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THEMATIC FIELDS

- Information and complexity measures. Physical aspects of the information theory.
- Classical, non-extensive and quantum information theory.
- Source and channel coding.
- Cryptography and data security.
- Complex systems. Dynamic systems.
- Self-organization. Causality in complex systems.
- Complex networks.
- Decision making in complex systems.
- Analysis and simulation of complex systems.

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Quantum Structures in Foundations and Applications of Quantum Theory

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Abstract

Realistic physical systems are composite, i.e. decomposable into subsystems. In classical physics decompositions are often regarded artificial, i.e. as a mathematical artifact. However, in quantum mechanical context, the things are not that simple. In this paper we describe the linear canonical transformations and the induced bipartite structures in different contexts: quantum measurement and decoherence, quantum correlations as resource for the quantum information processing, quantum thermodynamics and certain applications.

Key words: Canonical transformations, Tensor-re-factorization of Hilbert space, Quantum measurement and decoherence, Quantum correlations

Synopsis

Realistic physical systems (classical or quantum) are composite–i.e. decomposable (structured) into constituent subsystems. Transitions between different structures of a composite system are typically described by Linear Canonical Transformations (LCTs). In classical physics, certain structures are regarded artificial, i.e. as mathematical artifacts. However, in quantum mechanical context, the things are more subtle.

LCTs induce re-factorization of the composite system's Hilbert space, $\mathcal{H}$. If a composite system, C, can be decomposed as $S + E$, or as $S' + E'$, i.e. $S + E = C = S' + E'$, the Hilbert state space is re-factorized, $\mathcal{H}_S \otimes \mathcal{H}_E = \mathcal{H} = \mathcal{H}_{S'} \otimes \mathcal{H}_{E'}$. Given the composite system is closed (i.e. subject to the unitary Schrödinger law), the system's quantum state is "pure" and unique in every instant of time. However, as it can be shown [1,2], correlation (quantum or classical) in the composite system are not invariant. That is, amount of correlations is different for different structures (decompositions) of the total system C. So a new rule in the universally valid quantum mechanics is established, the so-called quantum correlations relativity (QCR) [1,2]: The kind and amount