RESEARCH ARTICLE

QUANTUM META-THEORY (Twisting the Tail of Schrödinger's Cat)

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Abstract: The problem of Schrödinger's Cat has figured prominently in the debates about the bearing of quantum physics on our understanding of physical reality. On its basis, various theorists have maintained the quantum physical world exhibits a probabilistically indecisive physical reality. The analysis of the paper that this appeal to quantum reality is methodologically at odds with and disjoint from its underlying approach to quantum theory itself. If there is to be methodological uniformity at this juncture it will have to be along the lines that Einstein always focused—an incomplete hidden factor (perhaps better than "hidden variables") approach.

Keywords: Complementarity; Hidden Variables; Many-Worlds Theory; Objectivity; Physical Incompleteness; Probabilistic Uncertainty; Quantum Indeterminacy; Schrödinger's Cat; State Superposition; Subjectvism

1. Quantum oddities

It is hard to escape the irony that physical science—our best hope for understanding how Nature works—is itself the source of puzzlement and perplexity. And contemporary physics manifests this circumstance nowhere more clearly than in the area of quantum theory.

Quantum physics seeks to explain the physical micro-processes that occur at very small levels of metric scale. And these processes involve phenomena that are highly unusual when regarded from the vantage point of the familiar macro-level of physical reality. Specifically, the anomalous phenomena at issue include such oddities as:

—*Probabilism and unpredictability*, as when we encounter such processes as the radical decay of heavy transuranic elements; occurrences that are predictable with statistical probabilities on the larger scale, but individually unpredictable.

—*Complementary uncertainty* of physical state parameters with a see-saw relation where the more precise specification of one impels the other into greater unspecificity.

—*Position ambiguity* via an infeasibility of specifying the precise location of physical processes and providing for continuity in physical interactions.

—*State superposition* with different quantum states combining or conjoining otherwise incompatible possibilities in an impenetrable fog of indetermination.

—*Wave-packet collapse* with observation presenting a definiteness that physical theory does not provide for and indeed disallows.

All such eventuations are "something completely different" from what we encounter in the course of ordinary, everyday experience. For in the physics of the macro-objects encountered in everyday life we have transactions that are subject to lawful determination, physical parameters that assume definite values not subject to probabilistic variation,

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descriptively different states that are disjoined and incomparable, and state-conditions that evolve in smooth continuity and are not disjointed in abrupt inexplicability. At the physical macro-level where we humans routinely function, things thus behave very differently from the ways of the quantum world.

2. Schrödinger's cat and the basic problem posed by the quantum theory

Reality at the quantum level enjoys a dramaturgy of its own. Everyday reality as we experience it yields observationally definite resolutions where theory can, at most, provide for probabilistically indefinite alternatives. Quantum waves function with smooth regularity among alternative possibilities in line with Schrödinger's Equation unless and until observation intervenes to disrupt matters by the theory-inexplicable collapse to a single alternative. This so-called "wave-packet" collapse is at issue in the curious thought-experiment of Schrödinger's Cat.

This thought-experiment is predicated on the following suppositions. A cat is placed in an opaque box containing apparatus that potentially produces a quantum event triggering the release of a jet of cyanide gas sufficient to kill the cat. Otherwise no further changes occur in the box. Eventually the box is opened and the life-condition of the cat determined. There are two possibilities: life or death.

The question now is: has a quantum event transpired? When the box is opened, will the cat be dead or alive? Prior to the box's opening, quantum theory does not declare YES or NO but only MAYBE with a certain probability. To be sure, when we open the box we are going to reveal the life-condition of the cat and so will definitely determine whether a quantum event has or has not happened. But until that happens all we have is the theory's indecisive indetermination which leaves the cat's life-condition in limbo between life and death. The quantum event issue emplaces the cat in a probabilistic halfway house ("superposition") between life and death, whereas when we open the box there is a "collapse of the wave-packet"—a transmutation of the theory's probabilities into a definite yes or a definite no.

We thus confront what might be called the Basic Problem of Quantum Physics, namely that quantum theory presents us with a range of alternatives, while nevertheless observational reality provides a single definite condition.

If quantum reality is ultimately basic and comprehensively determinative for physical processes, how can it be that while this theory predicates imprecision and indefiniteness, nevertheless when we subject its phenomena to interactions at the physically observable macro-level the results we realize are always precise and definite and never exhibit the alternative-embracing indefiniteness that quantum theory envisions?

3. Responses to the basic problem

Confronting this disconnect between physical theory and experiential observation, quantum theorists have opted for several varying responses:

1.*Quantum Positivism*. The contrast between a unique observational reality confronting a wider spectrum of varied theoretical possibility is an illusion. That uniqueness is not an aspect of physical reality, but only the product of a psychological (observationally dependent) outcome due to the fact that we discern only limited aspects of reality. (Bohr)

2.*Quantum Incompleteness*. The theory is incomplete. It would require some sort of amendment and supplementation to account for that unique objective reality. (de Broglie, Bohm)

3.*Quantum Conjunctivity*. All those possible alternatives are in fact actually realized. Every component of the spectrum of possibility is actual reality—within its own sector of a vastly enlarged all-comprehensive framework to which observational experience affords only very limited access. (Everett/Wheeler)

These three reactions to the relevant anomalies represent the principal lines of approach in quantum theorizing in recent years. Each has a different, characteristic approach to the reconciliations of dissonance.

4. Attitudinal stances towards quantum theory

Now, the crucial consideration here lies in the combination of two facts:

—That *quantum physics* envisions a physical reality that is indecisive among conflicting alternatives unless and until

there is a theory-external supplementation via the cognitive experience of observers.

—That *quantum theorizing* presents a situation that is indecisive among conflicting alternatives unless and until there is a differentiating supplementation via the cognitive experiences of theoretics.

Ironically, even as quantum physics itself under-determines the exact detail of physical states, so quantum theorizing under-determines the exact detail of quantum phenomenology. And at this point quantum theoreticians divide into three doctrinal schools:

1.*Positivists*. Here we are called on to abandon the quest for a unique reality that countervails against the possibilistic pluralism inherent in quantum physics. Those who adopt this position effectively say "Just do your quantum theoretical calculations and accept the physical results they indicate without demanding a definiteness of descriptive resolution that is not to be had." (This is basically the stance of the Copenhagen school.)

2.*Incompletists*. Here we are called on to abandon the idea that quantum theory as we have it affords a complete account of physical reality. Those who adopt this position effectively say "Press ahead in research towards a larger and more comprehensive account of physical phenomena that can provide for unique resolutions where existing quantum theory yields only a spectrum of probabilistic, all disjointed alternatives." (This would be the attitude behind the de Broglie/Bohm theory of electron motion via quantum wave direction.) Such an approach would have it that quantum theory needs to be developed, augmented, and modified to achieve a definite resolution of the issues.

3.*Conjunctivists*. Here we are called on to acknowledge that there is something to be said for all of those variant approaches. Those who adopt this position effectively say "Don't abandon any of them, but retain all of them, each to be used for illuminating one sector of the problems at issue." In effect, view the venture as a comprehensive tool kit accepting different tasks by different means.

Given these three alternatives, we are faced with a situation of *déjà vu* at the theoretical meta-level of alternative quantum perspectives that is effectively isomorphic with the situation obtaining at the ground level of quantum physics itself. For the uncertainty one confronts in the phenomena of quantum physics is now reproduced once more in an uncertainty in regard to quantum theorizing.

For at this point it transpires that every theorist has his own favored position. And so, even as *observational experience* plunges quantum experimenters into a world where quantum alternatives have but one single definite resolution for them, so *scientific experience* at large plunges quantum physicists into a world where theoretical alternatives have but one single resolution acceptable to them. In sum, there is a deep parallelism between the predicament of quantum *physics* and the project of quantum theorizing itself.

How is one to bring order into the resultant confusion? To make progress here we have to go back to basics.

Display A

The acceptability of higher-level theories as enjoined by that of base-level theories

	Ground-Level Possibilities			Corresponding First Meta-Level Conditions			Corresponding Second Meta-Level Conditions		
	T_0	T_1	T_2	T_0^1	T_1^1	T_2^1	T_0^2	T_1^2	T_2^2
	+	+	+	−	−	+	−	+	−
	+	+	−	−	−	−	+	−	−
	+	−	+	−	−	−	+	−	−
*	+	−	−	−	+	−	−	+	−
	−	+	+	−	−	−	+	−	−
*	−	+	−	−	+	−	−	+	−
*	−	−	+	−	+	−	−	+	−
	−	−	−	+	−	−	−	+	−

KEY:

T_0^1 affirms that none of the T_i hold

T_1^1 affirms that (exactly) one of the T_i holds

T_2^1 affirms that all of the T_i hold

5. Eliminating some alternatives

Let us embark on an analysis of the generic situation that is at issue here. We begin with a number of alternative base-level theories—for simplicity let it be just three: T_0, T_1, and T_2. And let it be that in principle any one of them could be correct and appropriate.

But now consider the survey of theoretical possibilities presented in Display A. Starting from the vantage point of the T_i we can move on to the next level of the T_i^1—and thereafter to the T_i^2 as per:

- T_0^2 none of the T_i^1 is true
- T_1^2(Exactly) one of the T_i^1 is true
- T_2^2All of the T_i^1 are true

But note that the basic principle of rational practice (to the effect that "like inputs yield like outputs") will have it that the first- and second-level resolutions be identical. And observe that the only possible prospects for agreement between T_i^1 and T_i^2 are those cases that have been starred, namely those where exactly one of the T_i obtain. These three cases uniquely and alone afford the prospect of procedural uniformity across the two meta-levels of deliberation. We are thus led—on a purely methodological basis—to have it that exactly one of those three ground-level theories must hold.

And there is another way of looking at the matter as well. Let us adopt the rational uniformity of treating theories via the same principles that they themselves use substantively in relation to the phenomena. This would call for reasoning about our theories in the same way that they themselves reason about their subject matter. In relation to quantum theorizing, the result of this approach is pictured in Display B.

Conjunctivism as per (3) in Display B is not a systematically harmonious approach seeing that it itself is simply one alternative that it cannot consistently endorse. And again, Experiential Positivism as per (1) is not systematically harmonious because the "observation" at issue in the Quantum Theory is interpersonally uniform, whereas the "experience" at issue in such theory differs from individual to individual. Only the invocation of external factors as a means to uniqueness presents an alternative that is coherently uniform as between the substantive and the meta-theoretical levels of deliberation. An analogue to the hidden variables account would present the only viable route to uniformity. The preceding methodological approach would accordingly seem to rule out the "no definiteness" indecision of the Copenhagen school, as well as the "everything goes" perspective incorporated in the Everett/Wheeler

Display B

	QUANTUM THEORY *How theorizing views quantum-physical states*	QUANTUM META-THEORY *How meta-theorizing views quantum-physical theories*
(1)	EXPERIENTIAL POSITIVISM Only one possible outcome is actualized, not for physical but merely substantive reasons provided by observers [Bohr]	Only one possible version is acceptable to theorists in line with their experience
(2)	INCOMPLETEISM ("Hidden-variable supplementation to established theory") Only one possible state is ever observationally realizable (for reasons whose explanations require resources above and beyond the reach of orthodox quantum theory) [Bohm]	There is a single correct version of quantum theory for theoretical reasons whose determination requires resources beyond the reach of present theorizing
(3)	NON-SELECTIVE CONJUNCTIVISM All possible physical states are actualized in some possible world [Everett/Wheeler]	All theoretically plausible doctrines are actualized in some issue-contexts

many-worlds theory. It is, to be sure, possible that a variant of the Everrett/Wheeler approach can be projected. That

would meet the uniqueness requirement that results. This would be a theory in which every theoretic possibility is realized in this actual world. To achieve this, one would return to the idea—as old as Aristotle's *On Interpretation*—that incompatibilities can be combined temporally: one now and another then. On such a temporalized version of Everett/Wheeler, one could have it that all those manifold quantum possibilities are indeed realized—but for the most part so briefly as to be effectively absent. The original Everett/Wheeler approach accommodates incompatible states by allocating this to different worlds; the presently contemplated variant allocates them to different times. On this approach there would need to be a time when superposition has it that Schrödinger's Cat is both alive and dead. But this bizarre condition could be realized in a near-instantaneous time span—one so small that neither we nor the cat or anyone, save possibly God himself, could possibly notice. So here the "hidden variable" is something that is so easily overlooked because it lies before us in plain sight—being nothing other than time itself.

In any case, however, the recourse to procedural rationality contemplated here speaks decisively for some sort of "hidden factor" (perhaps better than "hidden variable") "Incompletist" approach that looks to a completion of quantum theory along the lines that Einstein always favored—chance-averse rationalist that he was. If the classic principles of rational regularity and uniformity are to prevail, then we have to expect that in the final analysis a particular substantively orthodox theory will ultimately emerge to resolve the uncertainties inherent not only *in* but also *about* quantum theory.

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