Book Review

Plotnitsky on Quantum-Theoretical Thinking

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Arkady Plotnitsky
Epistemology and Probability: Bohr, Heisenberg, Schrödinger, and the Nature of Quantum-Theoretical Thinking.
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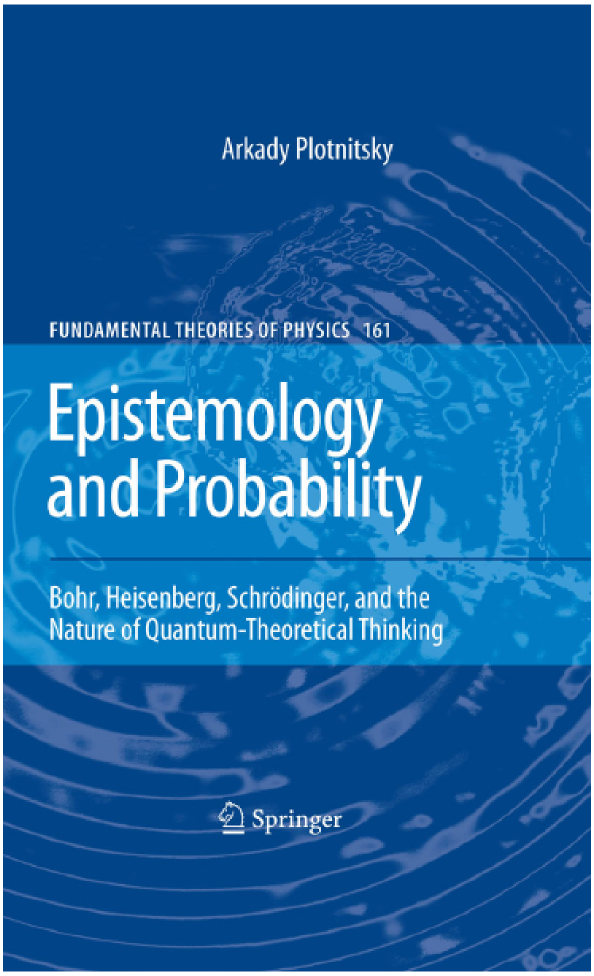

Arkady Plotnitsky is Professor of English at Purdue University. In *Epistemology and Probability* he has provided a very deep and detailed historical discussion of quantum theory. Plotnitsky is clearly a polymath with scientific, philosophical and literary insights, all of which are undogmatically applied in this work.

The book's subtitle gives a clearer idea of its content: "*Bohr, Heisenberg, Schrödinger, and the nature of quantum-theoretical thinking*." Einstein could well be included in the subtitle since his debates with Bohr also inform the discussion. Indeed, the book opens with Einstein's amendation of his well-known quotation about the role of probability in quantum physics.

Einstein famously refused to believe that God would resort to playing

> dice or rather to playing with nature *in the way* quantum mechanics appeared to suggest ... "That the Lord should play [dice], all right; but that He should gamble according to definite rules [i.e. according to the rules of quantum

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> mechanics, rather than by merely throwing dice], that is beyond me." (p. v)

Plotnitsky is attracted to the epistemological perplexities that arose in the history of quantum physics and continue to this day, including the notorious "measurement problem." His work in postmodern philosophy (*e.g.*, Plotnitsky, 1994) has likely sensitized him to the problematics of knowledge.

A surprising feature of the book is that very few equations are given. Plotnitsky is a master at discerning what the equations really mean in terms of ontology and epistemology. He not only draws on the published works but also correspondence between the great figures of quantum theory. Consistent with being a Professor of English, their struggles with the strange quantum phenomena, their personalities, feelings and relationships come through. A fine appreciation of their achievements is also offered. While mathematics is a "gift of nature,"

> it was still necessary to discover this mathematics and this way of using it in physics. Heisenberg was able to accomplish both. This is why his discovery of quantum mechanics was so momentous and why it earned him a place alongside Aristotle, Galileo, Newton, Maxwell and Einstein. At this magnitude of achievement, this list, while not exhausted here, may not be that much longer. (p. 136)

Such observations make the text more intimate and readable.

Plotnitsky's view of quantum physics is Bayesian in that the Schrödinger wave function is understood "in terms of expectations or beliefs, and degrees of uncertainty" (19), rather than any causal underlying dynamics. Quantum states relate to consciousness,

> they relate or even correspond to our probabilistic expectations concerning the experiments in question, which expectations are always mental. (p.175)

So wave function collapse, say in the Schrödinger *gedanken experiment, is not to a dead cat or a live one but to certainty in expectation*. Collapse of the wave function is a cognitive affair. Coordinate with his Bayseanism, Plotnitsky considers reality to be "nonclassical" *pace* Bohr (perhaps even more radically than Bohr).

Nonclassicality is the central theme of the book. Nonclassical "objects" are irreducibly different from the objects that we might observe indeed they are "entities placed beyond quantum theoretical description and even beyond any possible description, knowledge and ultimately conception" (p.6). (Strictly speaking, they are neither objects nor entities.) This theme of the *unknowable* is presented early in the book and hammered home throughout.

> As against the level of nature described by classical physics, the quantum constitution of nature is interpreted as irreducibly inaccessible not only to any description but also, and more radically, to any conception that we can form, now and possibly ever. (p.6)
>
> Quantum objects are real insofar as they exist, but there is nothing we can say or, in the first place, think about their reality except as manifest in the effects of their interaction with measuring instruments upon those instruments. (p.7)
>
> [q]uantum objects and processes may be inaccessible even as inaccessible, unrepresentable even as unrepresentable, unknowable even as unknowable, unthinkable even as unthinkable, inconceivable even as inconceivable, unintuitable even as unintuitable, and so forth. (p. 42)

Even though we cannot talk or think or have any intuition about them, yet quantum objects have efficacity.

Plotnitsky's absorption with the history of quantum theory precludes making connections with other *aficionados* of the unknowable, which somewhat limits the impact of the book. For example, Bohm's (1980) holomovement with its implicate order is unknowable as such.

> [t]he holomovement is not limited in any specifiable way at all. It is not required to conform to any particular order, or to be bounded by any particular measure. Thus, *the holomovement is undefinable and immeasurable*. (Bohm, 1980, p.151, italics original)

The possibility of knowledge begins with explication or unfolding of unknowable order enfolded to the holomovement. A difference between Bohm's unknowable and that discussed by Plotnitsky appears to be that the former is inherently dynamical, a holo*movement*, whereas nothing descriptive can be said about the latter. Furthermore, the holomovement is a plenum of implicate possibility. Bohm's unknowable is accordingly *thinkable* as a holodynamical plenum, whereas the unknowable Plotnitsky thematizes cannot even be thought.

Plotnitsky points out that Kant's noumenal *ding-an-sich* is unknowable by us, but we can think it through the medium of science.

> While, however, the objects and processes considered by classical physics are noumenal in Kant's sense, classical physics, and in particular classical mechanics, can circumvent the difficulties of their noumenal nature. It can do so by virtue of being able too idealize them for the purposes of the mathematical descriptions of observed phenomena that classical mechanics provides, via, on the one hand, the data obtained in the experiments and, on the others, the equations of classical mechanics. (Plotnitsky, 2011; p.477)

Plotnitsky's unthinkable is beyond even scientific thought.

The unknowable *and* unthinkable also lies at the heart of later Heideggerian theory (Heidegger, 1999). Heidegger calls this the "abground" (*der Abgrund*) and his conception is fully dynamical. Abground is "prior to any dimensionality" (p.267), "above all [beyond] temporalizing and spatializing" (p.268) (See Globus (2009) for an extensive discussion of Heidegger and quantum theory). Heidegger's unknowable and unthinkable abground has great affinity to Plotnitsky's conception.

The unknowable is also a theme in literature (*Cf.* Castaneda's (1974) unfathomable *nagual*) and of course the unknowable pervades mystical thinking (which in Chapter 10 Plotnitsky is at pains to distance himself from, as if this would detract from his scientific-philosophical credentials).

The chapter topics of this 422 page book will not do justice to the comprehensive and detailed scope of *Epistemology and probability*. Chapter 2 focuses on the double-slit experiment, including Wheeler's delayed choice version and Scully's quantum eraser. Chapters 3 and 4 are devoted to Heisenberg's revolutionary conceptions. Chapter 5 gives a detailed discussion of Schrödinger's wave function, while Chapters 6 and 7 discuss Bohr in depth. Chapters 8 and 9 focus on the debate between Bohr and Einstein, including the EPR controversy. These chapters bring out the subtle advances in Bohr's thinking both pre and post his 1927 Como lecture.

Chapters 10 and 11 restate and advance Plotnitsky's main theses. First is the persisting strangeness of quantum phenomena over a century after Planck formulated his quantum of action. Plotnitsky quotes Mermin (1990), "[t]he world behaves in a manner that is exceedingly strange, deeply mysterious, and profoundly puzzling" (p.126). Plotnitsky, following Bohr, makes ontological the inconceivable, unthinkable, unknowable, unsayable, while nonetheless maintaining quantum physics as a fully rational science of nature. We are creatures, says Plotnitsky, "that may never be able to grasp the ultimate (quantum) constitution of nature—and yet are able to create theories than can predict, even if only probabilistically, the impact of this constitution on what we can grasp" (p.323).

The 10.2 section of Chapter 10 reviews what Mermin (1998) called "correlations without correlata" and Bell (1987) termed "the speakable and the unspeakable."

> The (classically) measured quantity only establishes a correlation between the object and a certain classical stratum of the measuring instrument involved, since the measuring process unavoidably and irreversibly amplifies the interaction in question into a classical-level effect. In other words, this correlation has one classical correlatum and no quantum-level correlata. (p.332)

Plotnitsky pushes the consequences to the extreme.

> The ultimate constitution of nature itself may … be unspeakable even as unspeakable, unthinkable even as unthinkable, inconceivable even as inconceivable, and so forth. (p. 327)

Thus the quantum level is more profound than any recounting of negations (*Neti. Neti.*) might convey.

10.3 is titled "Epistemology Without Ontology." It discusses Bohr's unique concepts of complementarity, atomicity, phenomena and the classical description of measuring instruments. Phenomena are grounded in amplification effects, which are irreversible, resulting from interactions between quantum "objects" and classical measuring instruments. Yet phenomena as such cannot be obtained from measuring devices solely dependent on classical physical concepts.

> [t]he appropriate physical interpretation of the symbolic quantum-mechanical formalism amounts only to *predictions*, of determinate or statistical character, pertaining to individual phenomena appearing under conditions defined by classical physical concepts. (Bohr, 1949, PWNB 2, p.64, italics added)

Most striking, particle and wave properties both disappear in the absolute indifference of the unknowable.

10.4 "Probability Without Causality" reprises the suspension of causality in the quantum domain. The mathematical probability theory deployed in classical physics is unavoidable in quantum physics. However, it is not that we are unable to assess an underlying causal dynamics but that causality does not even apply. Thus chance can never be displaced by necessity, which is in principle excluded.

Relevance to Neuroquantology

In the 20th century history of quantum physics and its issues that Plotnitsky so thoroughly discusses, scant attention was paid to brain functioning, which was left to brain scientists to figure out. The observer plays a key role in many interpretations of quantum physics (since the Schrödinger wave function seems to sail merrily on, without some observer to collapse it). That there are "observables" is taken for granted in quantum physics. Even when the brain finally gets its turn in the von Neumann chain, it remains entangled in its innermost recesses with the measurement device, and it takes the intervention of a Copenhagenist consciousness finally to bring about collapse and the appearance of world (say, the pointer on a meter). The very failure to achieve any consensus regarding the measurement problem to this day raises the possibility that quantum brain theory is crucial to that problem's resolution.

Consistent with his historical focus, Plotnitsky mentions the brain on only three occasions and never past page eleven. One mention is a mere tribute. ("[t]he brain is one of nature's most remarkable products" (XXV).) A second mention close by is bare acknowledgement of the brain's powers.

> Nature, or our thought, given to us courtesy of the brain, appears to exceed the capacity of our thought to fully comprehend it. (XXV)

The third mention is a very conventional concession in a book otherwise preoccupied with revolutionary conceptions.

> It may be argued that classical thinking and indeed in particular "the brain's sense of movement" reflect the essential workings of our neurological machinery born with our evolutionary emergence as human animals and, in part, enabling our survival. (pp.10-11)

The nature of that "neurological machinery" is of no interest for Plotnitsky (at least in *Epistemology and Probability*), whether classical or neuroquantological.

Now for Plotnitsky, an avowed Baysean, the wave function represents the cognitive expectations of an observing subject, expectations which are continually modulated by new inputs.

> [q]uantum states are *states of knowledge* or of expectations concerning the outcome of possible experiments—"expectation catalogues," or catalogues of possible bets, whose basis is knowledge obtained in previously performed experiments. (p.176)

Whether the neural machinery for such cognition is classical or neuroquantological is not Plotnitsky's concern. Perceptual observation—say, reading a meter—is also handed off to brain science. (The squared coefficients interpreted by Born as probabilities are after all probabilities of *perceiving* this or that *observable*—cat looking dead, cat looking alive.) Any problems arising in relation to subjectivity are deferred to brain science, neurophilosophy and the like.

There have been many proposals for how subjective cognitive expectations might be realized in neuroquantological "machinery" (Conte, 2010; Craddock and Tuszynski, 2007; Khrennikov, 2008; Mender, 2007; Stapp, 2009). Hameroff and Penrose (1996) nicely term the process "*orchestration*" and locate it to the microtubules, where they propose orchestrated objective reduction of the wave function occurs. Given the unsettled state of work on cognition in neuroquantology, it might be considered "strategic" for Plotnitsky to ignore for now quantum brain theory, but to my mind *neuroquantology* will be part of the solution to the issues which Plotnitsky discusses.

Perhaps the closest neuroquantological neighbor to Plotnitsky's view is that of Globus (2003; 2006; 2009). In this work the "unknowable" that Plotnitsky thematizes is called "closure" and the perceptual experience of observation is "dis-closure." [2] The mechanism for dis-closure on this view is "between-two," between the *dual* ground state modes of dissipative thermofield brain dynamics (on dual mode theory see Vitiello, 1995; 2001; 2003). What is dis-closed is a function of the optimal match between (*1*) sensory input which has dissipated its energy and fallen into the ground state. (*2*) memory traces of prior recognitions. (3) self-tuning signals on the part of brain subsystems which dissipate their energy and fall into the vacuum state. Dis-closures, that is, perceptions of observables, arise in the belonging-together of the between-two. Continually adjusted Baysean expectations are conceived as the self-tuning component of the match between-two.

Whether or not this tentatively suggested rapprochement between Bohr-Plotnitsky and the quantum thermofield brain holds up, *Epistemology and Probability* provides a splendid inspiration and resource for neuroquantological thinking.

[2] While agreeing on the unknowable closure of reality, the two views diverge sharply regarding the status of observables, which are public for Plotnitsky and monadological for Globus.

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