FROM OBJECTIVE AMPLITUDES TO BAYESIAN PROBABILITIES

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Abstract

Many discussions on the foundations of quantum theory start from the abstract mathematical formalism of Hilbert spaces and some ad hoc "postulates" or rules prescribing how the formalism should be used. Their goal is to discover a suitable interpretation.

The Consistent-Amplitude approach to Quantum Theory (CAQT) is different in that it proceeds in the opposite direction: one starts with the interpretation and then derives the mathematical formalism from a set of "reasonable" assumptions. The overall objective is to predict the outcomes of certain idealized experiments on the basis of information about how complicated experimental setups are put together from simpler ones. The theory is, by design, a theory of inference from available information.

The "reasonable" assumptions are four. The first specifies the kind of setups about which we want to make predictions. The second assumption establishes what is the relevant information and how it is codified. It is at this stage that amplitudes and wave functions are introduced as tools for the consistent manipulation of information. The third and fourth assumptions provide the link between the formalism and the actual prediction of experimental outcomes. Although the assumptions do not refer to probabilities, all the elements of quantum theory, including indeterminism and the Born rule, Hilbert spaces, linear and unitary time evolution, are derived.

Within the CAQT approach probabilities are completely Bayesian, and yet, there is nothing subjective about the wave function that conveys the relevant information about the (idealized) experimental setup. The situation is quite analogous to assigning Bayesian probabilities to outcomes of a die toss based on the objective information that the (idealized) die is a perfectly symmetric cube.

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