

Quantum information and complexity*

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The notion of complexity is central in many branches of science. Common sense suggests what is simple and complex, nevertheless, formalizing this rather elusive notion is a daunting task. It is often assumed that complexity expresses the concomitance of a number of factors, including the presence and condition of numerous elements in a system and numerous forms of relationships among the elements. However, even single systems endowed with nonlinear features may display a complex behavior. Although there is no unique definition of the science of complexity, there is consensus on the general idea that complex behavior emerges from interaction, for example in a collection of interacting systems. The emergence of complexity is therefore an interesting problem in itself, and it is widely investigated nowadays.

The concept of complexity appears to be closely related to information (as a matter of fact, the seminal contributions to these areas come from the same author —W. Weaver— almost at the same time —1948-1949). On the one hand, both complexity and information are relative notions and can be traced back to the idea of “many possibilities” (and somehow “randomness”). On the other hand, complex systems are expected to have some information content, in contrast to purely disordered systems.

Recently, the advent of quantum information revolutionized classical information theory and introduced many novel concepts and tools that have impact potential also in the arena of complexity. The aim of this *Focus Point* is to present some cutting-edge results in the field of quantum information, that shed light on the science of complexity. The invited articles in this *Focus Point* cover a variety of topics, ranging from computational complexity to multipartite systems and networking, from single dynamical systems to thermodynamics, from algorithms to biological (living) systems.

The idea of publishing this *Focus Point* emerged during the conference *Noise, Information and Complexity at Quantum Scale* held at the Majorana Centre, Erice, Italy, in October 2013. We take here the opportunity to express our gratitude to the authors of the articles and the reviewers, for their efforts in ensuring the high quality of the work and its presentation.

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Guest Editors

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