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## Is Quantum Indeterminism Relevant to Free Will?

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### Summary

Quantum indeterminism may make available the option of an interactionism that does not have to pay the price of a force over and above those forces that are acknowledged in physics in order to explain how intentions can be physically effective. I show how this option might work in concrete terms and offer a criticism of it.

### 1. Introduction

The aim of this paper is to clarify in what respect quantum indeterminism may be relevant when it comes to the problem how free will relates to physics. I show that there is an option according to which quantum physics paves the way for a particular solution to this problem and offer a critical evaluation of this option.<sup>1</sup>

One can endorse compatibilism, that is the position that free will is compatible with physics even if physics is deterministic (see, for instance, O’Leary-Hawthorne and Pettit, 1996). In this case, one takes the issue of free will to be independent of the issue whether physics is deterministic or indeterministic. In this case, there is hence no need to pay particular attention to quantum indeterminism. By contrast, if one subscribes to a libertarian position, one claims that indeterminism in physics is a necessary condition for free will. One may then envisage making use of quantum indeterminism to support such a position. I shall be concerned only with examining this latter possibility. Let us therefore, for the sake of argument, adopt the following two assumptions:

- a) **Intentions are not identical with or realized as physical states or events, such as, for instance, brain states or events in the brain.**
- b) **Intentions are causally relevant to some physical events. For instance, if you have the intention to raise your arm, and your arm goes up, then that intention counts among the causes of that event. If there had not [178] been that intention, then, *ceteris paribus*, your arm would not have gone up at that particular time.**

By physical states or events, I mean, for the sake of the argument of this paper, all and only those types of states and events which are acknowledged in our physical theories taken in a broad sense – that is, including biology and neurophysiology, but excluding descriptions in intentional vocabulary such as “having the intention to raise one’s arm”. Note, however, that employing descriptions in intentional vocabulary as such is innocuous as far as the argument of this paper is concerned. The point is whether or not the phenomena to which these descriptions refer are identical with or realized as

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something that can in principle be described in the vocabulary of our physical sciences. Assumption (a) rejects such an identity or realization.

I refer to assumptions (a) and (b) taken together as *interactionism* for lack of a better word. Interactionism in this sense is a general concept under which all and only those positions that share (a) and (b) fall. Nonetheless, there may be considerable differences among these positions. By using the term “interactionism” I do not mean to imply that there is a particular type of interaction in the sense of a particular type of – non-physical – force in order that intentions can be causally relevant to some physical events. This is just the point at issue which I shall consider. Quantum indeterminism enters into this framework as a means to make (b) plausible.

I first point out that if one speaks of quantum indeterminism, one is committed to certain positions in the interpretation of quantum physics (section 2). I then consider whether there is a conflict between interactionism and physical conservation laws (section 3). By going into a concrete proposal that connects the physical effectiveness of intentions with quantum indeterminism, I work out what exactly can be achieved by taking quantum indeterminism into account (section 4). Finally, I suggest some critical conclusions (section 5).

## [179] 2. Commitments in the interpretation of quantum physics

Since the advent of quantum physics the indeterminism as regards the outcome of a measurement (the so-called collapse of the wave-function) has been linked up with the issue of free will in the philosophy of mind. The central idea is: quantum physics describes indeterministic events. For each such event there are only probabilities; but there is no physical cause which explains why one such particular event happens at a particular time. A widespread, popular example for events of this type apart from laboratory measurements is radioactive decay. If there are physical events which have no *physical* cause that accounts for one such particular event happening at a particular time, there may be scope for intentions acting as *mental* causes that contribute to the determination of some physical events. In this vein, physicists and philosophers from Jordan, 1932, pp. 819–820, on via Margenau, 1967, up to contemporary philosophers such as van Inwagen, 1983, Chapter 6.2, maintain that an indeterministic physics such as quantum physics is a prerequisite for free will having physical effects.

Beginning with Schrödinger, 1936, the most widespread objection against connecting quantum indeterminism with free will is the *randomness objection*: voluntary decisions reached after deliberation cannot be compared to chance events. This objection hits a position such as the one of Weaver, 1948, who claims that voluntary decisions are paralleled by quantum events. To put the point in the framework of the vocabulary which I have introduced in the preceding section: if one takes intentions to be identical with or to be realized as quantum events and then seeks to explain the physical effectiveness of free will by having recourse to quantum indeterminism, one runs into this objection. That is why the view that quantum indeterminism is a necessary condition for free will can acquire plausibility only in the framework of what I have described as interactionism (but see, by contrast, the position of Kane, 1996, in particular pp. 172–174). For, as far as interactionism is concerned, the randomness

objection misses the point: assuming interactionism, quantum indeterminism may be the mechanism that enables intentions, which are reached in deliberation, to be causally effective in the physical world.

If one seeks to link free will with quantum physics, one is committed to a realistic or ontological interpretation of quantum physics: quantum physics tells us something about the way nature is. To be more precise, [180] one is committed to an interpretation of quantum physics that is not only realistic, but which also assumes that indeterministic quantum events occur in nature. One example of such events may be radioactive decay. Measurement events in the sense of the events that are produced in laboratory measurements are then to be considered as a special case of indeterministic quantum events. One prominent example of an interpretation of quantum theory along these lines is Ghirardi, Rimini and Weber, 1986. Only if one endorses some such interpretation does one regard quantum theory as meeting the main philosophical criterion for indeterminism, namely to describe possible worlds which are such that the quantum physical states in these worlds agree at an initial time  $t$  while differing at a later time  $t^*$  (as to this criterion, see Earman, 1986, p. 13). In the following, I presuppose a realistic interpretation of quantum physics that admits indeterministic events for the sake of argument.

### **3. Is interactionism incompatible with physical conservation laws?**

If we endorse interactionism, an indeterministic physics is relevant when it comes to an account of how intentions can cause physical events. Let us consider the status of this relevance: Given interactionism, is a deterministic physics incompatible with free will? Based on classical physics, one can propose a world view according to which the physical world is deterministic and physically closed: every physical event is completely determined by other physical events. However, the question whether the physical world is deterministic and causally closed is not a physical one. For to assume that physics says all there is to say about the causes of all physical events is a philosophical position. If we limit ourselves to physics, determinism concerns conservation laws of physical quantities. The point at issue therefore is whether the conservation laws of physical quantities come into conflict with interactionism.

Conservation laws relate to closed physical systems. They require that a change in the total energy or the total momentum of a physical system be traced back to the influence of an external force on the system. One can consider as an external force anything that carries out a change in the total energy or the total momentum of a physical system. If a force is [181] conceived in this broad sense, then physics in itself does not require that this force is physical. The assumption that such a force has to be physical is a philosophical one. There may be good arguments for such an assumption. But the point is that these are philosophical arguments. As Averill and Keating, 1981, have shown, as far as the conservation laws of classical physics are concerned, it does not contradict these laws to countenance a non-physical force of intentions, that is, a force which is not acknowledged in classical physics; that force exerts a causal influence on the brain (or other bodily organs) as a result of which the total energy or the total momentum of the brain is changed. One may object that the compound of mind and brain (or mind and

body) is itself a closed system. But this compound is not a physical system according to interactionism. Consequently, physical conservation laws do not apply to this system, and, *a fortiori*, these laws do not apply to the world as a whole.

The point at issue between interactionism and determinism in physics as described by physical conservation laws is hence not logical compatibility, but plausibility. Assuming a non-physical force of the mind by means of which the total energy or the total momentum of the brain (or other bodily organs) is changed is a high price to pay for interactionism. Consider vitalism as an analogy: the assumption of a new force in living organisms contributed much to the downfall of vitalism. Accordingly, if interactionism is to be a plausible option in the philosophy of mind, it should seek to avoid a commitment to the claim that there is a force over and above those forces that are acknowledged in physics.

The most prominent interactionism, Descartes' dualism of mental and physical substance, can be construed in such a way that the mind does not exert a non-physical force on the brain as a result of which a change in a conserved physical quantity occurs: the mind does not change the quantity of motion of the physical animal spirits, but only their direction of motion; to change their direction of motion, no force has to be exerted on the animal spirits. (This interpretation goes back to Leibniz, *Monadology* § 80. For a recent elaboration and defense, see McLaughlin, 1993). A change of the direction of motion without exerting a force is possible in Descartes' physics, since Descartes recognizes only the conservation of the amount of momentum ( $|mv|$ ) (*Principles of Philosophy*, book II, §§ 36, 41). His suggestion fails, however, because momentum is also conserved as a directed quantity. The law of the conservation of momentum as a directed quantity is not yet known in Descartes' time. Given this conservation [182] law, if intentions are to influence the direction of motion of the animal spirits, they have to exert a force on these spirits which changes a conserved quantity of them.

#### **4. What can be achieved by taking quantum indeterminism into account?**

Although Descartes does not base himself on indeterminism in physics, what can be achieved by taking up quantum indeterminism in today's philosophy of mind is a revival of a solution of the type which Descartes originally targeted and which was then excluded by the development of classical physics: an interactionism which does not need to invoke a non-physical force by means of which conserved quantities of a physical system such as the brain are changed. This becomes clear when we consider the only elaborate concrete suggestion in today's literature as to how free will makes use of quantum indeterminism in order to have physical effects. This suggestion is developed by the late neurophysiologist John Eccles in collaboration with the physicist Friedrich Beck. Eccles and Beck write:

... the mental intention (the volition) becomes neurally effective by *momentarily increasing the probability of exocytosis* in selected cortical areas such as the supplementary motor area neurons. In the language of quantum mechanics this means a *selection of events*. ... This selection mechanism effectively increases the probability for exocytosis, and in this way generates increased EPSPs [Excitatory postsynaptic potential in a neuron – Eccles, 1994, glossary, p. 187] *without violation of the conservation laws*. ...

*quantum selection is the only possible way* of producing different final states from identical initial conditions in identical dynamical situations, and thus with the same values of the conserved quantities. ... Furthermore, the interaction of mental events with the quantum probability amplitudes for exocytosis introduces a coherent coupling of a large number of individual amplitudes of the hundreds of thousands of boutons in a dendron. ... We put forward the hypothesis that mental intention becomes neurally effective by momentarily increasing the probabilities for exocytoses in a whole dendron and, in this way, couples the large number of probability amplitudes to produce coherent action. (Eccles, 1994, pp. 160 and 163)

An intention thus is causally relevant to physical events by momentarily increasing the probability for a large number of coupled neurophysiological events. These neurophysiological events, in turn, finally cause [183] bodily movements such as one's arm going up. There is hence causation in the sense of the theory of David Lewis, 1986, Chapter 21, in particular pp. 175–179, which is the most prominent account of causation in today's philosophy: the intention raises the probability for certain physical events. If there had not been the intention in question, these physical events would have been much less probable. However, there is no additional force that brings about a change in conserved quantities of the brain. This proposal does not have to go beyond the four types of forces that are acknowledged in current physics. Eccles, 1994, adopts an interpretation of quantum physics in terms of propensities for individual events (in particular p. 157). Given such an interpretation of quantum physics it is logically possible to maintain that an intention momentarily increases the probability for individual neurophysiological events without a change in a conserved quantity occurring. *The relevance of quantum physics to free will is that quantum physics opens up the possibility of an interactionism which does not need to postulate a force in addition to the four known physical forces for intentions to be causally effective.* Consequently, interactionism given an interpretation of quantum physics in terms of indeterminism is at most as good or as bad a metaphysics as Descartes' interactionism, given the physics of his time.

## **5. A plausible option?**

Barry Loewer, 1996, pp. 103–106, argues that an interpretation of quantum physics in terms of objective probabilities fares no better than a deterministic physics as regards free will: objective probabilities for quantum events are determined by prior quantum events in the same way as in a deterministic physics physical events are determined by prior physical events. As regards a proposal such as the one of Eccles, this argument brings out the following point: when it comes to quantum events to which intentions are causally relevant, the quantum physical probabilities are not the complete probabilities; there is a further, mental variable. For, according to Eccles' proposal, intentions exert an influence on physical events in the brain *in a regular way*. They *regularly* raise the probability for certain neurophysiological events. For instance, whenever I have the intention to raise my arm, my arm goes up, unless there are physiological or external obstacles. Hence, when it comes to certain types of neurophysiological [184] events, the quantum probabilities are not the complete, objective probabilities for these events. This

fact, however, may not imply the possibility of new predictions; for decisions by free will, such as the decision to raise one's arm at a certain moment, can be taken to be unpredictable. To put the matter in more general terms: *Either one takes the quantum probabilities to be the complete probabilities, and then one runs into the randomness objection. Or one goes for interactionism and assumes a regular influence of intentions, and then one is committed to the consequence that the quantum probabilities are not the complete probabilities for some physical events.* This consequence may be considered as a weighty objection against a proposal of Eccles' type.

Nonetheless, this objection on its own is not decisive: the probability rules of quantum physics may not be the last word when it comes to applying quantum physics to neurophysiological research. Empirical evidence may suggest modifications. Thus, if there were empirical evidence for Eccles' proposal, it would be reasonable to regard quantum physics as being incomplete when it comes to certain types of neurophysiological events. But there is no such evidence. Eccles, 1994, concedes that the mechanism which he proposes "clearly lies beyond ordinary quantum mechanics" (p. 160). The large number of coupled quantum events on the neurophysiological level that he has to assume in order to explain voluntary action is not an established result of neurophysiological research which is then employed to connect neurophysiology with issues in the philosophy of mind.

Moreover, given the current state of the art, there is not even any firm evidence for the thesis that quantum physics is important to neurophysiological research. A judgement on whether or not quantum physics is relevant on the level of brain research seems premature. What is much more, even if it were established that quantum physics is pertinent to brain research, it is not clear which, if any, would be the consequences for the philosophy of mind.

Nonetheless, again, one can say that this objection is not decisive. Science proceeds by making new proposals which often lack empirical evidence at the time when they are put forward. But note the way in which Eccles proceeds: (a) He presupposes a metaphysics of what I called interactionism. (b) Against the background of that metaphysics, he shapes quantum indeterminism into a solution to the problem how free will can be physically effective by postulating the mentioned coupled quantum [185] events on the neurophysiological level. (c) By way of consequence, this proposal then implies that the quantum probabilities are not the complete probabilities when it comes to these neurophysiological events. *This methodological procedure is the decisive objection to Eccles' proposal.* Quantum physics is first welcomed as the science which enables us to show how free will can have physical effects. But it then turns out that in order to execute this function the quantum probabilities have to be amended when it comes to the neurophysiological events in question. An amendment of the quantum probabilities cannot be dismissed out of hand; but we need a good reason for it. In distinction to empirical evidence, metaphysical presuppositions in the philosophy of mind are, I submit, not an acceptable reason to subscribe to a commitment to amend the quantum probabilities in any area.

One may envisage limiting oneself to the following general thesis: a physics that admits some types of physical events for which there is no physical cause that accounts for a particular event of the type in question happening at a particular time is a necessary condition for free will. One may then approve of quantum physics because it can be interpreted in such a way that it meets this condition (for recent proposals along these lines, see Rohs, 1996, Chapter 21, and Suhm, 1997, as well as Carrier, 1999). However, as shown in the last but one section, there is no problem of logical compatibility between endorsing interactionism and physical conservation laws. The point at issue is a matter of plausibility: it is a matter of the price that one has to pay for interactionism. Indeterminism in physics in the described sense opens up the possibility of an interactionism which does not have to assume a force over and above those forces that are acknowledged in physics. It thereby reduces the ontological burden of interactionism.

Nonetheless, the point which I made in the preceding paragraphs in evaluating Eccles' proposal can be generalized: although the ontological burden of interactionism is reduced, the result is not a plausible option, because the link between indeterminism in physics and interactionism is built up by means of a highly objectionable methodological procedure. Whatever the physical events may be to which indeterminism relates and whatever the physical theory may be that describes the probabilities for these events, if intentions, as conceived in the framework of interactionism, are to exert a regular influence on physical events, the probability rules of the physical theory in question do not indicate the complete probabilities [186] of these physical events; given the state of the art, the only reason for such a claim would be the metaphysical presuppositions that characterize interactionism. In short, instead of having to endorse an additional force for metaphysical reasons, we have to endorse a change to the probabilities that a physical theory indicates for metaphysical reasons.

Within the framework of the positions considered in this paper, the conclusion is as follows: taking everything into account and given the current state of the art, quantum physics does not reduce the price which one has to pay for interactionism. No logical incompatibility with any known physical theory hinders one to go for interactionism if one is willing to pay the price for this position. If one considers that price to be unreasonably high, then one should adopt a compatibilist strategy, that is, question the metaphysical presuppositions from which interactionism starts.

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