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**Computational Mechanics of Coherent Structures in Spatiotemporal Systems** ADAM RUPE, JAMES P. CRUTCHFIELD, UC Davis — The use of computer simulation and numerical solutions have become common for handling increasingly complex mathematical models of physical phenomena. This has been most successful in nonlinear systems where analytic solutions are scarce, as exemplified by the discovery of deterministic chaos. As attention moves to higher dimensional systems, gaining insight from numerical solutions is no longer trivial. In particular, systems in which simple interactions propagate in a complicated manner to produce complex emergent behavior present serious difficulties for traditional mathematical analysis. Such difficulties are similar to those faced in the theory of computation. Thus a new approach to complex systems, computational mechanics, has been developed that employs the mathematical structures of computation theory to build intrinsic representations of temporal behavior, rather than relying solely on the equations of motion. A rigorous theory of coherent structures in fully discrete classical field theories using computational mechanics is given. The method is demonstrated on the simplest such systems that support emergent structures, namely elementary cellular automata. Results are compared with a similar, but distinct, approach using invariant sets of dynamical systems theory.

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