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Quantum Mechanics and the Social Sciences: After Hermeneutics[1]

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ABSTRACT: Quantum mechanics is interpreted, in the spirit of Niels Bohr and Werner Heisenberg, as about physical objects in so far as these are revealed by and within the local, social, and historical process of measurement. An analysis of the hermeneutical aspect of quantum mechanical measurement reveals close analogues with the hermeneutical social/historical sciences. The hermeneutical analysis of science requires the move from the epistemological attitude to an ontological one.

Since I have written widely on hermeneutics and the physical sciences,[2] I want now to show by a hermeneutic analysis that quantum mechanics can be interpreted as a bridge between the physical and social sciences.

According to Niels Bohr and Werner Heisenberg, the quantum theory of physics differs from classical physics in this respect above all that while classical physics characterizes a physical object by what is real and objective, the quantum theory characterizes a physical object only by what can actually be simultaneously measured. Since, however, measurement can perturb the object measured and (allegedly) does so significantly at the level of quantum physics, what is actually measured in quantum physics is significantly the outcome of a human interaction with the physical reality, and this interaction leaves the system irreversibly changed with respect to some of its parameters. That was the view of Niels Bohr and Werner Heisenberg and it constitutes the original core of what is called "complementarity." It is the view I am provisionally adopting for the purpose of this paper. I also think it is more right than wrong and that the rightness it contains has been undervalued.

Let me expand on what this view entails. It entails that the secular structure of a "quantum phenomenon" is not an objective reality, but is revealed only and strictly within the context of measurement, while recognizing that measurement has to be taken as a socio-historical process of empirical inquiry based on standardized technologies and skills and performed by (spatially and temporally) local scientific inquirers. When compared with the old physics, the new picture of scientific inquiry introduces elements of a socio-historical nature as essential to the analysis of the process of scientific inquiry, such as where, when, by what expert group, in what sequence, for what purpose, etc. In the Bohr/Heisenberg view, the relevance of two non-classical freedoms, namely, social factors and history, is implicit in their understanding of quantum theoretic inquiry. In this view, the quantum theory incorporates within it essentially the

socio-historical processes of measurement and relates to the socio-historical path of the system's disclosure within the world. Such knowledge is esentially hermeneutical.

Conversely, wherever these non-classical elements (where, when, by whom, in what sequence, for what purpose, etc.) are intrinsic to and inescapable factors of a scientific process, Bohrians and Heisenbergians would direct you to the quantum theory as a trusty model of such a process.

Measurement always involves a local community of expert scientific operators and witnesses – henceforth, the "local research community," or simply, the "local community" – and a laboratory niche in the local community's perceptual world; this is the local niche within which the phenomenon is disclosed through a measurement. A sequence of measurements defines a socio-historical path of disclosure. Using a Merleau-Ponty metaphor[3], any phenomenon takes "flesh" in the world only along definite socio-historical paths each defined by a particular sequence of decisions taken by local communities. A different sequence of decisions will define a different socio-historical path. To vary the metaphor, if the phenomenon is "dressed" for disclosure in a certain way by each measurement, then different socio-historical paths are characterized by different irreversible sequences of "dresses" resulting from the human decisions that are locally made.[4]

Firstly, the quantum theory gives an account of the essential or secular unity of a phenomenon vis-a-vis local communities since all presentable data are united formally by a single theory.

Secondly, under the interpretation given above, it is reasonable to take the "superposition" of two theoretical states to represent the disclosure possibilities of the system relevant to two different possible local communities. The "reduction of the wave packet" would then represent both the decision of a particular local community to equip itself to act, and the post-measurement disclosure of the phenomenon to that community. These are real changes in the world.[5]

Thirdly, the disclosure of a phenomenon is characterized by path dependent data. For example, in quantum physics, a change in the order of some pairwise decisions or measurements, such as momentum and position, or up-down and left-right spin (each measurement associated with a different possible local research community), would (according to the quantum theory) yield different sets of data irreversibly. The elements of each pair, though mutually exclusive in their local historical realizations, belong nevertheless to the definition of the same phenomenon insofar as this is full of real historical potentiality. We could speak of the same phenomenon as "fleshed out" by and for a particular local research community by the sequence of decisions made by past inquiries, i.e., by past research communities; it is this inquiry sequence that determines the historical path of its worldly disclosure. The phenomenon remains, however, throughout its evolution the *identical* secular phenomenon.

This hermeneutical account of data constitution confronts the ontology (rather than the epistemology) of social-historical time as constitutive of human understanding and experience, and the sequential order of local human decision-making as branch-points of real-world novelty. In the model here proposed, data production is path-dependent. Different local and historical communities can prepare and recognize the same phenomenon, but they will find it "dressed" or "fleshed out" differently – exhibiting the phenomenon's social and historical, in the sense of hermeneutical, dimensions.

The ontological interpretation implies a role in the scientific account for two non-classical freedoms, i.e., for social factors and for history. Social factors enter at decision points where local communities decide what representational superpositions are to be broken by measurement. History enters through the path-dependence of the data that trace the life history of the real phenomenon. Although both of these freedoms are real and can lead to real novelty, they are constrained by the essential secular unity of the socio-historical phenomenon which is what the quantum theory defines.[6]

Many of the sciences but especially the social sciences rely on methods of statistical analysis originally developed for the physical sciences; in these methods it is assumed that data are in principle *objective*, i.e.,

1. that what a datum is (how it should be described) does not depend on the local interests people may have in measuring and recording it; in other words, that the descriptive categories for data and phenomena are not derived from the local character of the scientific community but are rather in Newton's terms "universal" qualities (see Newton's "Rules of Reasoning in Philosophy") and,

2. that whether or not a datum is recorded (i.e., a data judgment is made) does not change the course of things in the world; in other words, the decision of the local community to equip itself and to act leaves the world unchanged.

In this classical view, scientific inquiry is a view from outside the world, disengaged from the course of events in the world.

Of the two components of objectivity stated above, the former, is concerned with the categories of objective knowledge, let me call it an *epistemological principle*; the latter, is concerned with the being of the world, let me call it an *ontological principle*. It is well known that quantum physics has undermined the latter of these principles, since a measurement leaves the measured phenomenon irreversibly changed; on the terms of the interpretation given above, quantum physics also undermines the former. With respect to both these principles, it is not clear what should replace them.

These objectivity principles have been challenged in recent years by many scholars, including philosophers, sociologists, anthropologists, and historians of science. I find all of these discussions turn on the relation between the domains of the mental (or more generally, the representa-

tional) presumed known and the physical presumed derivable from the representation by a set of principles. It should be clear to a critical reader that epistemological problems are not resolvable in this way but require a prior ontological analysis.

What is the meaning of ontology? and what is the ontology of an act of research? Research is the search for an understanding of what we experience. Understanding and ontology are linked. Inquiring, searching, understanding are, as Aristotle said in the Metaphysics, of the defining essence of being human. The domain of this activity is traditionally called Being. Acts of understanding relate people to the world by recalling where they are, where they have been, and where they might want to go. Each act of human understanding foresees possibilities and envisages choices against the background of the World; World in this hermeneutical sense is Being. Heidegger puts it well when he says that to be human is to-be-There-in-the-World, to be *Da-sein*.[7] By Being and World, I do not mean the set of all ready-made things and events (i.e., beings); I mean rather the background essential to human life that makes all things and events possible and understandable. Being is all there is and can be and human life is ultimately concerned with nothing but this.

Heidegger made a distinction, the rudiments of which are also found in Aristotle, between "*ontic*" beings and "*ontological*" Being; this he called "the ontological difference".[8] Ontic beings are given as ready-made things and events distributed in objective space and time and belonging from the theoretical viewpoint to the inventory of a local Euclidean world – this is *reality* as it is usually taken in modern philosophy – while ontological Being is the common essential and hermeneutical background of human life which makes ontic beings understandable and which, when interpreted by human life, confers affirmable reality on local worlds. Aristotle and Heidegger are representative of a tradition that addressed the activity of human understanding and research first and foremost as *ontological*, and only secondarily as the ontic.[9]

The activity of understanding then is to be defined as the ontological activity of local communities constituting local beings as known within the hermeneutical and ontological horizon of Being. Note that since understanding (the activity of) understanding does not presuppose prior epistemological principles (in the classically modern sense), it avoids the basic *petitio principii* of an epistemological starting point. One of the functions of such *constitution* is to construct and use representations; what these are and how they are used is then to be studied in this connection.

For Aristotle and, more generally, prior to Descartes and Locke, epistemological questions were formal, regional, and local in character, subsidiary to the ontology of knowledge. After Descartes and Locke, however, the general cultural consensus characteristic of modern times was formed; it had two parts, that science provides the single, true, and privileged account of Nature and that the scientific account ought to replace all other accounts of Nature. Modern philosophy turned to episte-

mology largely because of the dissonance between Nature as (ontically) pictured by the new science and Nature as assumed for the purposes of human life. The newly emerging scientific picture of Nature was bereft of those sensible qualities and feelings, moral purposes, and social organization that constituted the hermeneutical arena – the World – of human life; it had of itself no "meaning," i.e., no human, social "meaning" (whatever other meaning it had in modern philosophy was in the cold eye of an impersonal God). In this cultural transformation, it was inevitable that a new branch of philosophy would grow up, a general epistemology, which was both the science of scientific knowledge and claimed to be the foundation of all philosophy.

When epistemology moved to center-stage, problems were created that could at first be postponed: the problem, for instance, about how knowledge can build bridges between representations, such as scientific theories, diagrams, or data reports, and reality without presupposing a prior grasp of reality. The changes that have taken place in science since the 17th century have brought new and very different models of scientific knowing and with them confusion to those who believed that science provided unchangeable and privileged paradigms of objective knowledge. Certainly, it was the advent of quantum mechanics that dealt the severest blow to the view that scientific knowledge is objective. It is to solve these problems that I turn to an ontology of the activity of scientific research

Between an epistemology and an ontology of scientific research, there are significant differences in starting point and method. In the *first* place, the ontological starting point drops the Cartesian supposition that whatever functions as a representation can itself be known and judged by internal criteria (e.g., clarity and distinctness) and one returns instead to the Aristotelian position that representations (or *species*, as they were called) are not generally known in themselves but only in what they make known. The ontological starting point works from the principle that whatever scientific representations do, they do it only as a function of what human understanding is.

In the *second* place, the ontological starting point supposes that *real* or *evident* knowledge activity has somehow antecedently been identified and described – but not by an epistemological inquiry in the classically modern sense (i.e., concerned with the justification of mental or other representational contents), but in some other way, for example, by phenomenological inquiry. Phenomenology is explicitly concerned with the ways Being is given critically and evidentially to human understanding; it is not about representations and their validity, but about "*die Sache selbst*", i.e., about what is presented to the knower with evidence in the act of knowing.[10] Turning to phenomenology, however, is not without its problems for someone doing the philosophy of science.

In the *third* place, we take the paradigmatic fulfilment of scientific knowing to be the recognition of occurrences in the world of what science speaks, i.e., of scientific data. *Data constitution is the starting point and*

the central philosophical question of an ontological inquiry into science. Data production and analysis is a part of the experimental, i.e., laboratory, side of science. Compared to the interest philosophers have shown in theories, interest in experimental work has been small until recently.[11] Recent work, however, has failed adequately to clarify the notion of *data* and to address the central philosophical problems of the phenomenology and ontology of *data constitution.* [12]

DATA

I shall first present a preliminary clarification of the notion of *data*, and then return to the proposal discussed at the beginning of this paper. We start with a hermeneutic phenomenology of data observation.

Every datum is in relation to a phenomenon and in relation to a local suitably prepared community of data producing observers or expert witnesses.[13] By *community*, I mean, a group that shares outlooks and tasks and monitors the activity of its members so as to pass judgment on its quality as an expression of community goals. By a *local* community, I mean, one that exists in a certain place and time, not an ideal, universal, or global community. By *suitably prepared*, I mean, sharing an expertise and equipped with the appropriate instruments to constitute a community. By *data producing*, I mean, preparing, recognizing, and reporting data in question. In sum, I am speaking of the activity of research, particularly of laboratory science. I shall use the terms "observer" or "local observer" for such a local suitably prepared community of data producing observers or local community of expert witnesses.

In order to have a philosophical perspective, the local observer must be raised above the everyday attitude (i.e., ontic, instrumental, technical, or other) to become critically self-aware as *Dasein*, i.e., as understanding Being; they now are ready to become philosophers of science, i.e., to begin the work of interpreting science against the background provided by the textual and other resources of the philosophical community.

Considered phenomenologically, every datum is *for* an observer and *about* a phenomenon. The datum is some (real) *appearance* of a phenomenon to an observer; the datum judgment then is always about some secular phenomenon revealed through a datum, e.g., "The energy of this (just arrived) electron is 5 Mev." A (real) appearance of a phenomenon is often called a "profile" of the phenomenon, *having energy of 5 Mev* is a profile of the (just arrived) electron.

The phenomenon is the existential unit and essential secular invariant to which a multiplicity of data can be ascribed by the observer. The "about-ness" or "of-ness" of a datum implies that every datum is *intentional*, i.e., that every datum is an appearance of something else that is individually present.[14] The intentionality of a datum is threefold.

1. In the first place, a datum is not known for its own sake, but for the

sake of something with a secular structure that it reveals as present in the ambience of the observer; we call this *the phenomenon.*

2. In the second place, the datum judgment is synthetic (joins predicate [P] to a subject [S], e.g., S is P), since it is of the nature of a phenomenon (S) that, while remaining essentially the same, it is capable of showing itself to an observer under many different appearances (P's); the phenomenon then is the subject (*subjectum*, see below) to which is attributed a possible multiplicity of connected data.

3. In the third place, since the phenomenon in fact endures between appearings to observers, the phenomenon is more than any data accumulated about it and more than the law of data synthesis. Aristotle, though far removed from the sophistication of modern science, saw this point clearly and called what is so posited "substance" as "*subjectum*". This position re-asserts something that modern philosophy denied, namely, that human understanding has an *intuition of existence or being* that goes beyond the primary sensibles of spatial and temporal extention or the categories. It is this insight we are trying to recover when we say that the datum judgment affirms, in addition to the synthesis (e.g., S is P), the presence of a phenomenon as a being beyond both the data and the synthesis; more precisely, the synthesis is not just one of correlations among data, but of attribution to a common *subjectum.*

In relation to the research activity of any local observer, the *epistemological datum* is the content of what is *objectively represented* when a datum judgment is formulated as a report through the medium of some language and some theory. Data reports are offered in the form of numerical indices or values estimated by instrumental measurement and attributed to the qualities possessed by the phenomenon according to the theory in use.[15] Data reports are both *concrete*, denoting what has appeared to observers in space and time, and *abstract*, connoting the essential qualities of a kind that can occur again and again in observation or be prepared in standard ways under standard circumstances for observation. The language of data reports is, on the one hand, sensibly realistic and environmentally worldly, and on the other, loaded with numbers and theoretical vocabulary. This creates a paradox but it is not here my intention to resolve this.[16]

Data reports are the product of constitution and, once made, all reference to the process of constitution and representation is dropped; in contrast, the *ontological datum*, taken in the context of the *observer-being-in-or-coming-into-the-presence-of-a-datum*, retains this reference.

In the formation of an epistemological datum, a purge of locally irrelevant but ontologically significant factors may have, indeed usually has already, occurred. Measurement in quantum mechanics is accompanied by such a loss of information (an increase in entropy). *It is this feature that suggests a comparison with the quantum mechanical model of a transition from superposition states (before measurement) to a pure state (follow-*

ing the datum judgment). The constitution of the datum in the kind of theory we are considering is then the ontic realization of one possibility, executed at the expense of some excess of ontological possibilities that are lost irreversibly in the process; this irreversible change in the real course of historical events brings about the above mentioned increase in entropy. What this original excess of ontological possibilities is will need a more thorough discussion

CONCLUSIONS

Finally, some conclusions: theories of a quantum type are suggested wherever the phenomena under study have an essential socio-historical dimension on account of which data appear only as related to a specific path, i.e., 1. to specific local communities of expert witnesses, such as different laboratories, historians, even nationalities, and 2. to the sequencing of the phases of the inquiry (the order in which decisions are made and executed). Examples of the former are presently used to cast doubt on the existence of a single phenomenon; while examples of the latter are now turning up in the sequencing of questions in questionaires, of pedagogical materials in teaching, of stages of economic development, etc.

NOTES

1. Based on a paper read at the American Philosophical Association (Pacific Section) Symposium on "Philosophical Implications of Bell's Theorem", in March, 1989.
2. See the references.
3. See Merleau-Ponty 1962.
4. There is, of course, no such thing as an "undressed" phenomenon. (The metaphors of "flesh" and "dress" are introduced to substitute for Aristotle's "quality" while relativizing it to human communities and history; see Heelan 1989.)
5. Choosing to represent a state as a superposition state relative to a data operator Q is, I take it, the first step toward a decision to measure the quality represented by the operator Q.
6. The discussion at this point naturally leads to the topic of how secular changes in the ways the phenomenon is "dressed" over longer historical periods can be reflected in models of the quantum type. I can only offer some provisional comments here. For communities separated in time, some secular changes are perceived as evolutionary, some as revolutionary. The quantum model has the potentiality of incorporating revolutionary changes in science as evolutionary – that is, as preserving continuity with the past – by adding new data operators to the infinite-dimensional Hilbert space of wave-functions, leaving the rest of the structure intact. An example of this is the enlargement of the traditional set of operators to include the spin operators.
7. See 1962, p. 27, and in general, sect. 32; see also Heelan 1983 and 1989.
8. See Heidegger 1966.
9. Pragmatism has tried to escape the rigidity of modern philosophy's ontic framework by introducing human life and culture into the specification of the world (Dewey 1960), but such specifications fail to raise the ontological dimension, and Pragmatism consequently fails to be able to justify itself on other than instrumentalistic grounds.

10. See Husserl 1970; Heidegger 1962, and Merleau-Ponty 1962.
11. The recent interest in experimentation grew out of the seminal studies of L. Fleck (1979), G. Holton (1973, 1978), T.S. Kuhn (1962, 1977), C. Bernard (1957), and others. Among the more significant books on this topic recently published with a hermeneutical interest, are Babich (1993), Crease (1993), I. Hacking (1983), P. Heelan (1983), D. Ihde (1979), J. Kockelmans (1993), J. Rouse (1987). See also, in the history of science, R. P. Galison (1987), S. Shapin and S. Schaffer (1985); and in the social sciences, B. Latour (1987), A. Pickering (1984), B. Latour and S. Woolgar (1979).
12. See Heelan 1989.
13. See Heelan 1989.
14. With respect to observers, data perform a role analogous to what sensations would perform in classical theories of perception, if these were ontological theories rather than epistemological theories; they mediate the real presence of an object to an observer, but with the difference that instruments play the part of sense organs.
15. Ackermann 1985 presents this view but without the hermeneutical refinement.
16. The topic was addressed in Heelan 1989.

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