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Higher-Rank Gauge Theories - A quantum Monte-Carlo Study

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Condensed matter physics is the study of collective emergent states of matter. The field is enormously rich ranging over solid state physics including superconductivity and magnetism, quantum liquids, and topological states of matter.
Certain interacting quantum systems can be described at low energies in terms of emergent gauge theory.
Such effective theories can range from the familiar quantum electrodynamics to more exotic field theories that have no parallel in the theory of fundamental particles.
Recently, condensed matter theorists stumbled upon models harboring what are now called fracton phases. These quantum states of matter are characterized by the presence of "charges" that cannot propagate freely in the three dimensions of space but instead are restricted in some way. In trying to understand these phases better people realized that certain tensor gauge theories capture some features of fracton phases.
The principal goal of this project is to investigate the properties of tensor gauge theories coupled to matter including their phases and the nature of the excitations in these different phases.
Specific goals are: (i) obtain a discretized action of the tensor gauge theory; (ii) devise an effective algorithm to simulate the discretized theory with quantum Monte Carlo; (ii) implement large-scale simulations; (iii) study the phase diagram and the physical properties of the different phase.

Author: CRUZ, José Maria

Presenter: CRUZ, José Maria