dieks' argument, interpreted in this third way, is that it seems to deny that anything like Minkowskian space-time exists: in denying this, it would seem to deny SR itself. (Minkowskian space-time *diagrams* exist, but these diagrams cannot be conceived of as being imbedded in any kind of actual Minkowskian space-time.)

Certainly, SR as ordinarily understood, applicable to *deterministic* universes, presupposes or postulates one definite, precise Minkowskian space-time structure for actual physical space-time as a whole, common to all events and accommodating all events. Equally, SR understood in such a way that it is applicable to many-world *probabilistic* universes (as described in Maxwell 1985, fourth point, pp. 27–28), presupposes or postulates one overall definite Minkowskian-type space-time structure for actual physical space-time (a probabilistic generalization of the *deterministic* Minkowskian structure). It would seem reasonable to hold that SR given any acceptable interpretation must require there to be one definite Minkowskian-type space-time structure for actual space-time as a whole (however this is interpreted physically). The decisive point is that this is unquestionably required by SR *as ordinarily understood*.

But this requirement cannot be satisfied within the Dieks' universe. Within the Dieks' universe, all events (which would ordinarily be said to have) space-like separation have *no* definite space-time relationship (until such events lie in the past lightcone of some third event). Each event in the Dieks' universe has associated with it its own "space-time diagrams", its own space-time structure, in which other events are represented. In the cases of SR in deterministic universes or many-world probabilistic universes, all such diverse space-time structures can be interpreted to be *one* space-time structure, that of actual physical space-time, viewed from the vantage points of diverse events. But if diverse space-time structures of Dieks' universe are collapsed in this way into one overall space-time structure, that of actual space-time, then all events with space-like separation must acquire definite spatiotemporal relations (as in many-world probabilistic universes). In this case, the third version of Dieks' argument collapses into the second version, based on A_2. This can only be prevented by insisting that diverse space-time structures associated with diverse events (all with space-like separation from each other, in each other's space-time structures) cannot be coalesced into one common overall space-time structure, that of actual space-time.

In lacking one definite overall space-time structure common to all events in this way, SR in the Dieks' universe is very different from SR as ordinarily understood. SR in the Dieks' universe is somewhat reminiscent of Leibniz's monadology: it might be called "monadological SR" (MSR).

This third version of Dieks' argument thus establishes at most that MSR and ontological probabilism are compatible. But since MSR differs strikingly from SR as ordinarily understood, this does not suffice to establish that SR and ontological probabilism are compatible.

Ontological probabilism and special relativity ought, I conclude, to be regarded as incompatible as far as theoretical physics is concerned. Hence the incompatibility of PQT and SR does not pose a serious problem for PQT.

One final point. Dieks writes as if my concern is to discover whether the notion of the "flow of time" can be made compatible with SR. In fact this is not my concern at all. All ideas that have to do with such things as "the flow of time", "absolute becoming", "the specious present" or McTaggart's "A-series" (past, present, future) as opposed to his "B-series" (earlier, later), (see McTaggart 1927, chap. 33) are, in my view, the outcome of an appalling confusion—the outcome of the common sense tendency to try to put together the incompatible doctrines of *objectism* and *eventism* (see Maxwell 1985, p. 30; 1968, pp. 5–7). According to objectism, the world is made up of three-dimensional entities—objects—which change and persist: objects are spread out in space but not in time; it is facts about objects, histories of objects, not objects themselves, that are spread out in space-time. Space-time diagrams depict facts about objects and not objects themselves. By contrast, according to eventism, the world is made up of four-dimensional entities—events—which are spread out in space-time: space-time diagrams depict the basic entities themselves, and not just facts about entities. Common sense conceives of the immediate present in terms of objectism, but the distant past and future in terms of eventism (time being conceived of in spatial terms). The attempt is then made to make sense of this contradictory combination of objectism and eventism by adding the "absolute now", "absolute becoming", the "specious present", the "A-series" or "the flow of time" to eventism to do justice to the objectism of common sense. Only confusion results. What needs to be done, rather, is to recognize clearly the two mutually exclusive possibilities, objectism and eventism, and stick to one or the other. The temptation to think in terms of the profoundly confused notions of "the flow of time" etc., ought then never to arise. Thus, I sought, in my paper, not to render "the flow of time" compatible with SR, but rather to defend PQT against the charge that it is unacceptable because it clashes with SR—as I hope I have now made clear in this note.

REFERENCES

Dieks, D. (1988), "Discussion: Special Relativity and the Flow of Time", *Philosophy of Science 55*: 456–460.

Maxwell, N. (1968), "Can there be Necessary Connections between Successive Events?", *The British Journal for the Philosophy of Science 19*: 1–25.

———. (1976), "Towards a Micro Realistic Version of Quantum Mechanics", *Foundations of Physics 6*: 275–292, 661–676.
———. (1982), "Instead of Particles and Fields: A Micro Realistic Quantum 'Smearon' Theory", *Foundations of Physics 12*: 607–631.
———. (1984), *From Knowledge to Wisdom*. New York: Basil Blackwell.
———. (1985), "Are Probabilism and Special Relativity Incompatible?", *Philosophy of Science 52*: 23–43.
———. (1988), "Quantum Propensiton Theory: A Testable Resolution of the Wave/Particle Dilemma", *The British Journal for the Philosophy of Science 39*: 1–50.
McTaggart, J. E. (1927), *The Nature of Existence*, vol. 1. Cambridge: Cambridge University Press.
Rietdijk, C. W. (1966), "A Rigorous Proof of Determinism Derived from the Special Theory of Relativity", *Philosophy of Science 33*: 341–344.
———. (1976), "Special Relativity and Determinism", *Philosophy of Science 43*: 598–609.