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Tensor networks @UniPd: simulating quantum many-body systems and beyond

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Recent breakthroughs in quantum simulation and computation are fostering new insights into exotic phenomena in quantum many-body systems, as well as motivating extensive research to develop novel experimental protocols to speed up the solution of classical optimization problems.

On the one hand, these advances call for state-of-the-art numerical techniques to test new protocols and benchmark experimental results. On the other, they have driven the development of classical, quantum-inspired techniques and new optimization algorithms for solving use-case problems.

In our group, we investigate quantum simulation and computation protocols that can be implemented on state-of-the-art experimental platforms, as well as quantum-inspired algorithms to solve optimization problems. We extensively develop and use algorithms based on tensor-network techniques, an extremely versatile tool to efficiently compress, store, and manipulate the information contained in quantum many-body states. In particular, our algorithms are based on Tree-Tensor-Networks (TTNs), an Ansatz suited for the study of high-dimensional systems.

In my talk, I will present results obtained with TTNs, ranging from quantum simulation and computation protocols for quantum-many-body systems to algorithms for the solution of optimization problems.

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