▶ CASLAV BRUKNER, *Quantum correlations with no causal order.*
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In the quantum circuit model the computation is described as a temporal sequence of transformations (logical gates) acting on a register of input qubits. It is standardly assumed that the background time or definite causal structure exists such that every transformation is either in the future, in the past or space-like separated from any other transformation. Consequently, the correlations between transformations respect definite causal order there are either signalling correlations for the time-like or no-signalling correlations for the space-like separated transformations. Is it possible to arrive at quantum computational models that do not require notions of an underlying space-time or definite causal structure? We develop a framework that assumes only that transformations are quantum-mechanical (completely-positive maps), but relax the assumption that they are causally connected. Remarkably, we find situation where two transformations are neither causally ordered nor in a probabilistic mixture of definite causal orders, i.e. one cannot say that one transformation is before or after the other. The correlations between the transformations are shown to enable performing a communication task that is impossible if the operations are ordered according to a fixed background time.