A NEW COSMOGONY

ON THE ORIGIN OF THE UNIVERSE

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ABSTRACT

Digital Mechanics is a model of physics based on the Finite Nature assumption; that at some scale, space and time and all other quantities of physics are discrete. In this paper we will assume that Finite Nature is true and we will explore the consequences with regard to the origin of the universe. Contemporary physics has a lot to say about models of the early universe; down to the first tiny fraction of a second after the Big Bang. Digital Mechanics can tell us a lot about what might have occurred before the Big Bang. This paper will attempt to lead the reader down a connected path of consequences that all follow from the single assumption; Finite Nature.

Introduction

The greatest mystery is "Why is there anything at all?" This mystery is tied to the great cosmogonical question, "Where did the Universe come from?" These questions raise one's curiosity about other things such as "If the Universe came from something such as being made by a creator, then where is that creator? What are things like where the creator is or was? How did that place come into being?" and on and on. These are subjects that have been dealt with in mythology and religion. We presume to use science to look for plausible answers to these questions. If we assume that Finite Nature is true, we discover that surprising progress can be made in looking beyond our own world.

Finite Nature is the hypothesis that ultimately every quantity of physics, including space and time, will turn out to be discrete and finite; that the amount of information in any small volume of space-time will be finite and equal to one of a small number of possibilities. We call models of physics that assume Finite Nature "Digital Mechanics". The Finite Nature hypothesis makes no assumption about the scale of the quantization of space and time. Digital Mechanics is too immature a concept to say more about the scale of length other than it is probably between a Fermi, 10^{-13}cm, and Planck's length, $1.6 \mathrm{x} 10^{-33}$cm.

Today we simply do not know whether or not Finite Nature is true or false. Nearly every scientist in the world today believes that there is insufficient experimental evidence in hand to decide the issue in favor of Finite Nature. The author, on the other hand, has managed to convince himself that the odds are greatly in favor of the Finite Nature Hypothesis. What has been decided up to now is that many things of our world that were once thought of as possibly continuous are now known to be discrete. The most famous is the *atomic hypothesis*. Dalton wrote his papers in the early 19th century but as recently as 1900, a famous physicist (Ernst Mach) said that while there was evidence for the atomic theory, since no one had seen an atom and since no would ever see an atom, he was not convinced that the atomic theory was true. Times have changed and now we can see atoms with the scanning tunneling microscope. Now, we all ardently believe in the atomic theory.

The next to fall into the realm of the discrete was electricity. Originally thought of as a fluid, Thompson discovered the electron in 18xx and with it came the discovery that charge was a discrete or quantized phenomena. Einstein proposed that Planck's quanta of action could determine the relation between the energy and frequency of particles of light, which he called photons. Planck thought that Einstein was a very smart person in spite of Einstein's belief that light was made up of discrete particles! Today we all believe that photons are real and that light, electro-magnetic and other kinds of forces are made up of discrete particles.

As the consequences of the Quantum Theory became better understood, it became clear that the angular momentum of particles can only exist in multiples of $\pm {}^{1}\!/_{2}$ units of spin. This has the amazing consequence that a flywheel cannot have a continuous range of angular momentum, rather it must only have multiples of $\pm {}^{1}\!/_{2}\, \mathrm{H}$. Angular momentum is now known to be discrete. The story goes on with phonons and vibrons as quantized units of sound and other forms of energy.

So far, there is no convincing experimental evidence and no convincing argument based on experimental evidence that points to any quantity of physics as definitely continuous. What we can often say is "If it is discrete, then the quantization must take place below some level." It is difficult to even propose a test that could verify that some quantity of physics was indeed continuous.

Since we know of no verified continuous quantity in physics, and since there has been a steady historical progression of finding that more and more of the fundamental quantities of physics are discrete, it is perfectly reasonable to assume the possibility that all quantities of physics will prove to be discrete. What we shall reveal is the amazing consequences of such an assumption; consequences that are independent of the scale of the quantization!

"Finite Nature" is the name of the hypothesis that everything is, in the final analysis, discrete and finite. Finite Nature would mean that space and time, momentum and energy, position, velocity and acceleration and, of course, everything else is discrete. Finite Nature also rules out truly random numbers that do not depend on anything else for their values. The rest of this paper follows the consequences of assuming Finite Nature is the true picture of the world.

In this paper, we take the position that Finite Nature implies that the basic substrate of physics operates in a manner similar to the workings of certain specialized computers called Cellular Automata. This means that a volume of space has a certain amount of computational capability. If Finite Nature is true, then it seems necessary to assume that infinite computational resources are required to model physics exactly. Conversely it is reasonable to equate the order of computational power of any system with the order of computational power necessary to exactly model that system. That would mean that, if Finite Nature is false, then any volume of space time, no matter how small, would represent an infinite capacity for computation. The author believes that computational capability is a quantitative resource, like area, or energy. It should be possible to relate the physical units of computation to ordinary physical units (eg Mass, Length, Time...). This would make it untenable for a finite volume of space time to require an infinite amount of computation in order to model it exactly.

In this paper we will be working with large finite numbers, but any kind of infinity dwarfs them all. It is very hard to imagine what the purpose or necessity could be for any sort of infinity, since very simple to express finite resources can clearly dwarf the needs of a universe like the one we live in.

The Assumption: Finite Nature is True

If we could look into a tiny region of space with a magic microscope, so that we could see what was there at the very bottom of the scale of length, we would find something like a seething bed of random appearing activity. Space would be divided into cells and at each instant of time each cell would be in one of a few states. A snapshot would reveal patterns of two (or three or four or some other small integer) kinds of distinguishable states. It would be either pluses and minuses, blacks and whites, seven shades of gray, ups and downs, pluses and neutrals and minuses, clockwises and anticlockwises or whatever. The point is that it would be equivalent to digits. If every cell was either a black or a white, then we could rename them "1" and "0" or "+" and "-". It wouldn't matter.

What we would discover is that there is a rule that governs the behavior of the cells. It is logical to suspect that the state of each cell is some kind of function of a neighborhood; for each cell, a set of neighbor cells with some particular spatial relationship to the cell. We don't yet know what the rule is, or even the exact nature of the rule, but we know many kind of rules it could be. The fact that each cell is like a digit and that the overall behavior is a consequence of a rule where the next state of each cell depends on some function of the neighborhood cells means that the underlying mechanism must be some kind of cellular automata.

Comparing Ordinary Computers and Cellular Automata

Ordinary computers, such as an IBM PC can do several Million Instructions Per Second (MIPS) and typically have several million bytes of Random Access Memory (RAM). We normally think of a computer as a system that has two distinct kinds of resources; memory and processor. However, but are implemented on silicon, so it might make sense to think in terms of the square area of silicon, which could be memory or processor. In that sense, an up-to-date processor (1992) might be equivalent to 8 megabytes of RAM, since both are currently implemented on one big silicon chip.

We can equate a cell on an integrated circuit chip (a cell containing enough area to implement a bit of memory or a Boolean logic function), with a cell of a Cellular Automata. One cell of a CA can do a bit of logic or serve as the memory for a bit of information. If we equate one cell of a CA with one bit of ordinary computer memory we are on solid ground; however a large CA is very normally much more powerful then the typical computer system with the same total area of silicon because of the total parallelism inherent in the CA. Cellular automata and ordinary computers are quite different, but it is possible to give an approximate measure of the performance of a cellular automata in the same units as ordinary computers. The scarce resource is area on silicon, (or its equivalent), so we assume that a cellular automata and a computer are of approximately the same power when they both require the same area of silicon to implement.

We will define a unit of computational resources, the *Comp* as one bit of state with associated logic (as might be found between cells in a CA). Given a CA, with n 2 state cells, then a *Comp* would be a bit of state and 1/nth of all of the logic. In a 3-D CA, a *Comp* would be a bit of state along with 3 times the logic devoted to the interaction between a cell and its neighbor. The *Comp* is also appropriate as a unit of memory. One *Comp* is equivalent to one bit of memory. The additional logic associated with a *Comp* may be thought of as the logic that allows acces or communication to and from the memory bit. A *CPS* or *Comp per second* corresponds to a rate of computation.

Without going into technical detail, we will assume that 10^6 CA cells is about the same as a complex microchip of today in terms of computational-memory power. This means that a mega*Comp*/microsecond (or 10^{12} *CPS*) would roughly correspond to one MIPS or one MegaFLOP (one MIPS is one Million Instructions Per Second, a MegaFLOP is one Million Floating point Operations Per Second). To give an idea of the degree of approximation involved, an ordinary microchip might need about 10,000 computational steps to do what megaComp CA would do in one step, and a megaComp CA would need about 10,000 steps to do what the ordinary computer would do in one step.

If we assume the Digital Physics model, then we can come up with the computing power of space, given just one parameter, s, the cell to cell distance. If we assume that the time to do one step is approximately s/c (where c is the speed of light, 3×10^{10}cm/sec) then the computing power of the Digital Mechanics Cellular Automaton substrate, per cubic centimeter of space, is given by the formula $\frac{CPS}{cm^3} = \frac{c}{s^4} = \frac{3 \bullet 10^{10}\, cm/\sec}{s^4 cm^4}$ The result is in units of *CPS* per cubic centimeter. If the DM CA is down at a fermi (10^{-13} cm) then a cubic centimeter of space represents 3×10^{58} CPS. If the DM CA is down at Planck's distance, 1.6×10^{-33}cm, then a cubic centimeter of space represents 4.6×10^{141} CPS.

Memory is easy to compare when thinking about the amount of memory. A few CA cells are equivalent to one bit of RAM (computer memory). RAM, on the other hand has the strange property that the access time is independent of the distance (every access is as slow as the furthest access).

Human Memory and Intelligence

If and when we are able to make computer systems that have the intelligence and memory of humans, it is quite conservative to estimate that the amount of computation needed will be less than 1,000,000 MIPS (one MIPS is one Million Instructions Per Second. 1,000,000 MIPS is 10^{12} instructions per second). The amount of memory needed will be about 10^{11} bytes. To put that in perspective, we will assume that a blind, very intelligent young man received his education by being talked to at an average rate of 200 words a minute for 12 hours per day, for 20 years. The average word is worth about 16 bits for which word it is and about 16 bits for intonation, context and other non-verbal cues; 4 bytes per word.

$$20 yrs \bullet 365 days \bullet 12 hrs/day \bullet 3600 secs/hr \approx 3 \bullet 10^8 seconds.$$

$$\frac{180 words/\min \bullet 4 bytes/word}{60 \sec/\min} = 12 bytes/\sec$$

$$12 bytes/\sec \bullet 3 \bullet 10^8 secs = 3.6 \bullet 10^9 bytes.$$

We will multiply this number by three to take into account other sensory inputs plus the amount of information one is born with. We then multiply by an additional factor of ten to take into account the amount of information generated and retained as a result of mentally processing the input information. This analysis concludes that the amount of memory required for the operation of the mind of an educated blind man is about 10^{11} bytes. I doubt that the number is much different for a sighted person, but the justification of that statement is best left for a different paper. Having an exact number doesn't matter for the following discussion, but having an approximate number will be useful. If one silicon chip holds 8×10^6 bytes, then the memory required for an educated blind man would take $10^{11}/8 \times 10^6$ or 12,500 chips. The silicon needed for processing the thinking of a human mind, 10^{12} instructions per second will need another 7,500 chips for a total of 20,000 chips. This is the same as about 1.6×10^{11} cells of a CA. The speed of the CA can be made comparable by assuming that one step (or cycle) of the CA is equivalent to one instruction in a processor. Communication issues would argue that maybe there thousands of steps of the CA are needed to match one instruction in a general purpose computer, but the parallelism of the CA argues that one cycle time of a large CA (more than 10^{10} cells) is the equivalent of thousands of instructions of a general purpose computer. There is no simple and exact comparison possible, but what we are doing still leads to interesting results. Of course, it may seem extravagant from an engineering point of view to have all of memory in silicon, but we do it here to keep things comparable with the cellular automata paradigm.

A Human Lifetime of Thinking

Taking a normal life to be 3 score and ten of 70 years, and assuming that thinking is done continuously at the equivalent of 10^{12} instructions per second, we have $70 \bullet 365 \bullet 24 \bullet 3600 \bullet 10^{12} = 2.2 \bullet 10^{21}$ instructions per lifetime. The net result is that our overly conservative calculation says that a Cellular Automata that has 1.6×10^{11} cells that runs for 2.2×10^{21} steps has greater computing power that is expended by a human who thinks at top speed every moment of his life. In cell-cycles, its just the product of the number of steps and the number of cells, 1.6×10^{11} cells times 2.2×10^{21} steps gives 3.5×10^{32} cell-cycle per lifetime of intense human thought. Given a 3-D CA, it might be a cube with about 5,000 cells along an edge. At 10^{12} steps per second, it would take 5 to 15 nanoseconds for the longest communications path, depending on the nature of the CA rule. While it is somewhat difficult to compare the capabilities of vastly different computer architectures, it is very easy to compare one CA with another. If FN is true, then at the bottom is a CA, and we will be able to compare the computational power of a volume of space with the power of ordinary computers and with the power of human thinking.

A Fundamental Particle

Let us consider a simple fundamental particle such as an electron. An electron is completely characterized by a small number of facts. First, there are the facts that are true of all electrons, their mass and charge; First of all, second is where it is and where its going (position and velocity; $x, y, z, \dot{x}, \dot{y}, \dot{z} x, y, z, \dot{x}, \dot{y}, \dot{z}$). Finally, there is its internal state, limited to one bit of spin information. As far as we know, an electron is quite simple, without any apparent substructure. Its size is difficult to pin down, but if we say its radius is in the region of a Fermi (10^{-13}cm), we will not be too far off. Now, let us use our formula to calculate the computational power of a volume of empty space equal to the volume of an electron, $\frac{4}{3}\pi r^3 = 4 \bullet 10^{-39} cm^3 \frac{4}{3}\pi r^3 = 4 \bullet 10^{-39} cm^3$. The number of cell-cycles per second for that volume is $4.6 \bullet 10^{141} \bullet 4 \bullet 10^{-39} = 1.8 \bullet 10^{103}$. To put things into perspective, let's divide that number by the number of cell cycles per lifetime of human thought, $1.8\text{x}10^{103}/3.5\text{x}10^{32}=5.2\text{x}10^{70}$. Imagine a five trillion ($5\text{x}10^{12}$) galaxies, each with a trillion planets, each with a population of trillion people, and all that for a trillion generations. That's a total of 10^{48} people. It would take the computational power of one electron just 10^{-22} seconds (one tenth of a billionth of a trillionth of a second) to do the same amount of thinking (or computation).

Digital Mechanics

It seems logical to assume that the cell to cell distance of the Ultimate Cellular Automata is somewhere between 1 Fermi (10^{-13}cm) and Planck's Distance $1.6\text{x}10^{-33}$cm. A Fermi is a convenient measure of length because about the size of a fundamental particle. We have good evidence from high energy physics that events take place at a scale several orders of magnitude smaller than a Fermi, but the Fermi is still a good upper bound because of the possibility that a Universal Cellular Automata can emulate a system where events are accurately calculated at scales far below the cell to cell distance. Planck's Distance is derived by dimensional analysis, using the gravitational constant, G, Planck's constant, $\hbar$, and the speed of light, c; $\sqrt{(\hbar G / c^3)}$ $=1.6\text{x}10^{-33}$cm. Planck's Distance is thought to have significance for physics in the realm where Quantum Mechanics and Gravity (general relativity) come together. What we are interested in exploring is the computational significance of the cell to cell distance. Given an assumption of the scale of the granularity of space we will be able to relate the computational potential of a volume of space with concepts we are used to; ordinary computers and human intelligence. The outcome is surprising. We will start by assuming that the scale of length is equal to Planck's distance, $1.6\text{x}10^{-33}$cm.

The meaning of the digits in Finite Nature is that the information process that the digits and cells are engaged in define the space and time and matter and energy of our world. It is important to understand that while the cellular space may normally resemble the space of physics, the two kinds of space would become very different under certain conditions such as near a black hole. The same is true for the passage of time. An ordinary clock might, if unaccelerated and far from a strong gravitational field, keep reasonable time with respect to the goings on in the cells, However, strong gravitational fields or velocities near the speed of light would cause an ordinary clock to slow down with respect to the events in the cellular space.

Now to the big question, "How did the Universe get started?"

This is the greatest of puzzles because it seems impossible to find an answer. We are not asking "Did the Big Bang Happen?" but rather "What caused the creation of this Universe?" The question seems at odds with both science and common sense. Common sense tells us that something can't come from nothing. Science proclaims that the quantity of Mass-Energy is conserved or always the same and unchanging. Science has a fancy way of saying the same thing as common sense. Common sense says that the story of the Universe has to have a beginning. Science says that the Universe started with the Big Bang. Once again Science and common sense agree. Common sense tells us that there is something here; "Cogito ergo sum". Science estimates the mass of the universe as something like 10^{xx} (1 followed by xx zeroes) tons of stuff, which is a lot more than nothing. So far science and common sense are in complete agreement. The rub is: if the universe had a beginning then before the beginning the universe wasn't here; the universe can't come from nothing and yet the universe is here.

It just doesn't hang together. Either we have to believe the universe has been here forever or some kind of magic took place in the beginning. In a sense, physics lets us down when we try to peer at what was it that created the Universe so that the Big Bang could happen. Nevertheless, Finite Nature gives us a way to look beyond the Big Bang. It gives us the possibility of thinking about how the universe got here and even about why the universe is here.

The answer lies in the amazing consequence of the simple assumption of Finite Nature. As we have explained, Finite Nature means that what underlies physics is essentially a computer. Not the kind of computer that students use to do their homework on, but a close cousin; a cellular automata. We don't know the details of that computer, but that doesn't matter because a machine invented by a great and tragic British mathematician, Alan Turing proves we don't need to know the details!

What Alan Turing did in 193X was to invent the Turing Machine. It was a way to formalize all the things that a mathematician could do with pencil and paper. The result proves that any ordinary computer, given the proper program and enough memory, can do what any other computer can do. It can also do what any mathematician can do; if we only knew how to write the program! Finite Nature implies that the process underlying physics is a kind of computer, therefore it is subject to Turing's proof. This means that there is not just one kind of underlying computer, but there are an infinite number of possible equivalent computers. Of course some are simpler, some are more elegant, some use the least amount of various resources, some are faster... This means that once we have figured out that it's a computer at the bottom, we already know a lot even before we know exactly what kind of computer would, by some criteria, be most efficient at the task.

Where is the Ultimate Computer?

When my son Richard was a precocious 7 year old, we were walking back to our car from an outing in Rockport, Mass. We had parked some blocks away and suddenly we were uncertain as to where the car was. Richard volunteered "I know exactly where the car is!" I was surprised and impressed, "Where is it?" I asked. "The car is in the universe." he answered. As to where the Ultimate Computer is, we can give an equally precise answer; it is not in the universe -- it is in an *other* place. If space and time and matter and energy are all a consequence of the informational process running on the Ultimate Computer then everything in our universe is represented by that informational process. The place where the computer is, the one that runs that process, we choose to call "*Other*".

What Can We Know About the *Other* Place?

Surprisingly there is a great deal that we can deduce about the probable characteristics of *Other*. This can be done by a number of different approaches.

1. We must inquire about possible reasons for the existence of this universe; is it to serve a purpose or is it perhaps an artifact of some larger process?
2. We need to look at the resources that are required to compute this universe, as a measure of available resource in *Other*.
3. We can consider the laws of physics in this universe and the implications on *Other*.
4. We need to consider the grand design of this universe in the context of alternative universes. By means of these considerations, we will explore the Other.

Is There a Reason for the Creation of the Universe?

The first consideration is really a branch point where we must explore both branches. If the universe serves a purpose does that mean that there is an intelligent creator? First of all, we must get used to the idea that in this context, human-like intelligence is not relevant. Humans are the prototype thinking creatures on this planet. As such, our brains are very close in design and capability to the brains of other primates such as chimpanzees or gorillas. This is not meant to be demeaning to humans but simple a statement of the relative position of human intelligence; what else would it be close to? As the prototype thinking creatures we do our intellectual work with mechanisms that are really designed (by evolution) for other tasks. We haven't had scientists around long enough for brains to have evolved that are better at doing science; besides, what is the selection process? We can already see the possibilities of artificial intelligence appearing on earth that totally dwarfs human intelligence in every objective measure of capability.

We can imagine a cubic meter of computer that contains 10^{25} computing-memory elements, operating at cycle times of 10^{12} per second. One such machine could out-compute the combined powers of all of the computers built so far added to the combined thinking powers of all of the people who have ever lived.

This shouldn't frighten us, since no such machine will be better at being human that we are, it will just out-think us. Today we have machines that exceed humans in every physical measure; they are faster, more accurate, stronger, can fly, sail across oceans, explore the surface of Venus, look into distant galaxies, peer at atoms, etc. We are not intimidated by the physical prowess of machines, and we still engage in human sporting events, such as the marathon despite the fact that a motorcycle could do so much better. Similarly we shouldn't worry about machines doing arithmetic billions of times faster than humans, and eventually doing every kind of intellectual activity faster and more accurately than humans. Such machines will be no better at being human that a human can be better at being a mouse. Mice would rather live, work and play in the company of other mice even if offered the chance to substitute human companionship for mice. Ask any laboratory mouse.

The point is that machines (with Artificial Intelligence or AI) that we may build in the future will be qualitatively different in intellectual capability than are humans. We can't speak of AI as "intelligent" in human terms. Something that may have created our universe in a purposeful fashion is very different than something with human-like intelligence or the kind of intelligence we will see in Earthbound AI. There might be no more in common than the concept of questions and the concept of finding answers.

When primitive man gained control over fire, it was a great step. However, the universe is full of fire; consider the stars. Because we can think, and nothing else on our planet seems to be able to do so, it is natural for us to hold our intellectual prowess in great esteem. However, it may be that information processing, instead of being the sole province of us humans and our machines, may be a part of almost everything else in physics. Life itself, is clearly mediated by digital information; the genetic code. Digital Mechanics assumes that physics is also a process based on informational processes. We may need to rid ourselves of the prejudice that purposeful, thought related action is exclusively the domain of humans or perhaps aliens similar to humans. There are kinds of thinking that are qualitatively unimaginable to us though we can think about it quantitatively. We should not be afraid to consider intellectual activity as the driving force behind the creation of the universe. By a close and quantitative examination of the possible parameters of Digital Mechanics, we can arrive at reasonable guesses as to what might be the purpose behind the creation of a universe like ours. That, in turn, can lead us towards intelligent speculations about *Other*, the space that contains the engine of our world.

If we assume that the Ultimate Computer was purposefully constructed in order to find an answer, we still have the possibilities that:

1. What we see as our Universe might be working towards that answer.
2. The Universe we know, in its entirety, might be an artifact.

In either case, our existence here on Earth might or might not be completely incidental to the purpose.

If the Universe was designed and constructed by some *creator* to answer a question this poses another question. "If he was so smart and capable as to be able to create our Universe, why didn't he just think about it and figure out the answer in his head?" (Please pardon the anthropomorphic allusions.) One of the interesting results of computer science, that transcends the laws of physics, is that a result that is obtained by running a computer for a certain number of steps, cannot in general be obtained by some shortcut. This is a consequence of the famous halting problem first posed by Alan Turing. The name "halting problem" comes from the old idea that a computer at work should halt when it gets the answer. The question is, can some other computer look at what the first computer is trying to do and figure out a way to get the answer in fewer steps? Of course, if the first computer is inefficiently implemented, then some more efficient computer could speed things up. If the program is coded so that it runs inefficiently, then reprogramming it could speed things up. However, there is no way, in general to take programs and to reprogram them so that they now run faster. This limitation known as the Speed Up Theorem.

What the Speed Up Theorem tells us is that if Finite Nature is true, and if the *creator* of the Universe was competent, then there is no way for the creator to get the *answer* any faster than by letting things (the universe) run their course. As to the question "Why didn't the *creator* just do it in his head?" The answer is quite straight forward: Doing it on a computer is exactly the same thing as doing it in one's head. Both are examples of using an informational process to get to the answer. We are not referring to the creator's finding an analytical solution in his head (the speedup theorem forbids such solutions) but rather to his imagining each step of some cellular automata in his head. A common fable is that maybe God is dreaming all this, and we are characters in that dream. Maybe we should be careful not to do anything that might wake him up!

There are many different ways to run a particular computer program; where the state of some simulated system evolves. These different ways can be absolutely isomorphic to each other so that the informational result is exactly the same.

Arguments as to why what we know so far does not justify the existence of the Universe; especially if things are only quantized at Planck's Length.

The enormous computational capability of space-time is totally squandered by what we see and know. If we assume that the radius of the Universe is 20 billion light years, then the number of cells (at Planck's Distance) is about 10^{184}. For example, insofar as the computational model, almost nothing is being done. Most of space is empty, except for a little radiation (photons) passing by. Of the space that is not empty, such as the space occupied by an atom, well the normal atom is also mostly nothing. Even the fundamental particles such as the electrons, and the quarks that make up other particles are mostly nothing. (figure the number of Planck Length cells per atom, per proton, etc. Compare that with a super computer that might be asked to simulate it. The volume of a proton is about

What all of this means is one of at least two things: Everything we know so far is totally incidental to the purpose of the Universe, or, the entire Universe is incidental to some much larger problem. Let us imagine a really big machine, with at least 10^{184} cells, busy at work on some really big problem. And one cell goes awry causing the big bang. As soon as those who are in charge notice, they will clear out all this noise we call the Universe and start the real problem over again.

There are many other ways in which what we think of as the Universe may be totally incidental to the main purpose. For example, if the unit of length is at Planck's length, 1.6x10-33cm, then the computational power of one cubic Fermi of space is xxxxx.

Description of a Black Hole (no hair!)

The unit of length is most likely between a Fermi and Planck's Length.

From the computational viewpoint and considering what we now know about physics, a CA at a fermi squanders computational power while a CA at Planck's Length squanders resources at a rate 10

notes:

1. Estimate the informational cost to simulate one person and all he observes.

2. As far as we are concerned (in the course of human events) simulation down at one Fermi (cells 1 Fermi apart) is more than good enough. Of course if you're a physicist, playing at LEP or Fermilab, then the scale goes way down!

3. Simulate the human and what the human observes.

4. Construct tables of numerical facts assuming Planck's Distance, Fermi, or something reasonable!