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Copenhagen Interpretation

See ▶ Born rule; Consistent Histories; Metaphysics in Quantum Mechanics; Nonlocality; Orthodox Interpretation; Schrödinger's Cat; Transactional Interpretation.

Correlations in Quantum Mechanics

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The statistical algorithm of quantum mechanics predicts that measurements will reveal correlations among the values of magnitudes ("▶ observables"). Whenever such measurements have been performed, they have borne out the predictions. But the patterns exhibited by these correlations can be difficult to square with classical intuitions – about probability, about the nature and properties of quantum systems, and about causal connections between systems.

In a ▶ Hilbert space formulation, an observable is represented by a ▶ self-adjoint operator, while the state of a system is represented by a normalized vector (perhaps a ▶ wave function) or more generally a ▶ density operator $\hat{W}$ (a self-adjoint operator with unit trace). If $\{O_1, ..., O_n\}$ is a set of observables on a system represented by pairwise commuting operators $\{\hat{O}_1, ..., \hat{O}_n\}$, then quantum mechanics predicts that measured values of all these observables in state $\hat{W}$ will conform to a joint probability distribution $pr(O_1 \in \Delta_1, ..., O_n \in \Delta_n)$ given by

$$pr(O_1 \in \Delta_1, ..., O_n \in \Delta_n) = Tr\left[\hat{W}\hat{O}_1(\Delta_1).....\hat{O}_n(\Delta_n)\right] \tag{1}$$

where $\hat{O}_i(\Delta_i)$ is the element of the spectral resolution of $\hat{O}_i$ corresponding to Borel set Δ_i of possible values ($i = 1, ..., n$). If any two operators $\hat{O}_i$, $\hat{O}_j$ in such a set fail to commute, then no joint distribution is predicted.

For example, a simple quantum mechanical model of a Hydrogen atom ▶ Bohr's atom model will predict a joint probability distribution for energy, total angular momentum, and z-component of angular momentum in any state; but it will never predict a joint probability distribution for energy, position and momentum, nor for z-component and x-component of angular momentum.