Quantum Physics

Assessing dimensions from evolution

Michael M. Wolf, David Perez-Garcia

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Using tools from classical signal processing, we show how to determine the dimensionality of a quantum system as well as the effective size of the environment's memory from observable dynamics in a model-independent way. We discuss the dependence on the number of conserved quantities, the relation to ergodicity and prove a converse showing that a Hilbert space of dimension D+2 is sufficient to describe every bounded sequence of measurements originating from any D-dimensional linear equations of motion. This is in sharp contrast to classical stochastic processes which are subject to more severe restrictions: a simple spectral analysis shows that the gap between the required dimensionality of a quantum and a classical description of an observed evolution can be arbitrary large.

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