QUANTUM PHYSICS AND THE EMBODIED SUBJECT

A Foreword[1] to :

Patrick Aidan Heelan
THE OBSERVABLE: HEISENBERG'S PHILOSOPHY OF QUANTUM MECHANICS
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This is not an ordinary book on the philosophy of quantum physics. Patrick Heelan started working with Werner Heisenberg in the early 1960's while he was associated with the Edmund Husserl Archives at the University of Leuven in Belgium, and his research about the meaning of quantum mechanics bears a strong mark of this immersion in the heartland of phenomenology, hermeneutics and transcendental epistemology. Being a member of the Edmund Husserl Archives at the Ecole Normale Supérieure, in Paris, France, I can appreciate with a flavor of complicity the depth and extent of this philosophical influence.

About the latter, it must be said that, irrespective of one's position in the long-term debate between analytic and "continental" philosophies, and independently of any judgment about which one of these two philosophical strategies is best suited for clarifying the meaning of modern physical theories, the "continental" approach has the advantage of being akin to the one pursued by the creators of quantum mechanics themselves. Even when they disagreed, the physicists who first elaborated the formalism and tentative interpretations of this

[1] See also Babette Babich's foreword to the same book of Patrick Heelan, that she edited. I warmly thank her for her invitation to write this preface, about an author who was an inspirational source for my work on the foundations of quantum mechanics (see M. Bitbol, *Mécanique quantique : une introduction philosophique,* Flammarion, 1996).

theory were debating with common philosophical references, and with the shared cultural background of a post-Kantian and neo-Kantian German tradition. Thus, although he criticized the original Kantian orthodoxy, Einstein was quite impressed by the neo-Kantian reading of relativity theories offered by Ernst Cassirer[2] ; Bohr was exposed to Kierkegaard's existential philosophy and to post-Kantian ideas through Harald Höffding's lectures[3] ; and Schrödinger did not hide the breath-taking similarities between his philosophical ideas and Schopenhauer's[4]. As for Heisenberg, who is the central figure and theme of Patrick Heelan's book, he grew in the atmosphere of a heated debate about Ernst Mach's positivism[5], he then received a strong Kantian input from his student Karl-Friedrich Von Weizsäker and from the philosopher Grete Hermann[6], and he finally had a long-standing intellectual relationship with the hermeneutical phenomenologist Martin Heidegger.

The indisputable symptom of a transcendental and phenomenological influence on both Heisenberg and Heelan can be seen in the unconventional orientation of their philosophy of physics. Far from restricting their discussion to a metaphysical speculation about what the world is like according to quantum mechanics, or about how the symbols of this theory hook on to things out there, they systematically impose a *reflective* direction to their philosophical inquiry. They devote most of their effort to assessing the "indivisibility" of experimental phenomena, underpinned by the *inextricable* connections between the quantum mechanical

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[2] Letter of Einstein to Cassirer, June 5, 1920 : "I think that your treatise is very well suited to clarify philosophers' ideas and knowledge about the physical problem of relativity". *The Collected Papers of Albert Einstein, Volume 10, The Berlin Years: Correspondence, May–December 1920, and Supplementary Correspondence, 1909-1920,* Princeton University Press, 2004, p. 182

[3] J . Faye, *Niels Bohr : His Heritage and Legacy,* Kluwer, 1991

[4] E. Schrödinger, *My View of the World,* Cambridge University Press, 1951 ; M. Bitbol, *Schrödinger's Philosophy of Quantum Mechanics,* Kluwer, 1996

[5] W. Heisenberg, *Physics and Beyond,* Harpers & Row, 1971, chapter III

[6] G. Hermann, *Les fondemements philosophiques de la mécanique quantique,* Vrin, 1996 (French translation of : G. Hermann, *Die naturphilosophischen Grundlagen der Quantenmechanik,* Abhandlungen der Fries'schen Schule, N.F. Band 6, Heft 2, S. 69-152, Sonderdruck bei Hirtzel, 1935)

observer (with various instrumental extensions) and its purported object. These connections in turn imply an analysis of the instruments, mathematical symbolism and type of language which are essential to the practice of microphysics. In particular, it is shown that the observer-object entanglement expresses itself through the context-dependence of any description of micro-attributes, and through the correlative use of contextual, rather than universal, languages. As for the statement of contextuality itself, it can only be made by way of a meta-contextual language[7] which is consciously adopted throughout the book.

Heelan's analysis of the observer-object complex accordingly develops into the idea of a *hermeneutic circle*, which is a mutual relation between (i) a set of contextual preconceptions (about a text or a domain of scientific investigation), and (ii) the way preconceptions modulate the statement of those facts which could be used to test them. Here, the concept of a hermeneutic circle is generalized in a Heideggerian spirit so that the fabric of our measuring apparatuses, their scale, the way we interpret their indications, and even the whole "lifeworld of human scientific culture"[8], partake of the contextual preconceptions of inquiry. From that point on, it becomes clear that focusing attention exclusively onto the hypothetical object of physics or onto the terms that are employed to denote it would be naive, since the concept of this object emerges from the hermeneutic circle of our investigation process. The belief that remaining forgetful of the course and instruments of research is harmless for our understanding of physics, can be ascribed to a remarkable historical circumstance that enabled the onrise of classical science but is now obsolete. Indeed, at this early stage of the science of nature, the knowing subject could be shrinked into

[7] TO Chapter I (the capital letters TO abbreviate the title of the present book of Patrick Heelan : *The Observable) ;* P. Heelan, "Quantum logic and classical logic : their respective roles", *Synthese,* 22, 3-33, 1970. Also, M. Bitbol, *Mécanique quantique : une introduction philosophique,* Flammarion, 1996 ; M. Bitbol, "Quantum mechanics as generalized theory of probability", *Collapse,* 8, 87-121, 2014

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an almost invisible origin of spatial coordinates, and ignored rightaway[9]. As a consequence, the relation between subject and object was reduced to a sort of "epistemological parallelism"[10], in which a ghost-like subject faithfully expressed (but did not engage in) the physical processes. And the hermeneutical process of research could be oversimplified into a transparent reading of what Galileo called the "grand book (of) the universe"[11].

At this point, however, another pitfall must be avoided. Let's accept that, in the quantum domain, the subject must be construed as "embodied", thus establishing a kind of material continuity between it and the micro-object of study. This does not entail that the subject, together with its instrumental extensions, should be treated exclusively like an *object* of physics (especially of quantum physics) ; for this confusion of two epistemological categories would only give rise to a series of intractable paradoxes, whose best example is the celebrated measurement problem of quantum mechanics[12]. Instead, the subject's embodiment motivates the introduction of a new kind of subject-object cut, which separates neither the non-physical from the physical, nor one spatial domain of objects from another spatial domain, but rather the "*meaning-making process*"[13] from what is *meant* by it. Here, far from forcing one to ascribe the subject the status of some meant object, its embodiment is construed as a contribution to the meaning-making procedure. Along with Husserl's distinction between *Leib* (*lived* body) and *Körper* (*objectified body*), the

[9] H. Weyl, *Philosophy of Mathematics and Natural Science,* Princeton University Press, 2009, p. 123 : "The coordinate system is, as it were, the residue of the annihilation of the ego".
[10] TO Chapter X
[11] Galileo Galilei, *The Assayer*, in : S. Drake, *Discoveries and Opinions of Galileo,* Doubleday and Co., 1957, p. 237
[12] P. Mittelstaedt, *The Interpretation of Quantum Mechanics and the Measurement Process,* Cambridge University Press, 1998. Mittelstaedt here points out that, in order to avoid the measurement problem from the outset, one must give a meta-theoretical status to (at least part of) the measuring instruments and process. If this is not done, if the subject-side of the measuring process is treated like an object of the theory to be tested (here quantum mechanics), paradoxes of self-reference arise.
[13] TO Chapter XV

intrumentally enhanced body of the quantum mechanical observer is taken as a structured precondition of knowledge rather than a known object (be it an object of physics or psychology). In other terms, the embodied subject is ascribed a *transcendental* position : the position of a background framework of any act of cognition, rather than a cognized element[14].

A correlative feature of Heelan's approach of Heisenberg's view of physics that fits well with the conceptual equipment of transcendental epistemologies is its persistent, yet low profile, use of the duality of form and content. This couple of concepts here occasionally translates into a contrast between the husserlian *noema* (structure of an intentional act directed towards some object) and *noesis* (mental process associated to this act)[15]. More specifically, it also translates into a duality of theoretical structured expectations and observable features. However, Heisenberg's views partly differed from Kant's conviction that the structure of knowledge could only be ascribed to the cognitive faculties of the knowing subject, and from Kant's agnosticism concerning the alleged structure of the "noumenal" world.

To begin with, *observability* of a certain kind was taken by Heisenberg as an appropriate criterion of *reality*. So far, his position remained in good agreement with Kant's claim that the passive reception of sense-impressions is a mark of the finiteness of the knowing subject, and thereby the sign of it's encounter with something that exceeds it. But can one go further and say that those theoretical structures that can be filled (or confirmed) by observation are, solely on the basis of this fact, faithful images of "reality out there" ? It looks like Heisenberg came within a hair's breadth of holding this (quite un-Kantian) scientific realist thesis. And Heelan repeatedly insists on Heisenberg's quest for a "real order (…) totally independent of any knowing subject"[16], by way of theoretical

[14] M. Merleau-Ponty, *Phenomenology of Perception,* Routledge, 2005
[15] TO Chapter XV
[16] TO Chapter I

physics ; a quest that could only be supported by Heisenberg's strong inclination towards a Platonic or Pythagorean view of mathematical structures [17]. Heisenberg indeed looked for aspects of these structures which are interpretable as truthful representations of some independent realm of being, *despite* the strong entanglement he was first to recognize between reality and the material or semantic instruments of knowledge [18]. He furthermore did not hesitate to treat experimental phenomena as mere signs of something else, namely of the entities which are probed by the measuring apparatuses and adumbrated by theoretical structures. He thus clearly departed, in the domain of physics, from the dominant feeling of transcendental phenomenology according to which "being is *identical* to the phenomenon"[19]. At the end of his career, Heisenberg even felt that he had finally identified an ontology which is appropriate to the quantum formalism : not, of course, the standard ontology of *actual* entities permanently located in space-time (the so-called "particles"), but the pre-spatial Aristotelian ontology of *potentia* (or power), partly described by what he calls the "probability function"[20] of quantum mechanics.

However, the way Heisenberg elaborated his ontological view of the world gives me serious doubts as to whether he had truly relinquished a transcendentalist philosophy of science in favor of a more standard realist position. In his case, it seems to me, a renewed, neo-Kantian, version of transcendental epistemology is elaborated under the guise of scientific realism. After all, what is the defining feature of neo-Kantianism with respect to original Kantianism ? It is its adoption of a relativized and historicized version of the synthetic *a priori* forms of cognition[21], which were considered as unique and immutable by Kant. When one compares Bohr's

[17] W. Heisenberg, *Physics and Philosophy,* Penguin, 1990, p. 55
[18] W. Heisenberg, *Philosophie : le manuscrit de 1942,* Seuil, 1998 (French translation of : W. Heisenberg, *Ordnung der Wirklichkeit,* R. Piper GmbH & KG, 1989)
[19] E. Fink, *Proximité et distance,* Jérôme Millon, 1994, p. 120
[20] W. Heisenberg, *Physics and Philosophy,* op. cit., p. 40
[21] M. Friedman, *Dynamics of Reason,* Center for the study of language, 2001

and Heisenberg's conceptions of quantum mechanics, they can easily be understood in terms of this difference between semi-orthodox Kantianism and neo-Kantianism.

As Heelan cogently points out, "the Kantian element in Bohr's philosophy led him to take the position that it was not in our power to construct non-classical descriptive concepts to cover the quantum domain"[22]. A chain of consequences follows, according to Bohr. Firstly, classical concepts appropriate to our direct environment can by no means be overcome or dispensed with ; they represent the unshakable conditions of possibility of any communicable knowledge. Secondly, *observability* is defined within the framework of such concepts, since it consists of an ability to manifest somewhere in the classical space-time pattern. Thirdly, *objectifiability,* in the sense of a power to disentangle statements about natural objects from their epistemic context of validity, is made possible only by classical concepts. Yet, since these concepts are adapted to nothing else than the mesoscopic domain which approximates the size of our human body, the quantum domain in principle escapes their range of validity. The only thing that can be done in quantum physics is to use classical concepts in order to describe the effects of the interaction of the microworld with measuring devices, and then complement these concepts with a non-classical mathematical symbolism whose sole purpose is to afford (probabilistic) predictions of measurement outcomes. Here, quantum theory tends to be taken as a mere "paradigm", namely "a set or rules for the use of language or a set of models for an activity of a certain kind"[23], with little or no aspiration to open a window into the ontology of quantum mechanical systems.

In the late part of his career, Heisenberg distanced himself with most of these strong axioms of Bohr's interpretation of quantum mechanics. According to him, new concepts could be elaborated beyond the circle of the classical world, provided

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one relies on the generative power of the theoretical formalism. Any such concept is specified "by *implicit definition* through the interpretation of those mathematical relations which the theory established between its own primitive terms"[24]. On this basis, "observability" of a feature is established independently of the classical system of concepts. For, to claim that a feature pertaining to the new domain has been observed, it is sufficient to display an event that can be understood in terms of the current theoretical (and conceptual) system. Observability in this sense being the touchstone of our grip on reality according to Heisenberg, he could hope to build on it and elaborate a set of *ontological* propositions by drawing from "the theoretical (explanatory) linguistic framework of [the] physical theory"[25].

Now, looking closely at the *method* he used in order to elaborate this unconventional ontology, we find that Heisenberg relied on mathematics in order to perform two tasks which are typically neo-Kantian: (i) redefining objectivity and (ii) delineating a new field of objective phenomena according to the redefined acceptation of the concept of objectivity.

Indeed, mathematics enables physicists to achieve "computational synthesis of phenomena"[26], an operation which clearly carries on with the global Kantian project of constituting domains of objective knowledge. For, according to Kant, synthesis represents "the act of putting different representations with one another, and of comprising their manifoldness in one cognition"[27] ; and it is the resulting unity of phenomena in one cognition that plays the role of an object. Yet, this way of performing the synthesis by mathematics is much more general than the one, advocated by Kant, which uses standard forms of cognition adapted to our mesoscopic environment. Such generalization rather agrees with the

[24] TO Chapter VII
[25] TO Chapter II
[26] M. Bitbol, J. Petitot, P. Kerszberg (eds.), *Contituting Objectivity : Transcendental Perspectives on Modern Physics,* Springer Verlag, 2009, p. 3
[27] I. Kant, *Critique of Pure Reason* B103, Hackett Publishing, 1996, p. 130

relativized and historicized construal of the synthetic *a priori* which was developed by neo-Kantian philosophers against their Kantian legacy. Besides, it must be pointed out that mathematics exerts its synthetic power by using tools such as *groups* of transformations, which automatically implement a broadened conception of objectivity *qua* equivalence of various standpoints towards a common target. Mathematics thus contributes to a redefinition of the concept of objectivity, in the direction that Heisenberg found suitable to overcome the restrictive notion of objects which applies in classical science.

In point of fact, according to Heisenberg, quantum physics is a domain in which objectivity in the maximal sense of "objectifiability", namely complete detachment with respect to the experimental and lifeworld context, cannot be reached. Instead, in this case, objectivity can only be obtained in the minimal sense of "publicity", or universal intersubjective validity[28]. Invariance with respect to a set of standpoints, positions, or instruments (as formalized by mathematics) does not mean outright independence from them. But the dream of an ontology is *ipso facto* a dream of figuring out something entirely independent from the cognitive process. If such independance cannot be arrived at, as Heisenberg himself declared, ontological claims look like delusions. The best candidate Heisenberg had for his ontological project, namely the formalized *potentiality* to manifest, is so obviously dependent upon the variegated conditions of its actualization that it can hardly be taken as more than a ghost-like reification of a unified tool applied for prediction of actual experimental outcomes. This predictive tool is publicly valid, hence objective in the minimal sense ; but it is not totally independent from the contexts in which what it predicts can manifest, and it is therefore neither objectifiable nor ontologically interpretable.

Did Heisenberg overlook, in the later part of his life, that "it is *within this intentional space [of human consciousness]* that the 'cut' between subject and object is made"[29] ? Did he dream

[28] TO, Chapters I, XI
[29] TO, Chapter XV

to reverse once again the historical trend he had identified, according to which "post-moderns look away from the natural history of the cosmos and look inwards, back to the human observer's role in constituting the complexity of worlds"[30] ? If Heisenberg had clung to the most challenging aspects of the epistemological revolution he had triggered, he would have agreed with Ernst Cassirer that "true objectivity never lies in empirical determinations, but only in the manner and way, in the *function,* of determination itself" [31] . He would have interpreted the mathematical symbols of quantum mechanics as a momentous step in the self-revelation of the *function* of constitution of objectivity, not as an insight into the ontology of the cosmos. Thanks to the rigor and clarity of Patrick Heelan's book, we now have the appropriate tool to take this step for ourselves.

Michel Bitbol, Paris, February 2015

[30] TO, Chapter XI

[31] E. Cassirer, *Einstein's Theory of Relativity,* in : *Substance and Function, and Einstein's Theory of Relativity,* Open Court, 1953, p. 351