Henry Stapp and the Orthodox Interpretation

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Abstract. Henry Stapp studied with the founders of quantum mechanics, and has been one of the most forceful defenders of a version of what is known as the orthodox interpretation. Upon completion of his PhD under Emilio Segrè and Owen Chamberlain, Stapp was invited to work with Pauli, who unfortunately died prematurely the same year. Stapp was then invited to work with Werner Heisenberg, and then with J. A. Wheeler, on the foundations of quantum mechanics – one of the main topics on which Stapp has focused his remarkable career. These facts alone make Henry Stapp an icon in the field of physics, particularly the foundations of physics, but there is a lot more to say about Stapp and his work. In this paper we discuss Stapp's legacy, as well as his views about the connection between the observer, quantum measurements, and the mind/body problem.
Keyworkds: quantum physics; orthodox interpretation; Stapp's interpretation; quantum ontology; mind-body problem

Introduction

It is a pleasure for us to write an article introducing the special issue in honor of Professor Henry Stapp. Though often misunderstood, Stapp is a very influential and creative physicist, and his work will provide food for thought for many more generations of physicists to come. It is our hope that the current series of papers, aggregated in this special issue of *Activitas Nervosa Superior*, will not only allow for researchers to understand Stapp's view of quantum physics, or the differences between his interpretation and those of other researchers, but also the intertwined connections between quantum mechanics and theories of mind and consciousness. Thus, the audience for the papers in this special issue does not only include physicists, but also psychologists, philosophers, and neuroscientists interested in the connection between quantum physics and the mind.

The four co-editors of this special volume have known Stapp for several years (some, like SK and JAB for decades), and we were all inspired by his ideas. As a person, Stapp is well-known, both among his friends and in the scientific community, for being open minded, kind, and generous. The diverse fields of inquiry inspired by his work are reflected in the contributions to this Special Issue, and they reflect a wide range of disciplines and traditions. In this brief introduction, we don't have enough space to analyze the intricate relation between Stapp's proposals and all the other interpretations of quantum mechanics. For this reason, we briefly comment on Stapp's work, and then focus on a particularly popular interpretation among physicists: the Everettian or "many-worlds" interpretation (Schlosshaur et al., 2013).

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The legacy of Henry Stapp

Henry Stapp studied with the founders of quantum mechanics, and has been one of the most forceful defenders of a version of what is known as the orthodox (Stapp 1993, 2017) or *Copenhagen Interpretation* (there is no agreement of what is the Copenhagen interpretation; for a detailed discussion, see Jaeger 2009). Upon completion of his PhD under the supervision of Emilio Segrè and Owen Chamberlain at UC Berkeley, Stapp was invited to work at ETH Zurich by the legendary Wolfgang Pauli (Stapp 1993), who unfortunately died the same year. Stapp was then invited, ten years later, to work at the Max Planck Institute by the equally illustrious Werner Heisenberg. He then worked with J. A. Wheeler on the foundations of quantum mechanics – one of the main topics on which Stapp has focused his remarkable career. These facts alone make Henry Stapp an icon in the field of physics, particularly the foundations of physics. But there is a lot more to say about Stapp. He is a celebrated figure in many other areas of inquiry.

Stapp has methodically and rigorously addressed the topic of the mind's interaction with the world. His pioneering work on the inverse quantum Zeno-effect has implications for neuroscience and psychology, which Stapp and others have discussed at length (for details, see, e.g. Schwartz, Stapp, & Beauregard, 2005; Stapp, 2011; and Stapp, 2017). Stapp has defended views about consciousness, free will, and rationality, all in relation to the orthodox interpretation of quantum mechanics. He has explained in detail why, according to this interpretation, the most important insight of quantum mechanics, as the modern foundational theory of physics, is that the *agent* whose rationality is intrinsically related through their will to the measurements that determine outcomes in quantum mechanics, cannot be eliminated in any procedural or reductive way.

This is a subtle point that, according to Stapp, has been frequently (and unfortunately) misinterpreted by the proponents of alternative interpretations of quantum mechanics. According to some of the founders of quantum mechanics, on Stapp's interpretation, the irreducibility of agency, or the irreducible role of the rational experimenter to mere instruments, models, and equations, can only mean that the subjective awareness (or the subjective and rational access to information involved in observations and experiments) must be part of the new physical foundation established by quantum mechanics (Stapp, 2017). This irreducibility of the subject as essential ingredient in any measurable outcome is a *non-negotiable* aspect of the new quantum paradigm. It cannot, therefore, be an "interpretation" of the theory. Rather, it is a key aspect of the quantum world.

If this is the case, then physicists really have no option but to accept that the mental should play a fundamental role in their most basic theory of nature. This is not based on a principle, argument, or hope for future theorizing about consciousness and its place in the universe, but rather on a consequence of quantum theory. In particular, it is not the result of an a priori or purely epistemic thought experiment, which has become the standard way of proceeding in contemporary dualistic and panpsychistic views of consciousness in philosophy. The irreducible role of the agent is, therefore, part of the scientific understanding of how measurements

determine outcomes in the most fundamental theory of nature and it is, ultimately, a fundamental constraint on any interpretation of quantum mechanics.

This does not mean, of course, that the orthodox interpretation provides a fully detailed and unproblematic view of mind and quanta. In fact, quantum mechanics establishes the necessity of studying the interaction between the mental and the physical, but leaves the question of how exactly this interaction occurs wide open. The details about how this occurs are as intractable as ever. In this regard, Stapp has taken the orthodox interpretation to its natural consequences by studying how this relation between mind and world could be understood using philosophical, psychological, and neuroscientific considerations. By taking this approach, Stapp has pioneered several ideas in these fields.

The problematic situation the theorist confronts is as follows. On the one hand, if the result of adopting the theoretical framework of quantum mechanics is that the thinking agent must take central explanatory stage, then the account of the mind's role cannot be merely an "armchair" or archaic kind of *panpsychism*, according to which we proceed from a priori "first premises" to conclusions. On the other hand, the fact that the observer and her experiences are essentially related to the outcome of measurements, and might be more fundamental and primitive than physical or functional notions, is certainly incompatible with traditional reductive physicalism. This conundrum should not be entirely surprising given that reductive-physical "*mechanicism*" was developed under the Newtonian or classical assumptions that had to be abandoned and replaced with quantum mechanics. The new quantum worldview demands an intricate and novel compromise between measurement and mind.

Since the involvement of the mental is non-negotiable under the orthodox interpretation, the abstract philosophical views about mind and world that lack the details provided by quantum measurement must be updated. Stapp does this through the work of John von Neumann and Alfred North Whitehead (Stapp, 2011). Stapp's proposal includes a novel account of how free will, rationality, and choice are at the bottom of the structural and functional interaction between mind and world. The inverse quantum Zeno-effect thesis provides a plausible, and perhaps testable, mechanism for this interaction to happen (see de Barros & Montemayor, in press). The explanation about choice and rationality provides the foundation for a reasonable and semantically assessable access to information about the universe (an *indexical* kind of informational access), as well as the basis for the interaction between free will and mechanical consequences.

The fundamentality of consciousness, therefore, is not merely postulated a priori, based on intellectual scenarios, but on the necessity to address the crucial involvement of the mental. Moreover, for Stapp, this is not merely a metaphysical "connection" (necessary or contingent) between the unqualified "mental" and the "objective world" or between an intrinsic and an extrinsic feature of the universe. Rather, the relation between mind and world specifies a *rational* and *free* decision between *the knower and the known*.[2] One might disagree with these perspectives, but there is no doubt that Stapp's contributions to the scientific understanding of the interaction between mind and world are extremely valuable.

[2] We adopt this expression from Marjorie Grene's (1974) insightful book's title.

The metaphysics of mind and world

Einstein famously said that "Religion without science is blind, but science without religion is lame." One of us (JAB) likes to paraphrase Einstein, saying that "Metaphysics without physics is blind, but physics without metaphysics is lame." By metaphysics, here, we usually mean a part of it, ontology, which for some unknown reason is not as toxic a word among physicists working in quantum foundations as metaphysics is.

Now, explicitly or implicitly, many physicists reject certain interpretations of quantum mechanics not because of their inconsistencies or lack of empirical substantiation, but because they carry with them what could be called an "ontological baggage." Take, for instance, Stapp's view of the Copenhagen interpretation, with the mind being a non-material entity that interacts with regular matter (Stapp, 1993). This view is dualist, and hard to swallow for many physicists, who see dualism as an unnecessary and undesirable ontological complication. But this is, essentially, the criticism that one sees in the literature (other than the misguided claim that Stapp's interpretation has been falsified; see de Barros and Oas 2017 and references therein): the ontology is funky. Here we would like to point out the difficulties with this naïve approach to metaphysics, and examine at least one of the popular interpretations of quantum mechanics: the many worlds interpretation.

One of the key difficulties in contemporary physics that emerges from the so-called "measurement problem" is that there are too many interpretations of quantum mechanics that aim at solving this problem. Some interpretations emphasize the interaction between mind and world, such as Stapp's, while others emphasize the objective and more traditionally deterministic features of classical physics. Our focus here is on the many-worlds interpretation because of two reasons: its popularity among physicists (Schlosshauer et al. 2013) and its complex metaphysical assumptions that reveal how enormously intricate is the problem of relating mind to world in the foundations of physics. The purpose of this discussion is to highlight the merits of Stapp's view in the light of some complications that emerge from the many-worlds interpretation, particularly with respect to the distinction between actuality and possibility.

Although it is very unlikely that the debate on the interpretations of quantum mechanics will settle any time soon, we have more than enough interpretations for comparison. According to the many-worlds interpretation (Everett, 1957), the solution to the problem of how exactly to understand the interaction between the observer's actions and the collapse of the possible into the actual is to simply deny that the observer is relevant in the non-reductive way that the orthodox interpretation assumes. It achieves this by postulating a multiplicity of branching "worlds" that "split" upon measurement, thus avoiding the commitment to the collapse of the wave-function based on subjective observation. The many-worlds interpretation is, therefore, a direct challenge to the observer dependence of quantum mechanics, proposed by the orthodox interpretation. But what exactly does this branching of worlds mean? It has been suggested by the so-called "many-minds" interpretation (Zeh, 2000), that in order to avoid the unsavory result of having an infinite number of observers at the moment of measurement, the split needs to occur "in their minds" so that any observer has certainty at the moment of measurement (Albert and Loewer, 1988). Thus,

the debate between these two interpretations is about where the split of possibilities and the realization of certainty and actuality occurs: in the mind of the observer or in the universe(s).

We don't have the space here to discuss the merits and shortcomings of these proposals. Our goal is to highlight the substantial challenges one faces by denying the orthodox interpretation. The options for avoiding the non-negotiable role of the observer in the rationally mediated collapse of the possible into the actual are quite limited. In the case of the many-worlds interpretation, the option is to commit to a certain type of "blurring of the boundary" between the possible and the actual, with all that is possible becoming actual. In other words, the actual measurement means that the world splits into the many possibilities of experimental outcome, and all the possible outcomes of the "actual measurement" are somehow equally real. This type of "modal realism" or the view that possible worlds are on a par with the actual world(s) with respect to ontological status, might be a non-starter for most theorists. In particular, we keep the objective perspective on the world and eliminate the role of the observer only at the cost of eliminating the fundamental boundary between the actual and the possible.

There is, therefore, a high cost to pay if one wants to get rid of the observer assumed by the orthodox interpretation. This is why the many-minds interpretation was offered as an alternative to the many-worlds proposal. Between many minds and many worlds one immediate question is *how many*? And what are the constraints on rationality, choice, free will and the general physical invariants that allow for measurements? Why should worlds split at measurement, what exactly is the *reason* behind this? Or why should the split be mental? What is the reason behind the split? This is, ultimately, an issue regarding the nature of information in quantum mechanics. Information about possibilities can never have the status, epistemic or metaphysical, of information about what is actually the case.

Indexical information (so called "essentially indexical information," see Perry, 1979) is very relevant to understand this problem. The meaning of the expression "someone is making a mess" may be true of me in a descriptive, objective-referential, or self-referential way (i.e., we are making a mess). The sentence "someone is making a mess" then could be true of me as a description, an object of reference or ourselves. Only the latter is essentially indexical—it anchors "someone" as *ourselves* and eliminates any other possibility, similarly to the expressions "here" and "now" with respect to place and time. The information contained in "someone is making a mess" is true of "we are making a mess" but only the indexical information contained in "we are making a mess" is directly related to our immediate thoughts, decisions, and actions.

This kind of essentially indexical information plays an important role in measurements and their outcomes. Without the observer, events in the universe are all ambiguous. It is only through the observer that they acquire metaphysical actuality and epistemic certainty. This is why Stapp says that the fundamental aspect of the orthodox interpretation is "to attach to each Heisenberg actual event an experiential aspect. The latter is called the *feel* of this event, and it can be considered to be the aspect of the actual event that gives it its status as an intrinsic actuality" (Stapp 1993, p. 149).

Providing a metaphysical framework for the many-worlds interpretation requires a solution to the problem of *actual versus possible information*. One can postulate a type of "modal realism"

according to which possible worlds exist just as our actual world exist—possible worlds exist on a par with the actual world. This is not an uncontroversial view, and it generates difficulties regarding the identity of individuals and the relation between possible and actual properties. But even if modal realism were accepted as the best explanation of the metaphysics of quantum mechanics, it cannot provide a sufficiently satisfactory explanation without a solution to the problem of how the possible becomes actual. The view that possible worlds are as real as the actual world needs to be reconciled with the essentially indexical information of the here and now. As a thinker, observer and experimenter, one cannot be on equal informational states as our hypothetical possible-counterparts without falling into contradictions. This difficulty is at the heart of the debate between the many-worlds and the many-minds interpretations.

This defense of indexical information might be Stapp's most important contribution to the debate on quantum mechanics. The inverse quantum Zeno-effect is only one aspect of the explanation of the knower-known relation. This is not a brute metaphysical "connection" or the paradoxical relation between the essentially intrinsic (and uncommunicably mysterious) "consciousness of the universe" and the metric and therefore extrinsic relations of physical measurement. This more than "panpsychist" relation between knower and known influences much of Stapp's interpretation, and avoids the type of arbitrariness problems that the sheer vastness of multiple minds and worlds generate. The here and now is rationally determined by the expectations of the observer and the naturally given choices for measurement and calculation, according to Stapp's view.

We could extend the above discussion to include the problems brought by other interpretations of quantum mechanics when we try to detach the observer. For example, in the version espoused by David Albert, the Bohmian pilot-wave interpretation leads to an infinite dimensional space where the quantum potential and the particles live, which brings many ontological difficulties. Additionally, such interpretation is highly non-local, and presents difficulties with respect to a description in terms of a relativistic spacetime. Of course, an alternative is to throw in the towel, and to simply avoid discussions related to ontology, such as epistemic interpretations of quantum mechanics. But we think this is lame.

Thus, what we want to show with this discussion is Stapp's deeply philosophical approach to the foundations of physics. All interpretations of quantum mechanics are philosophical to the degree that they are addressing two philosophical problems: the nature of reality and the relationship between mind and world. But Stapp's is more philosophical than most interpretations because it addresses issues in philosophy of mind, philosophy of psychology, and epistemology.

This special issue evolved out of a special session in honor of Henry Stapp's 90th birthday, organized during the International Conference on Quanta and Mind held at San Francisco State University from April 10th to 11th, 2018. Many, but not all, contributors to this issue were present at this session. We would like to wholeheartedly thank all the contributors for their papers submitted to this volume, as well as Professor Petr Bob (the chief editor of ANS) for his support.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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