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DISCUSSION:

ON RELATIVITY THEORY AND OPENNESS OF THE FUTURE*

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In a recent paper Stein (1991) makes a number of criticisms of an earlier paper of mine (Maxwell 1985) that explored the question of whether the idea that the future is genuinely "open" in a probabilistic universe is compatible with special relativity. I disagree with almost all of Stein's criticisms.

I

For some twenty years I have been arguing for the need to develop a version of quantum theory (**QT**) which specifies precisely, in quantum mechanical terms, when and how probabilistic "wave-packet-collapses" occur, so that (an empirically testable version of) **QT** can be formulated without the inherently vague notion of measurement being employed in the basic postulates of the theory (see Maxwell 1972b; 1973; 1975; 1976a; 1982; 1984, 242–245; 1988; 1993a). Any such version of **QT** demands that wave packets that are spread throughout a region of space will on occasions collapse *instantaneously* into more localized regions; and this, on the face of it, clashes with special relativity (**SR**). But if probabilism as such clashes with **SR**, the fact that probabilistic **QT** clashes may be regarded as insufficient grounds for rejecting such a version of **QT**. In Maxwell (1985), I sought to show that at least one strong version of probabilism, which I called *ontological probabilism*, does clash with **SR**, thus providing some grounds for continuing to take probabilistic **QT** seriously despite its nonrelativistic wave-packet-collapses.

Howard Stein (1991) makes a number of criticisms of my paper (Maxwell 1985).

II

Stein begins his critique by reproducing a long passage from Maxwell (1985) which includes, "This fourth suggestion thus commits us to the

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view that whenever anything probabilistic occurs, there being *N* equally probable outcomes, three-dimensional space splits up into *N* distinct three-dimensional spaces, each space containing one of the *N* outcomes. Any such branching-universe or multi-universe view is, however, far too grotesquely *ad hoc* to be taken seriously" (1991, 151). Stein, then, comments:

> I have quoted this passage *in extenso* because there are a number of things in it that seem to me quite baffling. Why, for instance—supposing it true . . . that special relativity implies such "branching"—is this, not just *grotesque* (which for argument's sake we may concede), but "grotesquely *ad hoc*"? One might suppose that something implied by a theory that has some claim to be well-grounded should escape *that* imputation. Again, why suppose a *finite* number of possible alternatives; and, indeed, of *equally probable* ones? These, however, are side issues, relevant only as casting a strange light upon the quality of the argument as a whole. (Ibid.)

Stein attributes to me the view that **SR** implies "branching". But I do not hold this view. My claim, rather, is that a "branching-universe" view may be put forward as an attempt to resolve the apparent conflict between *ontological probabilism* on the one hand, and **SR** on the other. To say this is not to say that **SR** *implies* "branching". (At most it might be claimed that I hold that **SR** *plus ontological probabilism* imply "branching", but even that is too strong.) Stein finds it "baffling" that I hold that the "branching" view is ad hoc in view of the fact that it is a consequence of **SR**, which is very far from being ad hoc. But I do *not* hold that the "branching" view is a consequence of **SR**. The branching-universe view must be considered as a (possibly metaphysical) theory in its own right—closely allied to the view of things that emerges from the "many worlds" interpretation of quantum mechanics put forward by Everett (1957) and enthusiastically endorsed by Wheeler (1957). What needs to be said about such views is precisely that they are very ad hoc. Endlessly many—possibly nondenumerably infinitely many—other worlds are postulated, with no evidence whatsoever, in order to make sense of this world. Stein goes on to ask why I consider only *finitely* many branching universes, and indeed only *equally probable* ones. I do so because intellectual integrity in philosophy involves in part keeping arguments as simple as possible. If I can show that the *least problematic* version of the branching-universe view is untenable, this suffices to establish that all versions are untenable. Taking into account infinitely many branches, and branches not all equally probable, only introduces further complications and difficulties for the branching-universe view. Consideration of them is thus entirely irrelevant given that the least problematic version has been shown to be untenable.

III

A criticism of a more substantial matter has to do with Stein's objection to what he sees as my belief in a spatially extended present as an integral part of **SR**, when actually such a spatially extended present is *incompatible* with **SR** (1991, 151–152). Stein attributes this fallacy to many others as well, including Putnam, Rietdijk, Dieks and Lango.

SR does not reject the notion that many spacelike separated events can all be simultaneous and, to that extent, a part of the same "present" or "now". **SR** does deny that there is, relative to any event or spacetime point, a *privileged* or *unique* such "present" or "now". Stein objects, I take it, to what he sees as my belief in a privileged cosmic "now" as an integral part of **SR**.

This objection is mistaken. The basic problem and argument of my paper arises from the point, made clearly in the first two pages, that *there is no such unique, privileged "now", given* ***SR***! I argue that probabilism and **SR** are incompatible precisely because **SR** denies the existence of a privileged cosmic "now" (1985, 23–24).

Given this, it is odd that Stein should impute to me the belief that the notion of a privileged cosmic "now" is compatible with **SR**. Stein's *reasons* for making this imputation are no better. In speaking of "present alternative *actualities*" (Maxwell 1985, 27; emphasis in the original) I am discussing a (possible) version of relativistic ontological probabilism which postulates that events that have spacelike separation are ontologically open or indefinite. At no point does my argument against this possibility appeal to the idea that there is a privileged cosmic (or spatially extended) "now". Nowhere do I "insist upon a notion of present spatially distant actualities [interpreted as a privileged spatially extended 'now'] in assessing special relativity". In referring to three-dimensional space splitting up into distinct spaces corresponding to distinct possibilities (ibid., 28), I am arguing against a relativistic version of the branching-universe view. At no point does the argument appeal to a privileged "now".

Stein devotes three long sections of his paper (1991, secs. 3–5) to a discussion of why "philosophers with considerable scientific sophistication" (p. 162) such as Rietdijk, Putnam, Maxwell and Dieks, should believe in "cosmic simultaneity" (ibid.) or a "cosmic present" (ibid.). None of this is needed: I am sure that none of my fellow "scientifically sophisticated" philosophers has the slightest inclination to believe in a unique cosmic "now" as an integral part of **SR**.

IV

Stein's proposal as to how future "openness" can be made consistent with **SR** deserves to be taken more seriously. The proposal amounts to postulating that openness is relational between pairs of spacetime points such that, relative to any point A, what is in the past light cone of A is closed, fixed, ontologically definite, whereas what is in the future light cone or in the absolute elsewhere, relative to A, may be open, unfixed, ontologically indefinite. The basic difficulty I have with this *relational* notion is that it does not seem to be capable of capturing what *ontological openness of the future*, as discussed in Maxwell (1985), means. Presuming for the moment what may be termed a "Newtonian" conception of space and time (so that the full-blooded notion of ontological openness may be consistently developed), to say that the future is now "ontologically open" is to say (i) from the standpoint of everything that exists now, two or more different futures are possible, and (ii) from the standpoint of what exists in the future, viewed from the present, two or more distinct futures are possible.

Granted *predictive probabilism* (as I characterize doctrine in Maxwell 1985, sec. 2, 4–6), we have (i) but not (ii). Predictive probabilism postulates a spacetime view of reality, *eventism* as I have called it, according to which the universe is four-dimensional in character, being composed of events spread out analogously in space and time; the basic physical laws are such, however, that what exists at one spacelike hypersurface in general only determines *probabilistically* what exists within a region of a subsequent hypersurface. The future, like the past, is fixed, ontologically definite; but what can be *predicted*, even in principle, at one time t_1, on the basis of what exists at time t_1, about a later time t_2, is in general only probabilistic. Thus (ii) does not obtain even though (i) does. In order for (i) *and* (ii) to obtain, given predictive probabilism and eventism, there would need to be a branching, many-worlds universe, there existing many alternative futures—and indeed presents. In other words, so long as one holds onto eventism, a spacetime view of physical reality, an ontologically open future can only be accommodated by adopting an Everett-type, branching, many-worlds view. But *ontological probabilism* and *objectism*, as characterized by Maxwell (ibid.), *reject* the spacetime view of physical reality of eventism, and it is this which makes it possible to have an ontologically open future *without* resorting to a many-worlds view. According to objectism, the world is made up of three-dimensional things which persist and change but which are not spread out in time as they are in space. *Histories* of persisting, changing things—facts-about-things, and not things themselves—are spread out in time. The spacetime history of the universe is a conceptual artifact and not a physical reality. The physical universe is always three-dimensional, with a past and a future. Thus, for objectism, there is a radical difference between space and time which eventism denies. For eventism, the future exists much as the spatially elsewhere exists; for objectism, the future does not exist in anything like the way the spatially elsewhere exists. For objectism, in speaking of the future we are speaking of future possibilities of things that exist now, and not of temporally distant entities existing (tenselessly) just as much as spatially distant entities. Hence in referring to the many possible futures of ontological probabilism, we are not referring to the many different worlds of a full-fledged, Everett-type many-worlds view; we are merely speaking of possible futures of what exists now. The passage of time annihilates these possibilities as the future becomes the past; but to say this is to say no more than that what was a possible future once upon a time is not possible anymore because it did not happen after all. In brief, ontological probabilism and objectism can accommodate an ontologically open future in the sense of (i) and (ii) above without needing to resort to an Everett-type many-worlds view just because, according to these views, the world is not spread out in time as it is in space. This cannot be done by predictive probabilism and eventism because, since the world *is* spread out in both space and time, to have an ontologically open future in the sense of (i) *and* (ii) does require an Everett-type many-worlds view to be true.

Stein's (relativistic) relational openness can no more accommodate the full-blooded future openness of ontological probabilism and objectism than predictive probabilism and eventism can. Consider two friends, A and B, far apart in rockets that are at rest with respect to each other. According to Stein's relational notion, each is in an "ontologically open or indefinite state" with respect to the other at simultaneous times relative to their shared reference frame. But what can this mean? At any given time t, neither can *know for sure* what state the other is in; but each, surely, is entitled to believe that the other is in *some* definite state, which can subsequently be ascertained. Any "ontological openness" here is limited to the type permitted by predictive probabilism and eventism so far as the future is concerned.

The hollowness of Stein's "relational openness" is strikingly borne out by Stein's own observation that "openness" of this type can exist even in a *deterministic* universe (1991, 165). For any event e, only events in the past light cone of e are closed and definite; all other events, whether those with spacelike separation or those in the future light cone, can be, for Stein, ontologically open, relative to e. But what conceivable physical significance can this "relational openness" have in a deterministic universe? It is more like a philosophical joke than something that can be of genuine physical (or even metaphysical) significance.

I conclude that Stein's attempt at reconciling ontological openness and special relativity does not succeed.

V

Stein concludes his paper by claiming that the "positive scientific program" (1991, 166) that I advocate, though "concerned with deep and important matters, looks at this stage exceedingly tenuous" (ibid.). I close with some comments on this.

The general program is to (help) discover how to unify all of theoretical physics. This means, in particular, to discover how to unify ostensibly *probabilistic* **QT** and *deterministic* general relativity (**GR**). The structure of *orthodox* **QT** is, however, such as to obstruct the quantization of **GR**. Orthodox **QT** is such that, in assigning a quantum state to a physical system we are obliged to assume the existence of an external measuring instrument. This creates an insuperable difficulty the moment one seeks to assign a quantum state to curved spacetime, for how can one have a measuring instrument *external* to spacetime? For this reason, and for others (see Maxwell 1972b, 1976a, 1982, 1988, 1993a), a new fully microrealistic version of **QT** needs to be developed which is such that the quantum state can be interpreted as specifying the actual physical state of the physical system to which it applies, no use being made of the notion of measurement in the basic postulates of **QT** at all. One approach to developing such a version of **QT** is the one that I have explored: regard the quantum world as fundamentally probabilistic in character, and interpret the quantum state Ψ as specifying the physical propensity state of the system in question, which evolves deterministically except for isolated instants at which probabilistic transitions occur, and quantum propensities are actualized. The basic problem that needs to be solved in developing "propensiton **QT**" of this type is to specify (i) the precise quantum conditions for probabilistic transitions to occur and (ii) the possible outcome states and their probabilities. My suggestion is that probabilistic transitions are to be associated with the creation of new, real particles (or new-bound states). The hope is that propensiton **QT** will lead to the development of quantized **GR**, dynamic probabilistic geometry, which postulates evolving superpositions of curved space which jump probabilistically into one or another state of definite curvature.

Whatever the prospects may be for unifying **GR** and **QT** in this way, strong scientific grounds exist, having to do with the search for unity, for developing a precise, realist version of **QT** which makes no mention of measurement in its basic postulates. These grounds become all the more obvious granted the *aim-oriented empiricist* conception of science, defended at length elsewhere (Maxwell 1972a, 1974, 1976b, 1977, 1979, 1980, 1984, 1993b; Kneller 1978), which insists that to exhibit science as rational we must see science as assuming that the universe is comprehensible. Indeed, the propensiton version of **QT** that I advocate was developed in part to try to put into practice the rational method of discovery postulated by aim-oriented empiricism.

When I first argued for the need to develop a precise, probabilistic version of **QT** that makes no mention of measurement (Maxwell 1972b), I was not aware of anyone else holding this view. Since then, many others have, independently, taken up the idea. Bell (1987) has argued, with great cogency and wit, for the need to develop a *precise* version of **QT** that excludes all mention of measurement. Others have put forward proposals as to the precise quantum conditions required to induce probabilistic wave-packet-collapse (see Bedford and Wang 1975; Bussey 1984; and above all Ghirardi, Rimini and Weber 1986). Penrose (1986, 1989) has come to espouse the idea that wave-packet-collapse is a real physical process, arguing that the conditions for collapse may involve gravity; he conceives of the task of unifying **QT** and **GR** in very much the way that I have indicated.

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