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On Formalism and Interpretations

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A physical theory comprises a *mathematical formalism*, which allows for predicting the outcomes of scientific experiments, and some *ontological interpretation*.In the case of quantum theory, the predictions are probabilistic and often conflict with proposed descriptions of the experiment in terms of classical information.
The arise of *apparently classical information* during a measurement,i.e., a definite result, poses a conceptual problem for quantum theory. In what is called *standard quantum mechanics* , the measurement-update rule, commonly associated with a collapse, is a break with the otherwise unitary evolution governed by the Schrödinger equation. The formalism, however, provides no indication about when to apply this rule: It does not state what qualifies some interactions as measurements but not others (*the measurement problem*).
Everett's *relative-state formalism* seems to avoid the problem by postulating universal, unitary quantum theory. This, however, detaches the formalism from predicting outcomes of experiments, for which some sort of Born rule –i.e., a means to calculate probabilities of measurement results –is needed. This is not specified by the original relative-state formalism at all, but the use of the Born rule has been motivated by a many-worlds interpretation and decision-theoretical arguments.
We want to stress that universal, unitary quantum theory is a new type of*formalism* which is fundamentally different from the measurement-update rule of standard quantum mechanics. It is *not a new interpretation* ; the many-worlds interpretation is the best-known interpretation of the relative-state formalism. One can regard a generalised version of Bohmian mechanics as a different interpretation of that formalism.
We treat the relative-state formalism as a *different formalism* than the Born and measurement-update rule of standard quantum mechanics. We postulate an alternative "Born rule" motivated by the work of G. Hermann. Equipped with this "Born rule," the relative-state formalism reproduces the same probabilities as standard quantum mechanics for consecutive measurements on one quantum system –the same level of observation. But the two formalisms are inequivalent in case of encapsulated observers –different levels of observation, Wigner's-friend-type experiments. The latter was first considered by D. Deutsch's version of the Wigner's fiend experiment.
An *observer* –the friend –performs a measurement on the quantum system emitted by the source. Both the system and the friend (or the friend's memory) are then jointly measured by a *superobserver* –Wigner.
Standard quantum mechanics suggests that, according to the friend, the state of the system collapses to the eigenvector associated with the observed measurement result. To Wigner, however, the joint quantum system supposedly evolves unitarily. Such a *subjective-collapse* model, namely that each agent attributes a collapse merely to their own measurement, leads to *seemingly contradictory predictions*among the agents.
Descriptions of Wigner's-friend-type setups based on the relative-state formalism do not give rise to problematic predictions, neither do objective collapse models,orany other version in which there is consensus on the application of the measurement-update rule.
The possibility of *classical communication* between the agents in a Wigner's-friend-type experiment is essential for the problematic predictions to give rise to an *actual contradiction*.

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