Quantum Physics

Information flow at the quantum-classical boundary

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We study the nature of the information preserved by a quantum channel via the observables which exist in its image (in the Heisenberg picture), and can therefore be simulated on the receiver's side. The sharp observables preserved by a channel form an operator algebra which can be characterized in terms of the channel's elements. The effect of the channel on these observables can be reversed by another physical transformation. These results generalize the theory of quantum error correction to codes characterized by arbitrary von Neumann algebras, which can represent hybrid quantum-classical information, continuous variable systems, or certain quantum field theories.
The preserved unsharp observables (positive operator-valued measures) allow for a finer characterization of the information preserved by a channel. We show that the only type of information which can be duplicated arbitrarily many times consists of coarse-grainings of a single POVM. Based on these results, we propose a model of decoherence which can account for the emergence of a classical phase-space. This model supports the view that the quantum-classical correspondence is given by a quantum-to-classical channel, i.e. a POVM.

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