Possibility and Time in Quantum Mechanics

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It is common to use modal vocabulary in the field of physics in general and quantum mechanics in particular. The notion of "possibility" in which the modal categories are analyzable admits two interpretations. The actualist interpretation, which is dominant today, considers that every possibility is actual or not at all. The possibilistic interpretation distinguishes between the realm of the actual and the realm of the merely possible. According to possibilism, certain possibilities may never be actualized. The question of the interpretation of the notion of possibility acquires a particular urgency when we enter the quantum domain since modality seems to be attached to an intrinsic feature of the reality represented by quantum theory and does not seem reducible to a merely epistemic emergent. Therefore, the first objective of this presentation is to account for the different philosophical interpretations of the notion of possibility and to analyze how an actualist or possibilistic conception underlies some current interpretations of quantum mechanics.

On the other hand, the notion of time used in the quantum domain has certain peculiarities that differentiate it from the notion of time used in the classical domain. While in the latter the time of dynamic evolution is also the time in which physical events occur, in the quantum domain the notion of time is twofold. We have, on the one hand, the first notion of time as a parameter linked to the dynamics of the probability distribution between the possible values ​​of each observable. However, on the other hand, the theory does not contain any theoretical representation that accounts for the time in which quantum events occur, i. e., the time in which the observables acquire definite values. Precisely, the diversity of interpretations comes to supply in one way or another that lack of definition that the theory entails regarding in general what events must occur and in particular regarding the time in which those events occur. The second objective of this presentation is to draw attention to the link that we believe exists between parameter-time and the domain of the possible (in possibilistic terms) and the time of events and the domain of the actual.

Finally, efforts are known, motivated by the search for a solution to the problem of time formulated in the context of the program of a quantum theory of gravity, to eliminate the absolute character that the so-called parameter-time seems to have and reduce it to internal correlations between quantum observables from a closed system perspective (e.g., Page & Wooters 1983). However, there are not many attempts to construe the time of events relationally (as an exception: Fortin, Lombardi and Pasqualini 2022). The third objective of this presentation is then to propose a relational construction of event-time that can be a suitable complement to the relational program applied to parameter-time. To do this, we assume the interpretive postulates of a particular modal interpretation, the Hamiltonian-modal interpretation, and propose a model based on the consecutive measurements model.

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