

Hallmarking quantum states: unified framework for coherence and correlations

Gian Luca Giorgi and Roberta Zambrini

Instituto de Física Interdisciplinar y Sistemas Complejos IFISC (UIB-CSIC), UIB Campus, E-07122 Palma de Mallorca, Spain

The superposition principle is one of the axioms and most distinctive features of quantum mechanics and it is responsible for the presence of coherence in quantum states. When it comes to multipartite scenarios, the superposition principle is still the ingredient that makes quantum states intimately different from classical states and allows them to show inner correlations beyond any classical probabilistic model. Despite the previous considerations and the evident common roots between the phenomena of coherence and distributed correlations, the quantification of the quantum character of a state normally follows separate paths. Here, we propose a measure which is able to quantify both the contribution derived by the tensor structure of the multipartite Hilbert space and the presence of coherence inside each of the subparties [1]. Within this unified framework, global coherence of the state is identified as the ingredient responsible for the presence of distributed quantum correlations, while local coherence also contributes to the quantumness of the state. Our framework also provides a simple physical interpretation, in terms of coherence, of the difference between total correlations and the sum of classical and quantum correlations obtained using relative-entropy-based quantifiers. A scheme of such a framework is given in Fig. 1.

[1] G. L. Giorgi and R. Zambrini, arXiv:1706.03625.

[2] K. Modi, T. Paterek, W. Son, V. Vedral, and M. Williamson, Phys. Rev. Lett. **104**, 080501 (2010).

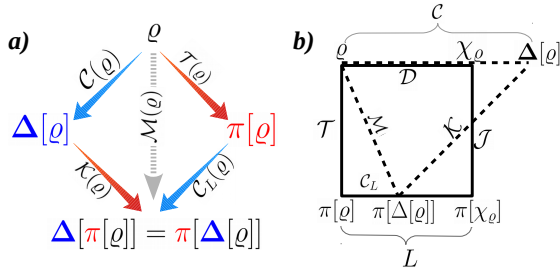


Figure 1: (a) The unified framework of coherence and correlations: from any initial state ρ , the closest useless state can be reached either by applying first the dephasing operation Δ (blue) and then the product operation π (red) or the other way around. Depending on the chosen path, the total hookup \mathcal{M} can be decomposed into the sum of the total mutual information and the local coherence or into the sum of the total coherence and the irreducible classical information. (b) Comparison between the correlation scheme of Ref. [2] (solid lines) and the unified framework of coherence and correlations (dashed lines). While the discord is a lower bound for the total coherence (that is, the distance between ρ and χ_ρ is always smaller than the one between ρ and $\Delta[\rho]$), \mathcal{K} can be longer or shorter than \mathcal{J} and \mathcal{C}_L can be longer or shorter than L .