# The QCD Abacus: A Cellular Automata Formulation for Continuous Gauge Symmetries

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**Abstract.** This talk will explain a new way to formulate statistical (or quantum field) theories entirely in terms discrete quantum spins. Remarkably even theories with continuous symmetries such as 3-d rotations can be exactly represented in such a discrete (or binary) "computational" framework. A new application of this idea to Quantum Chromodynamics (QCD), the fundamental gauge theory for nuclear forces, is presented. Here a classical theory with commuting (Bosonic) fields is replaced by anti-commuting (Fermionic) variables acting in an extra 5-th dimension. The effective Lagrangian for the path integral lives in $R^4$ X $S^1$ Euclidean manifold with a compact "fifth time" of circumference L and non-Abelian charge ($e^2$) both of which carry dimensions of length. For large (but finite) L, it is argued that continuum limit is reached and that the dimensionless ratio $g^2 = e^2/L$ becomes the QCD gauge coupling. This talk will emphasize general concepts and intuitive methods that hopefully can be applied to a wide class of quantum cellular automata and the general algebraic structure that can lead to fast cluster algorithms for Monte Carlo simulations.

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