Special Issue

Quantum Information: Fragility and the Challenges of Fault Tolerance

Message from the Guest Editors

The recent advances in scaling up quantum processors into the range of 50–100 qubits make quantum error correction (QEC) and fault tolerance urgent practical issues in order to achieve quantum advantage or even quantum supremacy. Interesting developments in regular QEC include new classes of codes, either in the qubit setting (topological, non-abelian, holographic...) or with continuous variables, such as Gottesman-Kitaev-Preskill (GKP) or cat-codes. However, universal fault-tolerant quantum computation based on QEC is not yet within reach. The near-term challenge is rather to make optimal use of available hardware and software resources. This requires developing useful characterization tools, typically involving the number, connectivity, and coherence of physical qubits, the available gate set, and the number of operations that can be run in parallel. On the software side, machine learning (ML) may be used for optimizing gate sequences, minimizing circuit depths, optimizing variational schemes. Other challenges involve new types of architectures, like dynamical complex systems based on (brain-inspired) adaptive quantum networks.

Guest Editors

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Deadline for manuscript submissions

closed (31 October 2019)

Entropy

an Open Access Journal by MDPI

Impact Factor 2.0
CiteScore 5.2
Indexed in PubMed

mdpi.com/si/18474

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