Diabologic: Physics, Math, & Information

by Frank Dolinar

Is the universe matter or energy? Particles or strings? According to physicist Vlatko Vedral's new book *Decoding Reality: The Universe as Quantum Information (2009*), it is made, at bottom, of information. (The fundamental reality of quantum foam?)

Years ago, in the mid-1970s, my friend Mike — a stereotypically off-the-wall thinker — said to me that he thought the only two disciplines that really had anything to say about how the universe worked were Information Theory and Quantum Mechanics – and he wasn't entirely sure about Quantum Mechanics.

It's a point of view that certainly got my attention, though I had no idea of how to reply.

Unknown to us at the time, theorist Frederick W. Kantor was writing *Information Mechanics*, a book in which he uses the fundamental theorems of information theory to (apparently) derive the basic results of relativity and quantum mechanics. He did indicate the work was preliminary and might not hold up to serious critiques, but he had the courage to publish it.

Anyone who has ever taken any course in physics at the university level knows how much of our understanding of the concepts rely on the underlying mathematics. The mathematics is initially relatively simple, but doesn't stay that way for very long, and rapidly becomes the scaffold upon which much of modern physics has been built.

Over the last couple of decades, a new theory has emerged which attempts to bridge the chasm between general relativity and quantum mechanics. This theory of everything is known by several names, but most commonly it is referred to as String Theory. The concepts of String Theory have been clearly discussed in physicist Brian Green's book *The Elegant Universe*.

Nobel Laureate Sheldon Glashow (Physics 1979), the Arthur G. B. Metcalf Professor of Physics at Boston University, doesn't consider String Theory to be physics. As far as he is concerned, physics is an experimental science and String Theory cannot (as yet) be tested by experiment, making it safe from being proven either true or false. Thus, according to Glashow, String Theory isn't physics and its mathematics, though beautiful, is equally incomprehensible.

Another way of looking at the universe is through the mechanism of cellular automata, a discrete, multi-state model, on a multi-dimensional grid of cells, with specific rules to determine the state (e.g. "On" vs. "Off") of each cell at each step in the execution of the model. A cellular automata model is an intricate version of Conway's Game of Life.

But if we now span the spectrum of discourse from the very complex mathematics of String Theory to the simple On/Off rules of Conway's Game of Life, where on this spectrum do we encounter a mathematics (aka "a descriptive language") that adequately describes the universe and how it works? How do we know?

This is one of those questions that the Large Hadron Collider (LHC) has been built for. If it finds experimental evidence that relates to String Theory, it will set new precedent. If it discovers the elusive Higgs particle, it will essentially prove beyond doubt the validity of the so-called Standard Model — from which we acquired the concept of the Big Bang origin of the universe.

Personally, I don't know what the LHC will find or if it will find anything.

The amount of physics data that will be generated by the LHC in the next few years is bound to be enormous. The theorists and experimenters will attempt to turn this into useful information.

As my friend Tom told me some years ago — in discussing a course in information theory — the fundamental idea of information theory can be paraphrased as "You can tell how much information you get in a message by how surprised you are."

Regardless of the answer, the universe continues to surprise us.