Digital Physics

Physicists job is to understand the functioning of the universe.

Laws, such as Newton's or Maxwell's, vs. entities, such as mass, electrons, etc.

Newton's laws were right, his entities were wrong: point mass particles, infinite propagation speed forces.

Possible entities are principally limited by current mathematical technique.

The three principal entities in physics: partical, field, wave. Corresponding math: ordinary calculus; vector calculus; differential equations and transforms. Other examples: curved space -- Riemannian geometry and tensor calculus.

Digital physics is based on the mathematics of computation and information instead of the various branches of calculus.

Why would we want a different math for physics? QM is correct on an atomic scale, but as yet unproven on the scale of "fundamental particles". Many mysteries, things unexplained. But QM is so sucessful, its got to be right. This is a fundamental philisophical question on scientific method. Newtonian mechanics as counterexample. Math as "universal computer".

Basics of DP: Physical law specifies a computation, entities are information in the strict sense, data structures. The principal of finite information content. The abandonment of continuous variables.

Status of DP: Much interest, but no theories that could withstand experimental verification. Very refreshing, compelling way of thinking. New possibilities, such as roundoff error. Easier to understand: space, time, matter, the speed of light, the beginning. Harder to understand: inertia, relativity, isotropic.

The cellular automaton. Definition: space, matter, time, physical law. Nondeterministic CA. Reversible CA, the Garden of Eden theorem.

Some history of CA.

Life. The physics. The chemistry. Static forms, oscillators, motion.

Trying to explain classical mechanics with CA. Why? Hope that QM will fall out, but that's not likely. Easier to understand. World behaves classical on large scale. Fundamental difficulties need to be resolved.

The difficulties: uniform motion; relativity; isotropic properties; independence of coordinates.

Uniform motion. A solution in one dimension. Unary representations in CA. Interactions: fields, force, acceleration.

The 2-D problem. Binary wave mechanics. Curved space.

Size of quantum of space and time. The Plank length, time, and mass.