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An Action Principle for Cellular Automata and the Linearity of Quantum Mechanics

We introduce an action principle for a class of integer valued cellular automata and obtain their Hamiltonian equations of motion. Employing sampling theory, these discrete deterministic equations are mapped invertibly on continuum equations for a network of interacting bandwidth limited harmonic oscillators, which encode the Schroedinger equation. Thus, the fundamental linearity of quantum mechanics — entailing, e.g., superposition principle and entanglement — is related to the action principle of such cellular automata and its symmetries derive from corresponding discrete ones. This holds irrespectively of particular models that may or may not incorporate interactions. It could have implications for the foundations of quantum mechanics, suggesting a different perspective on its primitive notions, and should be useful for simulations of quantum systems.

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